The role of Test Anxiety, Attachment Style and Gender on Math Performance

Demi Mares

ANR: 732782

SNR: 2043924

Eerste beoordelaar: T. M. J. Schleepen

Tweede beoordelaar: L. van Doeselaar

Major Ontwikkelingspsychologie en Levenslooppsychologie

Tilburg School of Social and Behavioral Sciences

Tilburg University

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Summary

Math is an important subject in elementary school, because individuals come in contact with math every day. Children's math skills are tested with different tests in elementary school, which can cause anxiety feelings, also defined as test anxiety. This study investigates the relationship between test anxiety and math performance and possible moderating role of attachment style and gender in this relation. In total 70 participants (37 boys and 33 girls), with a mean age of 8 years and 7 months, performed the Tempo Test Arithmetic (TTA), Attachment Security Scale (ASS) and Children's Test Attitude Scale (CTAS). A negative relationship was expected between test anxiety and math performance, but correlation analysis did not confirm this. In addition, it was expected that attachment style and gender are moderators in the relationship between test anxiety and math performance. Moderation analyses showed non-significant moderation effects of these results. More research needs to be conducted to see what factors influence the relationship between test anxiety and math performance in children and how this relationship develops. With this information, children can receive better help from teachers to increase math skills and achieve good grades.

Keywords: test anxiety, math performance, attachment style, gender, elementary school, correlation, moderator

The role of Test Anxiety, Attachment Style and Gender on Math Performance

Almost everyone will remember how the teacher in elementary school taught you how to count, how to add numbers, subtract, multiply and divide. Not only in elementary school math was an important subject, but also in high school. Math in high school became much more complex and the skills that were learned in elementary school were present in every calculation. Math is not just important in school, but also in the world outside school. The world we are living in nowadays (Ashcraft & Crause, 2007) increasingly rely on math, science and technology (Simpkins et al., 2006). Every day, individuals come in contact with math, for example when paying groceries. To deal with these requirements, math skills are learned at a young age. Math achievement at school predicts math achievement and reading abilities later in life (Gunderson et al., 2018). An explanation for this is that harder concepts are based on the basic concepts. So, children who struggle to understand the basics, will have difficulty learning these harder concepts (Gunderson et al., 2018). Studies have shown that several factors influence math performance, such as test anxiety. This anxiety feeling is caused by tests (Zeidner, 1998, pp. 17). High levels of test anxiety are negatively correlated with test achievement (McCarthy & Goffin, 2005) and there could be a gender effect, because more girls than boys experience test anxiety (Cassady & Johnson, 2002). Another factor that may be important for anxiety and performance is attachment style. Individuals who are insecurely attached to their caregivers are more likely to develop anxiety symptoms (Dan et al., 2013). These individuals tend to focus on their own distress and ruminate on negative thoughts (Dan et al., 2013). Yet, it is unknown if children who are insecurely attached are more likely to develop test anxiety and if this influences math performance. This study focuses on the relationship between test anxiety and math performance and the possible moderating role of attachment style and gender.

As described before, tests are common in the world we are living in, so our society can be described as test oriented (Zeidner, 1998, pp.4). In education, testing is used as a tool to help make decisions about students and everyone will encounter tests at some point in life. A test is an assessment method that provides objective information that affects choices in the process of selection. Test anxiety refers to the set of physiological, phenomenological, psychological and behavioral responses that accompany concern about a negative consequence, an evaluative situation or failure on a test. Individuals with test anxiety view tests and evaluative situations as threatening. As a result of this, individuals will react with intense emotional reactions, threat perceptions, reduced feelings of self-efficacy and they experience high levels of arousal when they think they are failing (Zeidner, 1998, pp. 18). Feelings of extreme test anxiety can lead in some cases to dropping out of school, withdraw from classes and in college, students will select courses in which there is less evaluation (Jones & Petruzzi, 1995). Putwain and Daly (2014) found in a sample of English students that 16,4% of the students reported themselves to be highly test anxious. Because of the chance of dropping out of school, highly test anxious individuals could be underrepresented in studies (McDonald, 2001).

Test anxiety not only leads to withdraw from classes, but it also has a weak negative relationship with test performance according to McCarthy and Goffin (2005). Meaning that if an individual experiences more test anxiety, he or she will perform lower on tests. Kurosawa and Harackiewicz (1995) found results that are in line with the results of McCarthy and Goffin (2005), college students and adults who are test anxious perform more poorly under stressful and evaluative situations than low test anxious individuals. So far, it is unknown if this relationship is also present when children with high levels of test anxiety perform a math test. Therefore, this study investigates the relationship between test anxiety and math performance in 7-10-year-old children.

Next to test anxiety, attachment may have an influence on math performance. Bowlby was the first one who conceptualized the attachment theory (Levy et al., 2010). Attachment is a person's way of relating in an intimate, caregiving and receiving relationship with an attachment figure (Levy et al., 2010), it also contains the availability and confidence that the attachment figure can be used as a secure base (Bowlby, 1974). The attachment figure often is one's parents or caregivers or romantic partner (Erozkan, 2009). Bowlby found two types of attachment: secure and insecure (Erozkan, 2009). Securely attached children perceive their caregiver as available, caring and responsive to their actions and needs. Because of this, the child will be less prone to develop feelings of fear and anxiety (Bowlby, 1973). In contrast, insecurely attached children cannot rely on the availability, caring and responsiveness of their caregiver. This uncertainty could increase the fear response when the child experiences an alarming situation or distress (Bowlby, 1973) and could make the child more prone to develop anxiety (Muris et al., 2000). In reaction to the attachment theory of Bowlby (Levy et al., 2010), Ainsworth, Blehar, Waters and Wall (2015) investigated the attachment of infants with the Strange Situation Test. Ainsworth and colleagues (2015) found three styles of attachment: secure, avoidant and anxious-resistant (ambivalent). However, current study only focuses on the secure and insecure attachment style from Bowlby. Although scarce, Dan et al. (2013) investigated the relationship between attachment style and anxiety in children. They found that insecurely attached adolescents report more test anxiety than securely attached adolescents, it is unknown if this is also present in children (Dan et al., 2013). In addition, Dobbs and colleagues (2006) found that a more secure attachment is related to better math skills and performance. In line with these results, Moss and St-Laurent (2001) found that securely attached children had higher scores on performance related measures like cognitive engagement and exploratory behavior. Yet, it is unknown if attachment style has a moderating role in the relationship between test anxiety and math performance, meaning that the

relationship between test anxiety and math performance is different for a secure attachment and an insecure attachment. Current study investigates this possible moderating role of attachment style.

Another possible moderator in the relationship between test anxiety and math performance could be gender. Putwain & Daly (2014) found that more girls experience test anxiety than boys, girls also reported higher levels of test anxiety in the emotional component and in the cognitive component (Cassady & Johnson, 2002). In addition, Cassady & Johnson (2002) found that girls rate evaluative situations as more threatening than boys. Putwain & Daly (2014) also found gender differences in test anxiety. Girls and boys differ in the worry and tension components of test anxiety, this could explain the difference between boys and girls (Chapell et al., 2005). Several studies found that this gender difference already starts in elementary school (Chapell et al., 2005). Because of the fact that several studies found differences in test anxiety between boys and girls, current study investigates the possible moderating role of gender, meaning that the relationship between test anxiety and math performance is different for boys and girls.

The research question of this study is: What is the relationship between test anxiety and math performance in 7-10-year-old children, and are attachment style and gender possible moderators in this relationship? First, it is expected that there will be a negative relationship between test anxiety and math performance (hypothesis 1). Meaning that, when a child experience high levels of test anxiety, he or she will score lower on math performance. Second, it is expected that attachment style is a moderator in the relationship between test anxiety and math performance. Meaning that this relationship is stronger for children who are insecurely attached. The last hypothesis assumes that gender will be a moderator in the relationship between test anxiety and math performance (hypothesis 3), meaning that this relationship is stronger for girls than for boys.

Method

Participants

In this study, participants were 78 children attending the third grade of elementary school. However, seven children did not fill in all the items of the Attachment Security Scale (ASS) or did not fill them in correctly and one child did not fill in all the pages of the Children's Test Attitude Scale (CTAS). Complete data was therefore only available for 70 children (mean age is 8 years and 7 months, $SD = 0.602$; age range 7-10 years). Of these 70 children, 37 children were boys and 33 children were girls. The native language of the children was Dutch and they were recruited from 5 elementary schools in the southern part of the Netherlands (Limburg). Furthermore, these children were not diagnosed with developmental disorders according to their teacher. Parental consents were obtained from all the participating children. The study was approved by the ethical committee at the Faculty of Psychology and Neuroscience at Maastricht University.

Procedure

This study is part of a larger project, in which several tests were administered to the participants and was conducted in March and April 2016. At first, the children received an information letter and after this, parental consents were obtained. After these were signed and collected, the participants were asked to fill in some demographic questions about age and gender and the children performed several tests. Mathematical performance was measured with the Tempo Test Arithmetic, level of test anxiety was measured with the Dutch translation of the Children's Test Attitude Scale (CTAS) and attachment security was measured with the Attachment Security Scale (ASS). The participants read and made these tests individually in a silent room. To be sure that the children were not distracted by noise, they wore headphones. At the end, the children were rewarded with a small present to thank them for their participation.

Measures

Attachment Security Scale The Attachment Security Scale (ASS) is a self-report questionnaire that measures the perception of the attachment security in the parent-child relationship in middle childhood and early adolescence (Granot & Mayseless, 2001). In this study, the Dutch translation of the Attachment Security Scale was used. The items measure the degree to which children believe that the attachment figure is available and responsive, the tendency to which they can rely on the attachment figure when the child experiences stress and the interest in communicating with the attachment figure. The ASS consists of 15 items. The format of the items is: "Some kids … other kids …". The child has to choose which statement is more a characteristic of them and after that the child has to rate if the statement is really true for them or sort of true for them on a 4-point scale (Granot & Mayseless, 2001). The lowest possible score is 15 and the highest score is 60. In this study the total score of the ASS was computed and used in the analyses. A higher score indicates a more secure attachment. Granot & Mayseless (2001) found an acceptable internal consistency (Cronbach's alpha = .72).

Tempo Test Arithmetic The Tempo Test Arithmetic (TTA) is a Dutch mathematical skill test, it measures basic mathematic skills in children aged 7-12 years (De Vos, 1992). The TTA consists of five columns of 40 calculations each. Every column tests a different mathematical skill: adding numbers (+), subtraction of numbers (-), multiply numbers (x), division (:) and one column with a mix of these mathematical four different mathematical skills (Fränxel, zd; Schleepen & Van Mier, 2016). The child has to solve as many calculations as possible within a minute per column, so the total duration of the TTA is 5 minutes. One point was assigned for every correct calculation (Schleepen & Van Mier, 2016). This study is interested in the overall mathematical performance and therefore the mean score was

computed (adding the scores of all the columns up and divide it by 5), the possible range of scores is between 0 and 40.

Test Anxiety The Dutch translation of the Children's Test Attitude Scale (CTAS; Wren & Benson, 2004) is a self-report questionnaire that was used to measure test anxiety in children. The CTAS consists of 30 items in total, with 9 items on the subscale Automatic Reactions, 8 items on Off-Task Behavior and 13 items on the subscale Thoughts. The children rate how often an item would occur on a 4-point Likert scale, with 1 is almost never and 4 is almost always (Wren & Benson, 2004). The total score was computed by adding up the score of each question, the possible range of scores is between 30 and 120. The reliability for the CTAS was 0.02, 0.85 for the subscale Autonomic Reactions, 0.78 for Off-Task Behavior and 0.89 for Thoughts (Wren & Benson, 2004).

Statistical analysis

The variables that are used in the analyses are test anxiety (CTAS), math performance (TTA), attachment style (ASS) and gender. Math performance is the dependent variable, test anxiety the independent variable and gender and attachment style the moderators. At first, descriptive statistics were calculated, such as the mean age, the number of boys and girls, the mean scores on the different tests and the mean TTA score. The first hypothesis (hypothesis 1) states that there is a negative relationship between test anxiety and math performance, which will be investigated by means of a Pearson's correlation analysis. Hypothesis 2 states that attachment style is a moderator in the relationship between test anxiety and math performance and this hypothesis was tested with the program PROCESS v2.16.3. In this analysis, math performance is the dependent variable, test anxiety the independent variable and attachment style the moderator. The last hypothesis (hypothesis 3) states that gender is a moderator in the relationship between test anxiety and math performance and will be tested with the program PROCESS v2.16.3. Math performance is the dependent variable in this

analysis, test anxiety the independent variable and gender the moderator. In all the analyses *p* < 0.05 was taken as the significance level and before every analysis, the assumptions were checked. The assumptions that were checked for the Pearson's Correlation analysis are level of measurement, normality, linearity and homoscedasticity. For the moderation analyses the assumptions for regression analysis were checked. These are homoscedasticity, normally distributed residues, uncorrelated residues, linearity and multicollinearity.

Results

Descriptive statistics

First, it was checked if there was missing data. Seven children did not fill in all the answers of the ASS or did not fill in them correctly and one child forgot to fill in one page of the TAS, so the data of 70 children was included in the analyses. Next, the descriptive statistics of the used variables are computed, which are shown in Table 1 (mean, standard deviation, minimum and maximum score of the variables math achievement (TTA), test anxiety (CTAS) and attachment style (ASS)).

Table 1

Descriptive Statistics of TTA, CTAS and ASS

	N	Mean	*SD*	Minimum	Maximum
TTA	70	16.2886	5.0596	6,40	30
TAS	70	52,56	13,1	31	94
ASS	70	48,93	5,417	33	58

Note. TTA = Tempo Test Arithmetic, TAS = Test Attitude Scale, ASS = Attachment Security Scale

Assumption check

Before the correlation analysis and the two moderation analyses were conducted, the assumptions were checked. For the correlation analysis, the assumptions measurement level

and homoscedasticity are met. Homoscedasticity was checked through residual plots. The

assumption of linearity is also met, but the linearity is very small ($R^2 = .003$). The assumption

of normality is violated; the skewness and kurtosis are not equal to zero and because of this,

the nonparametric test Spearman Correlation was used in the correlation analysis instead of

Pearson Correlation. For the moderation analyses, assumptions for regression analysis were

checked. Again, there was a linear relationship, but this was small ($R^2 = .003$). The assumption

of multicollinearity was checked with VIF and this assumption is not violated (VIF values of

1.027 and 1.019). The assumption of homoscedasticity is also not violated and this was

checked with residual plots. The assumption of normality is met and tested with the histogram

of errors and the central limit theorem. To check if there were possible outliers, boxplots were

analyzed. Visual inspection of these boxplots yielded two outliers on the TAS, but these

scores lay within the possible range of scores (with a minimum score of 30 and maximum of

120). So, these participants were not excluded.

Correlation analysis

To test if there is a negative relationship between test anxiety (TAS) and math

performance (TTA) (hypothesis 1), a correlation analysis was conducted. Because the scores

of the TTA are not normally distributed, the nonparametric test Spearman Correlation was

used. The Spearman Correlation analysis showed no significant result ($Rs = - .068$, $p = .576$),

meaning that there is no (negative) relationship between test anxiety and math performance.

Moderation analysis with attachment style (ASS) as moderator

To test hypothesis 2, the program PROCESS v2.16.3 was used. This hypothesis stated

that attachment security is a moderator in the relationship between test anxiety and math

performance, meaning that the relationship between test anxiety and math performance is

different for a secure and insecure attachment style. In this analysis, model 1 was used, TTA

was the outcome variable, TAS the independent variable and ASS the moderator variable

(M). The total model explained no significant variance in math performance (R^2 = .0248; F (3,66) = .5595; p = .6437). Table 2 shows that the moderation effect of ASS is not significant, the interaction effect between TAS and ASS is also not significant and there was no main effect from ASS. This means that attachment style is not a moderator in the relationship between test anxiety and math performance.

Table 2

Moderation Analysis with Attachment Style as moderator

	Coeff (b)	Se	T	p	LLCI	ULCI
Constant	38.3997	25.9059	1.4823	.1430	-13.32331	90.1228
ASS	-.4227	.5265	-.8029	.4249	-1.4738	.6284
TAS	-.3081	.4799	-.6420	.5231	-1.2662	.6500
Interaction	.0058	.0098	.5872	.5591	-.0138	.0253

Note. ASS = Attachment Security Scale, TAS = Test Attitude Scale, Interaction = ASS x TAS

Moderation analysis with gender as moderator

To test if gender is a moderator in the relationship between test anxiety and math performance (hypothesis 3), a moderation analysis was conducted. This was done to examine if the relationship between test anxiety and math performance is different for boys and girls. For the moderation analysis, PROCESS v.2.16.3 was used. Model 1 was selected, TTA was the outcome variable, TAS the independent variable and gender the moderator variable (M). The total model explained no significant variance in math performance (R^2 = .2796; F (3,66) = 1,8663; p = .1439). Table 3 shows that gender is not a moderator in the relationship between test anxiety and math performance, as there is no significant interaction effect between test anxiety and gender. Further, there were no main effects of gender and test anxiety on math performance.

Table 3

Moderation Analysis with Gender

	Coeff (b)	Se	T	p	LLCI	ULCI
Constant	14.812	7.569	1.9569	.0546	-.3005	29.9247
Gender	1.5917	5.0001	.3183	.7512	-8.3914	11.5748
TAS	.1004	.1410	.7125	.478	-.1810	.3819
Interaction	-.0789	.0921	-.8570	.03946	-.2628	.1049

Note. TAS = Test Attitude Scale, Interaction = TAS x Gender

Discussion

The goal of this study was to investigate if there is a relationship between test anxiety and math performance and the possible moderating role of attachment style and gender in children who are 7-10 years old. It was expected that there will be a negative relationship between test anxiety and math performance (hypothesis 1). The correlation analysis showed no significant results. Hypothesis 2, which stated that attachment is a moderator in the relationship between test anxiety and math performance, was not confirmed by the moderation analysis. Hypothesis 3 stated that gender is a moderator in the relationship between test anxiety and math performance and was also not confirmed by the moderation analysis.

Hypothesis one, which stated that there is a negative relationship between test anxiety and math performance, was not confirmed in this study. In line with this result, Ndrangu et al. (2010) found no significant relationship between test anxiety and performance in Kenyan secondary school children (11-16 years old). This result could imply that test anxiety does not correlate with performance, so future research could investigate if other factors correlate with math performance and interventions should focus on these factors instead of test anxiety. In contrast to the current study's findings, McCarthy & Goffin (2015) found a negative

relationship between test anxiety and math performance. A possible reason for this contrast is that the participants in the study of McCarthy & Goffin (2005) were undergraduate volunteers between 17 and 49 years old, whereas the participants in the current study were between 7 and 10 years old. The difference in age could be an explanation for the difference in results. Support for this comes from DordiNejad and colleagues (2011), who showed that younger students feel less stress and test anxiety than older students, this means that there is a positive correlation between test anxiety and age. It could be that the participants in current study are still too young to experience levels of test anxiety that are high enough to have a correlation with math performance. Another possible explanation for the discrepancy in results, is that McCarthy & Goffin (2005) used three different tests to measure test anxiety (the Test Attitude Survey, two-dimensional Test Attitude Inventory and the Reactions to Test Scale), while in the current study only the Test Attitude Scale for Children was used. The two-dimensional Test Attitude Inventory (TIA) contains items about worry and emotionality components of test anxiety and the Reactions to Test Scale (RTT) consists of items that measure tension, worry, thoughts that are test irrelevant and bodily symptoms (McCarthy & Goffin, 2005). Because the tests differ on measured components, this could be a cause for different levels in test anxiety and so an explanation for the discrepancy in results. Kurasowa and Harackiewicz (1995) found another possible explanation for the discrepancy in results in current study and the study of McCarthy & Goffin (2005). Kurasowa and Harackiewicz found that persons who experience high levels of test anxiety perform at least as well as persons who experience low levels of test anxiety when the situation is not stressful. According to this, it might be that the children in current study experienced the Tempo Test Arithmetic as not very stressful, so that test anxiety does not interfere with math performance. This could imply that more research needs to be done to investigate the relationship between test anxiety and math performance in

children to give more clarification about the relationship, and in which situations there is a relationship between these two factors.

Hypothesis 2 expected that attachment style is a moderator in the relationship between test anxiety and math performance. This moderation was not significant as shown by the results of the moderation analysis. However, there are limited studies that investigated the possible moderating role of attachment style on the relationship between test anxiety and math performance, one study found that younger children (11 years old) show a weaker relationship between attachment style and anxiety (Bar-Heim et al., 2007). Because the participants in current study and the participants in the study of Bar-Heim and colleagues (2007) were about the same age, it could be that there is no moderation effect of attachment on the relationship between test anxiety and math performance. More research is needed to check if attachment style is not a moderator in the relation between test anxiety and math performance in children aged 7-10 years old.

Hypothesis 3, which states that gender is a moderator in the relationship between test anxiety, was not confirmed by moderation analysis. This result is in contrast with the results of Putwain & Daly (2014), they found that girls experience higher levels of test anxiety and that children (11-16 years old), who experience higher test anxiety, are at risk of underperforming in tests. However, in another study Putwain (2008) found that gender is not a moderator in the relationship between test anxiety and GCSE (General Certificate of Secondary School) in secondary school children (aged 11-16 years old) in the UK. Oneyizugbo (2017) found results that are in line with the results of current study and the study of Putwain (2008), no moderator effects of gender were found. This could imply that gender is not a moderator in the relationship between test anxiety and math performance, there is no difference in the relationship between test anxiety and math performance for boys and girls. Interventions do not need to focus just on boys or on girls. Possibly, there are other factors

that influence the relationship between test anxiety and math performance, future research could investigate what these factors are.

However, this study has some limitations. First, the number of participants (70) is small. This possibly influences the reliability of the research and it is difficult to generalize conclusions to the whole population. Future research should test a larger number of participants to get a more reliable result. Second, this study has a cross-sectional study design. Future research could use a longitudinal design to investigate if the relationship between test anxiety and math performance develops or changes over time when the child gets older. This has not been investigated yet. A third limitation of this study is the range of scores on the ASS and TAS. The range of scores on the ASS was between 33 and 58, while the possible range of scores on the ASS is between 15 and 60, with a higher score meaning a more securely attachment. Future research should include more participants to get a better width of scores. On the TAS, the range of scores in this study was between 31 and 94. The highest possible score is 120, so none of the participants experienced high levels of test anxiety. Because of this, the results need to be interpreted carefully. Next to some limitations, this study also has some strengths. This study investigated approximately just as much boys as girls (37 boys and 33 girls). A second strength is that this study used an independent sample. Thirdly, the tests are taken under strict conditions, so that these were taken as valid as possible. Another strength of this study is that this study investigates the possible moderator effect of attachment style. This has not been investigated before.

Since test anxiety, math performance, attachment style and gender are not investigated in one research yet, the current study is an added value for the existing literature. It is a first indication for the fact that gender and attachment style are no moderators in the relationship between test anxiety and math performance. It is important to investigate this, because when there is more information about test anxiety, possible moderators and its effects, better

interventions can be developed to cope with test anxiety (Gibson, 2014). To achieve a better

understanding about test anxiety, future research could investigate if different levels of test

anxiety has an influence on math performance. For example, mild test anxiety can sharpen a

student's mind and contributes to a successful outcome on a test (Gibson, 2014). Lastly,

future research should explore if there are other variables and predictors of test anxiety or if

there are other moderator variables in the relationship between test anxiety and math

performance.

     In sum, this research investigated the relationship between test anxiety and math

performance and possible moderating effects of attachment style and gender. However, none

of these results were significant. More research needs to be conducted to see if there are other

moderators in the relationship between test anxiety and math performance. When there is

more information about test anxiety, better interventions can be developed to cope with test

anxiety and when there is more information about what factors influence math performance in

children, teachers can help students better to achieve good grades and develop better math

skills.

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