The role of personality, self-concept and defensive motivation in predicting maths anxiety[1]

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Abstract

The goal of this research was to explore the relationships between personality, self-concept, learning strategies and mathematics anxiety in elementary school students. The sample consisted of 511 8th grade students from 36 Croatian elementary schools who completed the Maths Anxiety Scale, Big Five Inventory, the Self-Description Questionnaire-II and measures of self-regulatory learning strategies to assess self-handicapping, defensive pessimism and external attribution of failure. Separate hierarchical regression analyses were conducted by gender to test the predictive power of personality, self-concept and defensive motivational strategies on mathematics anxiety. Results indicate that the variables explained significant variance for both genders (girls R^2 = .54; boys R^2 = .38). Personality, self-concept and motivational strategies were all related to maths anxiety, however, a different pattern emerged with respect to gender. Maths self-concept is significantly negatively related to maths anxiety for both genders, while for boys, maths anxiety is related to low agreeableness and the use of external attribution of failure, and in girls it is predicted by higher neuroticism and defensive pessimism. Results indicate that maladaptive patterns of academic beliefs, motivations and behaviour related to mathematics in Croatian students are to some extent gender-specific, thus calling for specific intervention strategies tailored for boys and girls.

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Introduction

Mathematics anxiety has been researched for decades as a major source of academic stress and one of the key factors in low mathematics achievement (Dowker, Sarkar, & Looi, 2016). It has been defined as a feeling of tension and anxiety that interferes with the numeric operations and solving of mathematical problems in academic and life settings (Richardson & Suinn, 1972). Students who reported high anxiety related to mathematics consistently demonstrated lower achievement in mathematics compared to their peers who reported low or no maths anxiety (Hembree, 1990; Ma, 1999). When facing mathematical problems, they were not able to mobilize sufficient cognitive resources required to solve the task due to excessive worries about the performance (Beilock & Carr, 2005; Maloney & Beilock, 2012). Program for International Students' Assessment (PISA), a large-scale international comparison of 15-year-old students' achievements in reading, maths and science, provided evidence supporting the universality of the negative relation between maths anxiety and performance. Across 65 participating countries, students' reported mathematics anxiety explained 14% of the variation in maths performance (OECD, 2013). This relation appeared to be reciprocal, with low performance in maths leading to enhanced maths anxiety, which in turn impaired performance (Carey, Hill, Devine, & Szucs, 2016). Maths anxiety significantly reduces interest and intrinsic motivation for learning maths and promotes the use of surface learning strategies such as simple rehearsal (Pekrun, 2006). Authors of models of self-regulated learning have proposed that anxiety related to academic tasks promoted the use of defensive self-regulation strategies focused on preserving well-being and protecting self-esteem (Boekaerts & Niemivirta, 2000; Lončarić & Peklaj, 2008).

The role that maths anxiety plays in students' academic behaviour and achievement in mathematics has promoted research interest into the development and determinants of this major academic emotion. A history of research on maths anxiety has singled out gender as an important background variable in experiencing maths anxiety (Dowker et al., 2016). Recent PISA study found that girls experienced a significantly higher level of anxiety and other negative emotions concerning mathematics compared to boys in 52 of the 65 investigated countries, including Croatia (OECD, 2013). Nevertheless, some studies have revealed no or very small gender differences in mathematics anxiety (Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Ma, 1999). Such contradictory results might be due to the differences in the way mathematics anxiety was conceptualized. Evidence has shown that girls on average reported higher maths anxiety than boys on generalized assessments (OECD, 2013). This difference diminished when anxiety was measured in real-life settings such as maths exams in the classrooms (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013).

Maths anxiety has been consistently related to self-beliefs such as self-concept and self-efficacy (Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010). This relation is reciprocal, with lower levels of maths self-concept predicting subsequent higher levels of anxiety and higher levels of maths anxiety predicting subsequent lower levels of self-concept (Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Pekrun, 2006). Mathematics self-concept is related to adaptive behaviour when learning mathematics (Trautwein, Lüdtke, Roberts, Schnyder, & Niggli, 2009) and affects maths performance indirectly, through maths anxiety (Ferla, Valcke, & Cai, 2009).

Recent research has demonstrated that students with lower mathematics self-concept overemphasized their trait maths anxiety as compared to the level of maths anxiety they actually experienced (Bieg, Goetz, & Lipnevich, 2014).

While the role of gender or self-beliefs has been well-documented, less research has examined dispositional factors playing role in maths anxiety. Behaviour genetic research demonstrated that mathematics anxiety was influenced by genetic differences in general anxiety (Wang et al., 2014). General anxiety is a component of neuroticism, a dimension of personality in the five-factor model (Costa & McCrae, 1992). Neuroticism has been demonstrated to play a role in the experience of anxiety in academic settings (Chamorro-Premuzic, Ahmetoglu, & Furnham, 2008). However, research evidence relating maths anxiety to other personality dimensions of the five-factor model is scant, although personality has a significant role in academic achievement and effort invested in learning mathematics (Poropat, 2009; 2014; Trautwein et al., 2009).

Research on math-related academic traits and behaviours in Croatian elementary schools corroborated universal findings that girls reported more maths anxiety, but failed to support well-documented gender differences in maths self-concept (Matić, Marušić, & Baranović, 2015). The importance of context-specific evidence is that it informs a design of context-sensitive and more efficient interventions in educational settings. Thus, the aim of the present research is to explore the relationship of personality, self-concept, and learning strategies on boys' and girls' mathematics anxiety in a sample of students enrolled in their final year of elementary school in Croatia.

Method

Participants

The participants were 511 eight-grade students (aged 14-15, 223 boys and 284 girls)[2] from 36 elementary schools in the city of Zagreb and Zagreb County. The representative sample of students was stratified according to size and rural-urban location of the school.

Instruments

All participants provided relevant sociodemographic data, and completed the following questionnaires.

Self-Description Questionnaire – II (Marsh, 1990) measures academic and non-academic aspects of self-concept in younger adolescents. The students were asked to read 10 statements and endorse these on a scale from 1 = *does not describe me at all* to 6 = *describes me very well*. Sample items for mathematics, general and academic self-concepts are "I have always done well in mathematics.", "If I really try I can do almost anything I want to do." and "I learn things quickly in most school subjects.", respectively. The reliabilities of the Croatian versions of the mathematics, general and academic self-concept scales are $\alpha = 0.93$, $\alpha = 0.84$ and $\alpha = 0.90$, respectively.

[2] Four participants did not specify their gender.

Academic efficacy was assessed by Croatian translation of Academic Efficacy Scale, adapted from Midgley et al.'s (2000) Patterns of Adaptive Learning Scales. It has five items referring to a general feeling of efficacy related to academic tasks. The students were asked to read statements and endorse these on a scale from 1 = *very untrue* to 5 = *very true*. A sample item is "I can do almost all the work in class if I don't give up.". Scale reliability on this sample is $\alpha = 0.86$.

Big Five Inventory (BFI) for children (John & Srivastava, 1999) measures basic personality dimensions: extraversion ($\alpha = 0.73$), agreeableness ($\alpha = 0.71$), conscientiousness ($\alpha = 0.77$), neuroticism ($\alpha = 0.73$) and openness to experience ($\alpha = 0.71$). Participants endorse each of the 44 statements on a 5-point Likert-type scale from 1 = *strongly disagree* to 5 = *strongly agree*. Sample items for extraversion, agreeableness, conscientiousness, neuroticism and openness to experience are "I see myself as someone who is talkative.", "I see myself as someone who is helpful and unselfish with others.", "I see myself as someone who does things carefully and completely.", "I see myself as someone who is depressed, blue." and "I see myself as someone who is original, comes up with new ideas.", respectively.

Maths Anxiety Scale (Arambašić, Vlahović-Štetić, & Severinac, 2005) contains 16 situations related to mathematics (e.g."When I write a maths test…") where participants rate the potential intensity of their anxiety from 1 = *I am not anxious* to 4 = *I am highly anxious*. The reliability of the Croatian version of the scale is $\alpha = 0.92$.

Self-regulatory Learning Strategies Scale (Lončarić, 2014) measures defensive learning strategies aimed at preserving self-esteem and well-being. In this study, we used 5-point Likert-type scales from 1 = *very untrue of me* to 5 = *very true of me* to assess self-handicapping behaviour, defensive pessimism and external attribution of failure. Sample items for self-handicapping behaviour, defensive pessimism and external attribution of failure are "While others study for the exam, I'm having fun.", "I always expect a poor grade so I don't get surprised if I get it." and "I got a bad grade because the teachers don't know how to make the assignments interesting.", respectively. Defensive pessimism and external attribution of failure are four-item scales with $\alpha = 0.79$ and $\alpha = 0.88$, respectively, while self-handicapping behaviour scale consists of five items with $\alpha = 0.82$.

Procedure

Questionnaire administration took place in classrooms, during regular school classes. Due to the comprehensiveness of the questionnaire, data collection was carried out at two time points, with two weeks between the administrations. Participants' data were anonymous and parents' informed consents were obtained.

Results and Discussion

In order to explore how personality, self-concept, and learning strategies relate to mathematics anxiety, hierarchical regression analysis will be conducted. First, we outline gender differences in some of the relevant predictor and criterion variables that justify performing separate regressions for criteria of boys' and girls' maths anxiety.

Table 1 contains the arithmetic means and the standard deviations of the relevant variables on girls' and boys' samples, as well as the statistical test of significance of the difference between the results.

Table 1. Means and standard deviations of the results for girls and boys, and the results of t-tests for gender differences.

	Girls		*Boys*		***t***
	M	***SD***	***M***	***SD***	
Mathematics anxiety	2.00	0.65	1.84	0.58	2.85**
Mathematics self-concept	3.59	1.36	3.58	1.23	0.10
General self-concept	4.89	0.82	4.93	0.75	-0.49
Academic self-concept	4.74	0.98	4.66	0.88	0.89
Academic efficacy	19.30	4.43	19.74	4.01	-1.14
Extraversion	30.62	5.86	29.46	4.87	2.40*
Agreeableness	32.66	5.81	30.57	4.96	4.22**
Conscientiousness	30.19	6.28	30.12	5.84	0.13
Neuroticism	23.17	5.76	20.63	4.98	5.07**
Openness	36.73	6.21	34.08	5.77	4.71**
Self-handicapping	14.16	5.03	14.40	5.15	-0.52
Defensive pessimism	12.31	4.07	11.27	4.22	2.77**
External attribution of failure	9.04	4.25	10.47	4.95	-3.40**

** $p < .01$; * $p < .05$

As evident from the Table 1, girls tend to express somewhat higher levels of maths anxiety than boys, supporting universal differences in maths anxiety found in international research (OECD, 2013). Nonetheless, the difference in mathematics anxiety is rather small and both genders, on average, experience low levels of anxiety in relation to mathematics. The mean results on math, general and academic self-concepts do not differ between genders. The average self-concept level is considerably lower for mathematics compared to general and academic self-concepts. Boys and girls also show comparable levels of academic efficacy. Gender differences were obtained for some personality variables and variables assessing students' motivational learning strategies. Female students demonstrated higher means on the scales of extraversion, agreeableness, neuroticism and openness, as well as more frequent use of defensive pessimism strategy. On the other hand, boys tend to attribute their failure to external factors more often than girls. No gender differences were found with respect to boys' and girls' conscientiousness nor their tendency to use self-handicapping learning strategy.

With respect to the well-documented gender differences in mathematics anxiety, we performed separate hierarchical regression analyses by gender to test the predictive power of personality, self-concept and defensive motivational strategies in explaining the variance of mathematics anxiety, i.e. to obtain insight into potential gender-specific determinants of mathematics anxiety. First, the personality variables were entered in the analysis followed by the more proximal academic self-concept variables. The last block of predictors included three measures of defensive motivational learning strategies. The results of the hierarchical regression analyses are shown in Table 2.

Table 2. The results of the hierarchical regression analyses for the girls' and boys' mathematics anxiety criteria.				
	Girls' mathematics anxiety		*Boys' mathematics anxiety*	
	β	*p*	β	*p*
Blocks of predictors				
1 – Personality	$\Delta R^2 = .15$ $p < .001$		$\Delta R^2 = .12$ $p = .007$	
(Constant)	$B = .91$, $p = .146$		$B = 3.49$, $p < .001$	
Extraversion	.21	.011	-.21	.037
Agreeableness	.13	.086	-.22	.028
Conscientiousness	-.15	.062	-.13	.213
Neuroticism	.35	.000	-.09	.344
Openness	-.13	.084	.12	.223
2 – Self-concept	$\Delta R^2 = .36$ $p < .001$		$\Delta R^2 = .21$ $p < .001$	
(Constant)	$B = 1.68$, $p = .002$		$B = 3.50$, $p < .001$	
Extraversion	.09	.144	-.12	.182
Agreeableness	.11	.065	-.22	.015
Conscientiousness	.03	.645	-.01	.956
Neuroticism	.24	.001	-.06	.533
Openness	-.05	.397	.06	.503
Mathematics self-concept	-.68	.000	-.54	.000
General self-concept	.07	.491	.01	.909
Academic self-concept	-.03	.807	.20	.178
Academic efficacy	.02	.769	-.09	.435
3 – Defensive learning strategies	$\Delta R^2 = .02$ $p = .036$		$\Delta R^2 = .05$ $p = .029$	
(Constant)	$B = 1.46$, $p = .021$		$B = 3.39$, $p < .001$	
Extraversion	.08	.186	-.09	.321
Agreeableness	.10	.105	-.24	.006
Conscientiousness	.02	.822	-.02	.839
Neuroticism	.22	.003	-.07	.444
Openness	-.06	.361	.03	.759
Mathematics self-concept	-.66	.000	-.50	.000
General self-concept	.09	.347	.01	.959
Academic self-concept	-.04	.721	.26	.069
Academic efficacy	.07	.409	-.11	.315
Self-handicapping	-.11	.105	-.14	.140
Defensive pessimism	.13	.030	.02	.808
External attribution of failure	.13	.064	.27	.005
	$R^2 = .54$ $F_{(12,163)} = 15.91$ $p < .001$		$R^2 = .38$ $F_{(12,116)} = 5.96$ $p < .001$	

Personality, self-concept and defensive self-regulation explained significant amount of variance in both genders, having stronger predictive power for girls ($R^2 = .54$) compared to boys ($R^2 = .38$). Personality variables explained around 15% of variance, self-concept variables

accounted for additional 36% and defensive learning strategies contributed with 2.5% of the explanatory potential in the female sample. With all variables taken into account, girls' mathematics anxiety was significantly predicted by neuroticism, mathematics self-concept and defensive pessimism. The set of predictors explained 38% of the variance in boys' mathematics anxiety. Again, self-concept variables explained the largest amount of variance (21%), with personality variables accounting for 12% and defensive learning strategies contributing to the explanation of around 5% of the overall variance. In the final step of the analysis, agreeableness, mathematics self-concept and external attribution of failure were found to be significant individual predictors of mathematics anxiety in male students.

In general, personality, self-concept and motivational strategies were all related to maths anxiety, but somewhat different pattern of relations between personality/motivational variables and maths anxiety emerged with respect to gender. Maths self-concept was found to be significantly negatively related to maths anxiety in both genders, thus supporting universal findings that students who felt they are competent in mathematics experienced less anxiety related to mathematics tasks (Ahmed et al., 2012). Theoretical prediction that higher level of neuroticism as a general disposition towards negative emotionality would be related to anxiety in relation to mathematics was only supported in the female sample. Girls with general proneness to experiencing negative emotions reported more maths anxiety, in line with findings linking neuroticism to avoidant patterns of motivation in academic settings (Kommaraju & Karau, 2005). Maths anxiety was related to low agreeableness in male sample, indicating that boys who assessed themselves as less prosocial and cooperative experienced a higher level of negative emotions associated with math. Meta-analytic evidence showed small, but consistent relations of agreeableness with academic achievement (McAbbee & Oswald, 2013; Richardson, Abraham, & Bond, 2012). Cooperativeness and compliance of agreeable students might promote adaptive academic behaviours related to successful learning, while lower agreeableness could be related to maladaptive experiences and behaviours in learning situations, such as maths anxiety. In line with models of self-regulation, mathematically more anxious students in our sample more frequently used defensive learning strategies aimed at reducing anxiety and thus protecting well-being and self-esteem.

Conclusion

In sum, our research found evidence of meaningful relations between personality/self-concept/defensive learning strategies and maths anxiety, with some gender differences evident in the pattern of these relations. The predictive power of Big Five personality factors, different aspects of self-concept and several defensive self-regulation strategies appeared to be larger when examining girls' compared to boys' mathematics anxiety.

Our findings support the simultaneous inclusion of variables with various levels of generality in the analysis of academic behaviour. Recent meta-analytic findings advocated this approach that enables more differentiated predictions and more specific guidance in designing intervention strategies for different groups of students (Richardson et al., 2012). In our sample, maladaptive patterns of academic beliefs, motivations and behaviour related to mathematics are to some extent gender-specific, thus calling for specific intervention strategies tailored for boys

and girls. These intervention strategies should target not only maths anxiety; instead, they should simultaneously promote the development of students' adaptive academic behaviours such as more positive maths-related self-concept and proactive learning strategies. Our research indicates that this could be particularly beneficial for girls with higher levels of neuroticism who are more prone to the development of maladaptive academic emotional and behavioural patterns in academic settings, including maths anxiety.

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