

Exploring the Presence of Test Anxiety and its Relation to Mathematical Achievement in a Sample of Grade 3

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The present study aims at exploring if a sample of Swedish grade 3 pupils reported any test anxiety and whether there were any relations to performance in different mathematical areas. Overall, test anxiety explained 20% of the variance for the total mathematical score, with the subscale “thoughts” as the significant predictor. The model of test anxiety also explained Number understanding, Mass and Time, Patterns, and Mathematical problems; however Mental arithmetic and Written arithmetic algorithms were not significantly explained by the model. Test anxiety seems not to be a major problem in this sample; still, significant negative correlations were found, which likely might influence the pupils in some aspects.

Introduction

In 2006 the Swedish Government decided as a first step to introduce educational goals in mathematics and Swedish for grade 3 and as a second step to introduce national tests. The first mandatory national tests were implemented in spring 2010. National tests in these subjects will consist of several short subtests designed to assess some parts of the mathematics and Swedish syllabus goals for this age group. These tests are to be administered within a ten-week period, on dates decided by the school. The mathematics and Swedish tests are connected by a story of two children on an adventure, with the aim of lessening the impact of the test situation (Skolverket, 2010).

It is well recognized that exams can trigger intense emotions (Pekrun *et al.*, 2004). There seems to be no difference between positive and negative emotions, both are reported by pupils to the same extent (Spangler *et al.*, 2002). Both sides also appear to be necessary for optimal performance in achievement situations (Hopko *et al.*, 2001). To motivate the child to put adequate effort into performance on for example a test and reach his/her full potential, a certain degree of anxiety is seen as beneficial (McDonald, 2001). Wolf and Smith (1995) found, however that in testing situations high motivation in combination with high

anxiety in pupils resulted in almost the same levels of performance as low motivation in combination with low anxiety. Thus, although high motivation on a test may be necessary, the anxiety accompanying increased motivation levels could have unfavourable consequences. For some pupils the stress might be too big and seriously impact on their performance in the wrong direction. At present there is convincingly research pointing to these debilitating effects of test anxiety on academic performance (Eum & Rice, 2010).

The preamble paragraph in Swedish education is equity across curricula, *i.e.* equitable opportunity to learn in school. Thus, one important purpose with national tests in Sweden is to support the individual learning, and identify weaknesses and strengths for each pupil (Skolverket, 2010). Test anxiety could represent a bias factor that impedes pupils from reaching their true potential. In these cases, test results are misleading and not educationally justified (Zeidner & Matthews, 2005). To meet equity in testing fairly and justly practice in testing must be attained. Although the impact of test anxiety on exam performance might be modest, its potential influence on children leading to underperforming on an exam is considerable for the individual and it is necessary to attend to this in education (McDonald, 2001). Accordingly, the present study focuses on the potential negative feeling that might accompany pupils when taking a test, and the relation of this to actual performance in mathematics. To gauge the Swedish sample it is also being compared to the American reference sample for the test anxiety instrument used here. Many studies have been conducted in the field of test anxiety. However, these have mainly focused on older pupils; in younger pupils and in a Swedish context research is less complete in test anxiety, and thus, the present study is explorative in nature.

Test Anxiety

Test anxiety is seen to be learnt, typically evoked in educational settings, and developed during early school years (Pekrun, 2000). The occurrence of test anxiety differs considerably; 10% to 40% in pupils (e.g. McDonald, 2001; Bodas *et al.*, 2008). In children test anxiety is viewed to be a situation-specific trait being manifested during formal evaluative situations and argued to include cognitions, somatic symptoms and test-irrelevant behaviours that may weaken academic performance (Wren & Benson, 2004). The construct of test anxiety can be theorised as multi-dimensional. Among older pupils two empirically distinct but interrelated components of test anxiety are found to be worry and emotionality (Zeidner, 2007). Worry represents the cognitive aspect of anxiety and concerns the person's own evaluation of his/her performance. Compared to emotionality worry is experienced for a longer period of time, some days before the exam, and throughout the test. Emotionality is the person's subjective awareness and understanding of physiological reactions in different test situations. This affective component is present immediately before a test and then

diminishes. Worry is believed to have a stronger negative influence on test performance than emotionality (Eum & Rice, 2010). Worry can be categorised as a trait or a predisposition, and emotionality as a state, temporary and depending on the context of a given test and testing environment (Zeidner, 2007). Children's test anxiety is likely first to be dominated by emotional-affective responses, and later by cognitive concern or worry (Wigfield & Eccles, 1989).

Test anxiety seems to be present in all age groups (Connor, 2003), although older compared to younger pupils report more test anxiety (Zeidner, 1998). Test anxiety is thought to peak around grade 4 (Araki, 1992) up to junior high school, where gender differences also become more marked (Lowe & Lee, 2008). Still, few studies report on test anxiety as a widespread experience in the lower ages (Zeidner, 1998). Commonly, girls compared to boys report more test anxiety. However, there might be other reasons than actual higher levels of test anxiety behind; girls are believed to be socialised to show their feelings publicly and boys to hold back or hide them (Bodas *et al.*, 2008). School related aspects are also believed to be more feminine and hence are not valued by males (Skelton, 2001). Among school subjects, mathematics in particular seems to cause more stress in test situations (Putwain, 2008) and failure in it attributed to the learners own competence and not to the task in question (Boekaerts *et al.*, 2003).

Method

Participants and setting

Eighty-three Swedish pupils (39 girls, 44 boys) aged 9-10 years from six grade 3 classes in five schools in different demographic settings participated in the study. During a ten weeks period the pupils took the national tests and filled in the questionnaire. Data collection complied with the ethical guidelines regarding information, consent to participate, scientific use and confidentiality. Consent was obtained from the parents, who were informed by letter and at an open meeting. All of the children gave their assent to participate. Schools were selected on the basis of representativeness of national average on demography.

Instruments

The *Children's Test Anxiety Scale* (CTAS; Wren & Benson, 2004) contains 30 items tapping: (a) "thoughts", 13 items, (e.g. "While I am taking tests I worry about failing"); (b) "autonomic reactions", 9 items, (e.g. "While I am taking tests my belly feels funny"); and (c) "off-task behaviours", 8 items, (e.g. "While I am taking tests I check the time"). The CTAS is a refined and modernised self-reported pen-and-paper questionnaire. Participants rate their level of agreement with each statement on the CTAS based on a Likert scale from 1 (almost never) through 4 (almost always). The CTAS has satisfactory reliability coefficient (0.92) and high practicality in naturalistic field settings (Zeidner, 2007). Results

from a recently conducted study provide evidence for the reliability and validity of the CTAS with Scandinavian younger pupils (Nyroos *et al.*, 2011).

Academic performance was assessed by the *National test*, which included seven subtests: Patterns, Mass and Time, Number understanding, Mental arithmetic, Mathematical problems, Written arithmetical algorithms, and Communication and Concepts. The latter is excluded as it was a group assignment. The tasks varied in form (e.g. simple numbers, complex tasks) and required different methods of expression (e.g. drawing, writing). The national test was administrated by the class teachers, and the CTAS by the researchers.

Data analyses

Data analyses were made in SPSS Version 19.0 (IBM). The raw score counts for each subtest (descriptive statistics in Table 2) are viewed as reasonable approximations of continuous, interval scale measures (Wright & Linacre, 1989), and are being used as an indication of a possible measure of the latent trait. The pattern of results was similar for boys and girls (Table 1), thus, the total sample is presented in the text. Possible scale ratings on the scale levels between boys and girls and mean ratings between the Swedish sample and the reference sample (Wren & Benson, 2004) were analysed through *t*-test (Table 1). Degree of relationship was measured by a Pearson correlation analysis of the results for the mathematical areas and the CTAS measurements (Table 3). Finally, a series of regression analyses, using each mathematical area as the dependent variable and the three CTAS measurements as independent variables are presented to examine how the CTAS predicts the outcome of the different mathematical ability assessments (Table 4). In addition, the overall Math total scores were examined within the regression analysis. Data had normal distribution (histogram and probability plot), missing data are excluded, model assumptions are fulfilled and no influential cases were detected when checked with residuals properties and statistics. One class differed notable in mean from the other five; however, this did not affect the mean, mode and median greatly. Where significant differences were flagged, Cohen's *d* effect sizes were calculated in order to estimate the magnitude of the difference between mean values. The subtests and CTAS items had relatively high internal consistency, Cronbach's alpha .756 and .911 respectively.

Result

The Swedish sample on average reported significantly lower levels of CTAS measurements than the reference sample (Wren & Benson, 2004) did (Table 1). Cohen's effect size values suggested a moderate practical significance for "thoughts" ($d = -0.77$) and "off-task behaviours" ($d = -0.63$), and a high practical significance for "total" ($d = -1.05$) and "autonomic reactions" ($d = -1.25$). Since the reference sample starts school one year earlier than the present sample, *t*-tests were also conducted for grade 4. For the significant differences

Cohen's effect size values suggested a moderate practical significance for “thoughts” ($d = -0.59$) and “off-task behaviours” ($d = -0.71$), and a high practical significance for “total” ($d = -0.86$) and “autonomic reactions” ($d = -0.94$.)

CTAS	Mean (Sd)					Swedish sample: Gender		
	<i>Swe grade 3</i> (n = 74)	<i>Reference sample grade 3</i> (n = 46)	<i>t-test</i>	<i>Reference sample grade 4</i> (n = 55)	<i>t-test</i>	<i>Girls</i> (n = 34)	<i>Boys</i> (n = 40)	<i>t-test</i>
thoughts	23.16 (8.11)	29.54 (8.51)	-6.705**	28.07 (8.65)	-5.077**	22.13 (7.65)	24.10 (8.50)	1.082 <i>ns</i>
autonomic reactions	11.95 (3.77)	17.15 (4.53)	-10.138**	16.25 (5.25)	-7.234**	11.81 (4.20)	12.07 (3.41)	.304 <i>ns</i>
off task behaviours	13.27 (4.51)	16.07 (4.36)	-5.672**	16.65 (5.06)	-5.899**	12.97 (4.57)	13.54 (4.50)	.550 <i>ns</i>
total	48.00 (13.15)	62.76 (14.81)	-8.573**	60.98 (16.61)	-6.722**	46.79 (14.00)	49.03 (12.46)	.725 <i>ns</i>

* $p < .05$, ** $p < .01$

Table 1: Means and standard deviations (in parentheses) of scores in CTAS measurements and t -scores.

<i>Patterns</i>	<i>Mass and Time</i>	<i>Number Under-standing</i>	<i>Mental Arithmetic</i>	<i>Mathematical Problems</i>	<i>Written arithmetical Algorithms</i>	<i>Mathematical Total</i>
8.12 (1.06)	8.78 (1.83)	11.65 (1.81)	24.99 (4.12)	8.63 (1.93)	16.30 (3.35)	78.60 (10.32)
<i>max 9</i>	<i>max 11</i>	<i>max 13</i>	<i>max 28</i>	<i>max 10</i>	<i>max 20</i>	<i>max 91</i>

Table 2: Means and standard deviations (in parentheses) of scores in Indicated Subtests in Mathematics. Maximum score in italics.

Correlation analysis was conducted for the different mathematical areas, total math scores, the different CTAS measurements and total (Table 3).

Variables	1	2	3	4	5	6	7	8	9	10	11
1. CTAS-thoughts		.611**	.320**	.897**	-.307**	-.443**	-.406**	-.379**	-.380**	-.322**	-.485**
2. CTAS-autonomic reactions			.348**	.786**	-.390**	-.335**	-.155	-.280*	-.222	-.130	-.317**
3. CTAS-off task behaviours				.648**	-.020	-.018	-.148	-.067	-.062	-.001	-.053
4. <i>CTAS-total</i>					-.282	-.350**	-.312**	-.281*	-.297*	-.196	-.382**
5. Patterns						.376*	.575**	.375*	.349*	.316*	.723**
6. Mass and Time							.521**	.553**	.512**	.283	.758**
7. Number understanding								.522**	.551**	.385*	.810**
8. Mental Arithmetic									.480**	.249	.721**
9. Mathematical Problems										.140	.752**
10. Written Arithmetical Algorithms											.502**
11. <i>Mathematics total</i>											

* $p < .05$, ** $p < .01$. Note: Significant correlations are highlighted in bold. Two-tailed.

Table 3: Correlations for the CTAS measurements and subtests.

As can be seen in Table 3, “thoughts” significantly correlated with all mathematical areas and Math total. “Autonomic reactions” significantly correlated with

Patterns, Mass and Time, Mental arithmetic, and Math total. “CTAS total” significantly correlated with Mass and Time, Number understanding, Mental arithmetic, Mathematical problems and Math total.

Dependent variables	Independent variables	R²	B	F
Patterns	<i>CTAS total</i>	.16**		4.30**
	thoughts		-.10	
	autonomic reactions		-.36*	
Mass and Time	off task behaviours		.14	
	<i>CTAS total</i>	.20**		5.99**
	thoughts		-.32*	
	autonomic reactions		-.22	
Number Understanding	off task behaviours		.17	
	<i>CTAS total</i>	.13*		3.33*
	thoughts		-.38**	
Mental Arithmetic	autonomic reactions		.09	
	off task behaviours		-.07	
	<i>CTAS total</i>	.09		2.28 <i>ns</i>
Mathematical Problems	thoughts		-.24	
	autonomic reactions		-.08	
	off task behaviours		.00	
Written Arithmetical Algorithms	<i>CTAS total</i>	.11*		2.94*
	thoughts		-.35*	
	autonomic reactions		.04	
	off task behaviours		-.03	
Mathematics total	<i>CTAS total</i>	.08		1.94 <i>ns</i>
	thoughts		-.33	
	autonomic reactions		.07	
	off task behaviours		.06	
Mathematics total	<i>CTAS total</i>	.20**		5.68**
	thoughts		-.41**	
	autonomic reactions		-.09	
	off task behaviours		.07	

* $p < .05$, ** $p < .01$

Table 4: Regression analyses with subtests as dependent variables and CTAS measurements as independent variables.

CTAS contributed different proportions of the explained variance for the subtests (Table 4). For the collapsed Math Total Score, 20% of the variance was significantly explained by the overall CTAS with significant predictor “thoughts”. For Pattern 16 % of the variance was significantly explained by CTAS (significant predictor “autonomic reactions”). The significant contribution of CTAS to the variance observed for Mass and Time was 20%, for Number understanding 13%, and for Mathematical problems 11% significant predictor in all cases being “thoughts”.

Discussion and conclusion

Test anxiety is not a harmless experience but related to several severe conditions and constraint career advancement (Stöber & Pekrun, 2004). It is however, possible to learn how to cope with it early in life, and therefore it is important to

investigate the existence of test anxiety in younger pupils. In general, research on test anxiety in children is a neglected area, and in Sweden few studies on test anxiety have been conducted. Even if test anxiety is a well recognised syndrome and has been found to be equally present in diverse geographical settings, there are reports on culture-specific aspects influencing (Bodas *et al.*, 2008). Thus, the purpose of this study was to explore the existence of test anxiety in a sample of Swedish grade 3 pupils, and to investigate the relations between test anxiety and mathematical performance.

The present sample reports on test anxiety but compared to the reference sample (Wren & Benson, 2004) to a significantly less extent; the effect sizes indicate medium to big differences. Despite that the test conditions in US differ from the Swedish conditions it offers a benchmark to gauge against. For example pupils in US have had high-stake standardised testing since 2001 (Lowe *et al.*, 2008). In general high-stake tests are perceived as being stressful, resulting in anxiety (O'Neil & Abedi, 1992). Test anxiety is also believed to be a learned condition (Pekrun, 2000) and therefore the present sample might not have incorporated such experience. Further, one important aspect stressed by the National Board of Education was to play down the test situation, thus deemphasising possible negative consequences of large scale testing. The pupils being studied thus might not have experienced any high levels of test anxiety. Notwithstanding, the more test-anxious pupils in the sample performed more poorly in mathematics; and in size and direction this is consistent with other studies of test anxiety and academic performance (Putwain *et al.*, 2010). No difference was observed between boys and girls in reported test anxiety, which also is in line with previous research on this age group (Lowe & Lee, 2008).

Test anxiety is a learnt condition with many aspects influencing. Order and delivery of teaching, individual dispositions and context are some. Mathematics is further not a unidimensional subject but consists of many competencies necessary to consider. Several significant correlations were observed between mathematical performance and CTAS measurements. The regression analysis also revealed that the CTAS contributed different to performance in subtests. Overall, the CTAS explained 20% of the variance for the total mathematical score, significant predictor being "thoughts". Thus on a general level it seems like pupil were a bit worried for the national test. In Patterns 16% of the variance was significantly explained by the model of CTAS with significant predictor "autonomic reactions". One reason for this outcome might be the assignments in hand; the pupils were asked in several tasks, to draw own detailed pictures or patterns, which was time consuming and perhaps stressful at that time. "Autonomic reactions" is a state of test anxiety being experienced when having the test, and not a feeling brought with the pupil to the test like "thoughts" (Zeidner, 2007). The total model of CTAS significantly explained 20% of the

variance for Mass and Time; 13% for Number understanding; and 11% for Mathematical problems; significant predictor in all subtests being “thoughts”. Mass and Time is a mathematical area commonly connected with difficulties. Children and adults find those tasks hard to solve (NCTM, 2000). Pupils categorised as having major difficulties with mathematics in general have problem with number sense. These pupils lack a basic innate understanding of numbers (Jordan *et al.*, 2006). Problem solving involves a complexity of conceptual knowledge to understand the situations described in those problems. Thus, this is a demanding task to manage, requiring a good working memory capacity (Andersson, 2007). High demands on the working memory as in those competencies mentioned, together with anxious thoughts steal additional capacity of the working memory resulting in poor solving (Hadwin *et al.*, 2005). The subscale “thoughts” as the significant predictor to the variance for Mass and Time, Number understanding and Problem solving can here be interpreted as a predisposition loading on the working memory (Zeidner, 2007). Regarding Mental arithmetic and Written arithmetic algorithms, which had no significant relations with CTAS this could be due to being typical routine mathematics text book tasks, which the pupils are used to work with. They felt familiar with the design and contents of the tasks (Araki, 1992).

The present study is done with a rather small sample, limiting the conclusions that can be made based on these results. Thus any far reaching conclusions about the national situation drawn from this small sample of 83 pupils may not be convincing. Even if the variances could be significantly explained by CTAS, the variances in the subtests are also small and no other variables are included in the model like parents background, teacher’s role *etcetera*; however, test anxiety does have some influence since the correlations are negative and significant. The authors therefore suggest two educational implications; primary teachers should start to actively intervene to reduce test anxiety and its negative effects. Different mathematical competencies also need to be dealt with separately in regards to test anxiety. Nevertheless, the impact test anxiety will have on Swedish pupils is for the future to tell. Swedish primary pupils till now have not had national tests, but with increased experience in test and evaluative situations, the question is if they might become accustomed to testing, developing a resistance to anxiety, or acquire the learning of test anxiety.

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