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Trait-anxiety's moderating role in predicting academic performance improvement in PISA[4]

Abstract

In our research we explored the moderating effect of trait-anxiety on improving academic performance during one year. A large sample of 3457 adolescents (1695 girls and 1762 boys) aged from 16 to 17 years took part in the Polish extension in 2009 of the OECD (Organisation for Economic Co-operation and Development) Program for International Student Assessment (PISA) measuring mathematics, reading and science skills. After 12 months they completed the academic performance test once again, and trait and state-anxiety was measured using STAI (State-Trait Anxiety Inventory). Trait-anxiety moderated the change in performance in mathematics but not in science or reading. A high level of trait-anxiety impaired mathematics skills development. Additionally three models for mathematics, reading and science were tested in which state-anxiety predicted 2010 academic performance in these domains.

Key words: trait-anxiety, state-anxiety, academic performance, adolescence, PISA

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Streszczenie

Nasze badanie miało na celu sprawdzenie, czy cecha lęku może być moderatorem poprawy wyników edukacyjnych w ciągu jednego roku. Badanie prowadzone było w ramach opcji krajowej PISA (Program for International Student Assessment – Program Międzynarodowej Oceny Umiejętności Uczniów koordynowany przez OECD), w ramach której zmierzono umiejętności matematyczne, czytanie i interpretację oraz rozumowanie w naukach przyrodniczych u 3457 nastolatków (1695 dziewcząt i 1762 chłopców). Po 12 miesiącach badani jeszcze raz rozwiązali test umiejętności, a także wypełnili Inwentarz Stanu i Cechy Lęku. Okazało się, że cecha lęku moderowała zamianę w wynikach z matematyki, ale nie z czytania, czy przyrody. Wysoki poziom cechy lęku obniżał rozwój umiejętności matematycznych. Dodatkowo przetestowano 3 modele dla drugiego pomiaru matematyki, czytania i przyrody dokonanego w 2010 roku, w których predyktorem okazał się stan lęku.

Słowa kluczowe: cecha lęku, stan lęku, wyniki w nauce, okres dojrzewania, PISA

Studies exploring the relationship between anxiety and academic performance take into account trait- and state-anxiety or test-anxiety. As Derakshan and Eysenck (2009) state, "it is a matter of practical and theoretical importance to develop an understanding of the effects of anxiety on cognitive performance" (p. 168). In this article we focus on trait anxiety (individual differences in anxiety as a personality dimension) and on state anxiety (a mood state) both measured by the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). Understood as such, state anxiety is an aversive motivational condition that occurs when the level of a perceived threat to the individual is high. As Eysenck & Calvo (1992) note, it is interactively determined by trait anxiety and by situational stress. There is a considerable body of research devoted to the relationship between anxiety and cognitive performance (see Eysenck and Calvo, 1992, for a review). A large number of studies show a negative relationship between trait-anxiety and academic performance operationalized usually as a grade-average, the result in an academic achievement test or final examination or graduation grade (e. g. Spielberger, 1966, Anson, Bernstein & Hobfall, 1984; Hulse et al., 2007; Siddique, La Salle-Rici, Glass, Arnkoff & Diaz, 2006; Petrie & Russel, 1995; Grinnell & Kyte, 1979). A negative relationship was also established for trait-anxiety and creative thinking or motor skills performance (Byron & Khazanhi, 2011; Morris, Smith, Andrews & Morris, 1975). The results predominantly show that anxiety regarded as a personality dimension (trait anxiety) as well as a transitional mood state (state anxiety) impairs performance, especially when the task being performed is complex and attentionally demanding (Eysenck and Calvo, 1992).

There are also many studies in which the relation between test-anxiety and academic achievement has been analyzed. These works predominantly show that more test-anxious students have poorer academic performance (f. ex. Sarason, 1960; Allen, 1970; Hunslay, 1985; Munz, Costello & Korabik, 1975; Chapell et al., 2005; Eum & Rice, 2011; Nathan & Fordham, 2000; Raffety, Smith & Placek, 1997). Meta-analysis results indicate as well that academic performance deteriorates along with anxiety growth (Hembree, 1988; Seipp & Heinrich, 1991), and a stronger effect is observed for test-anxiety (d = -.46) than for general anxiety (d = -.32). It was also found in meta-analysis that anxiety reducing interventions contribute to improvement of school grades with a medium size effect ranging from d = .39 for academic tests results to d = .61 for grade-averages (Schwarzer, 1990) with a mean effect size d = .40 (Hattie, 2009).

In the relevant literature some possible theories were proposed explaining the processes underlying the relation between anxiety and academic performance.

One of the earliest theories developed by Wine (1971) explained the difference in the performance of high and low anxious students by the varying ability to focus on the task. While the low anxious student is able to focus all required attention on the task during a testing situation, the high anxious test taker is focused on his or her internal self and the feeling of anxiety. The attention of high anxious students is then divided between themselves and the test and therefore they do not perform as well as less anxious pupils. Another classic theory by Liebert and Morris (1967) focuses on cognition (worry) and emotion engaged in performance impairment due to anxiety. Cognitive factors, such as negative expectations but also emotional components manifesting themselves by increased heart rate or muscle tension, create the feeling of anxiety, but it is the cognitive factors that have the strongest connection to performance.

Other conceptualizations are focused on negative thoughts, self-efficacy, and worry and are recognized as effects of state-anxiety, which in turn could be predicted by trait-anxiety (e. g. Beck & Emery, 1985; Diaz, Glass, Arnkoff & Tarnofsky-Kraff, 2001; Siddique, La Salle-Rici, Glass, Arnkoff & Diaz, 2006). In some early theories Spielberger (1966 & 1972) argued that trait-anxiety effects state-anxiety in such a way that in a threatening situation (e. g. a test or examination situation) a person with higher trait-anxiety will react with higher state-anxiety, which then would impair performance more in complicated than in simple tasks. In his other research Spielberger also agreed that the relationship between trait-anxiety and performance might also be direct (King, Heinrich, Stephenson & Spielberger, 1976).

Nowadays there are two main groups of theories that attempt to explain compromised performance in pressured situations (DeCaro, Thomas, Albert & Beilock,

2011). The first group consists of explicit monitoring theories, which state that pressure may cause an increased self-consciousness, inward focus and step-by-step monitoring of the activity what can inhibit one's ability to execute the task. The second group of theories, better supported by my study results (Beilock & Ramirez, 2011), are the distraction theories. Those theories state that high-pressure environments create a dual-task situation, in which the person's attention is divided between the task and worries (negative thoughts about the consequences of poor performance). Attention is an important part of working memory which is a system that holds several pieces of information in mind while inhibiting irrelevant information. Working memory is a limited resources though, and emotional stimuli like stress can easily reduce its potential to focus on relevant information. Such emotional stimuli may then dominate thoughts, and any attempt to suppress the anxious feeling will require an additional working memory (Beilock & Ramirez, 2011). Research has accordingly found that tasks that rely heavily on working memory are the ones that suffer the most during pressure (Beilock & Ramirez, 2011). DeCaro et al. (2011) found also that performance on a rule-based task that heavily relies on working memory was impaired mostly by the outcome pressure (in which an individual performance is influenced by the consequences of the testing result), while performance on an information-integration task was diminished rather by the monitoring pressure (created by the presence of an audience).

Referring to distraction theories, Eysenck and Cavalo (1992) proposed in their Processing Efficiency Theory (PET) and later in the Attention Control Theory (Derakshan and Eysenck, 2009) that high levels of worry related to anxiety, drain cognitive resources and diminish working memory capacity, thereby leading to reduced efficiency with greater amounts of time and effort required to achieve typical levels of performance on cognitive tasks. Research on working memory as a mediator between trait-anxiety and academic performance supports that model (Owens, Stevenson, Norgate & Hadwin, 2008).

Current research

Although so much research confirms the negative relationship between anxiety and educational outcomes, still there are some results which show no relation between these variables (Allen, Giat & Cherney, 1974; Robbins, Spence & Clark, 1991; Stewart, Lam, Betson, Wong & Wong, 1999; Diaz, Glass, Arnkoff & Tarnofsky-Kraff, 2001). In some studies it was even found that higher or medium trait-anxiety was associated with better academic performance (Mellanby & Zimdras, 2011; Fernandez-Castillo, Gutierrez, Rojas & Esperanza, 2009; Calapaglu et al., 2011). Conflicting results convinced us that more research on well selected sam-

ples is needed in this area. We also noticed that there is no research (or at least we do not know of any) on achievement growth in contrast to the large body of studies exploring the relation between anxiety and academic performance. In addition samples studied in most of the research cited include undergraduate or graduate students while very few researchers ask about the effects of anxiety on the academic achievement of a younger population. Our research was designed to find out whether trait-anxiety impairs not only academic performance but also improvement in, and growth of, knowledge and skills in mathematics, reading and science among 16-17 year old adolescents during a 12-month period. We also wanted our sample to be representative and the academic competences measurement instrument to be precise. We were able to achieve the standard set by integrating our research with the OECD (Organisation for Economic Co-operation and Development) Programme for International Student Assessment (PISA) procedures. PISA assesses how far students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in society. In all cycles, the domains of reading, and mathematical and scientific literacy are covered not merely in terms of mastery of the school curriculum, but in terms of important knowledge and skills needed in adult life (OECD 2009a; Federowicz 2010). PISA is a pencil-and-paper test with multiple-choice items and questions requiring students to construct their own responses. The assessments last a total of two hours for each student. The last cycle took place in March of 2009 when 74 countries participated in the assessment. To achieve the main objective of our research, which was to determine whether trait-anxiety impairs performance improvement, the PISA test (with different but comparable tasks) was administered once again one year later in April 2010 to the same group of students along with state- and trait-anxiety assessment. We also controlled for other factors: self-esteem, hope for success, social competences and nonverbal intelligence.

Basing on previous results and theories like PET or ACT (Derakshan and Eysenck, 2009; Beilock and Ramirez, 2011), we could predict that trait and state anxiety would be negatively related to mathematical, reading, and scientific literacy in the 2009 and 2010 measurements. We also hypothesized that other psychological variables (self-esteem, hope for success, social competences and nonverbal intelligence) would be positively associated with the results of both assessments but that trait-anxiety would have a significant effect on academic performance, over and above that made by control variables. Concerning the moderating role of trait-anxiety for academic outcome, we expected that teenagers with the highest levels of anxiety would improve their mathematical, reading and scientific literacy the least in comparison with less anxious participants. We also wanted to test whether trait-anxiety will predict academic performance in 2010 directly

or whether the relationship will be mediated by state-anxiety. According to Spielberger we expected that mediation will be more probable than solely a direct effect.

Although our prediction is based on well-established theories connecting high anxiety poorer performance during testing, we should underline that PISA is a low-stake test which means that it holds no important consequences for the taker and as such it may not put enough pressure on the student to elevate the level of state anxiety. If the level of state anxiety would be low, then one can suspect that even highly trait-anxious students will be able to concentrate their attention on the task well enough. On the other hand when we take under consideration the improvement of students' performance, then it is not only the single test situation that counts by putting stress on the individual and distracting his or her attention, but the whole process of learning that might suffer in anxious children producing smaller improvements after a year. In that case trait anxiety could influence skill growth.

Method

Participants

The study was conducted on a representative sample of secondary school students from Poland who attended their first year in 2009 (aged 16-20, M = 17.5, SD = .05). The sample was selected in a stratified two-stage sampling procedure. In the first stage, the sampling units were schools divided into four strata by school type (general upper secondary, two types of vocational secondary, basic vocational). Within each stratum schools were randomly selected with a probability proportional to the number of classes at stage one. In the second stage, one class from stage one in each school was selected at random with equal probability (Federowicz, 2010). Because the age range of the participants was large due to some basic vocational school students – most likely several-time grade-repeaters – we decided to include in our analysis only the students who were from 15.7 to 17.7 years old at the time of the first wave (±1 year from the mean age). Therefore, the number of students included in our analysis was 3457 (1695 girls and 1762 boys). Age distribution in various school-types was very similar. During the first measurement the youngest general and profession oriented high-school students were 15.7 years old, four-year vocational schools pupils were 15.8 years old and basic vocational school students were 16.1 years old. The oldest general high-school students were 17.5 years old and in other school types the oldest students were 17.7 years old.

Measures

Anxiety Measure

To measure anxiety we used the *State-Trait Anxiety Inventory* (STAI) by Spielberger, Gorsuch, and Lushene (1970) in its Polish adaptation by Wrześniewski, Sosnowski, Jaworowska and Fecenec (2006). It is a self-report instrument that differentiates between the temporary condition of state anxiety and the longstanding quality of trait anxiety. The STAI consists of 40 items. The test is split into a State-Anxiety scale and a Trait-Anxiety scale, each having 20 items. The scale uses a 3-point (1 = almost never, 2 = sometimes, 3 = often) Likert-type scale, where higher scores indicate higher levels of anxiety. Separate scores for State and Trait anxiety can be found (maximum score = 60 in each scale). Internal consistency of STAI in the current sample has been good, with Cronbach's .87 alpha for state-anxiety and .84 for trait-anxiety.

Academic Performance

Polish adaptations of the PISA instrument were used to measure academic performance. A two-hour rotated test design included an extensive test on the major domain (in 2009: reading) and smaller subtests for two minor domains (mathematics, science). All domains were linked through the use of common test items across booklets, and plausible values were computed as student proficiency estimates. For each domain, sub-sets of link items provided the basis for measuring trends. The dataset included plausible value (PV) estimates for each of the above three subjects, standardized into a score with a mean of 500 and a standard deviation of 100. In the study 16 versions (booklets) of the PISA test were used. Each booklet had a similar level of difficulty. A detailed description of the development of the equal test versions can be found in the Manual (OECD 2009a, 2009b).

Psychological control variables

Non-verbal intelligence. A Polish adaptation of *Raven's Standard Progressive Matrices* (RSPM), by Jaworowska & Szustrowa (2000) was used to measure the general intelligence factor. The RSPM is a pencil-and-paper multiple choice test of non-verbal reasoning ability or general intelligence (Raven, Raven & Court, 2003). The RSPM consists of 60 items arranged in five sets (A, B, C, D, & E) of 12 items each. Each item contains a figure with a missing piece. Below the figure are either six (sets A & B) or eight (sets C through E) alternative pieces to complete the figure, only one of which is correct. For each test item, the subject is asked to identify the missing segment required to complete a larger pattern.

The students were asked to complete the test within 35 minutes. Internal consistency for the Polish RSPM version has been very good, with Cronbach's .99 alpha in the current sample.

Self-esteem. Self-esteem was measured using *The Rosenberg Self-Esteem Scale* (RSES, Rosenberg, 1965) in a Polish version by Dzwonkowska, Lachowicz-Tabaczek and Łaguna (2008). This is a one-dimensional instrument elaborated from a phenomenological conception of self-esteem that captures subjects' global perceptions of their own worth by means of a 10-item scale comprising five positively worded items and five negatively worded items. The scale uses a 4-point (1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree) Likert-type scale. Internal consistency has been good, with Cronbach's .83 alpha in the current sample.

Hope for success. In the study, a Polish version (Łaguna, Trzebiński and Zięba, 2005) of Snyder and others' (1991) Hope Scale was used to measure the respondents' positive expectations. The tool consists of 12 statements. Participants determine the degree to which they consider a statement to be true using a scale from 1 = definitely false to 8 = definitely true. Internal consistency has been good, with Cronbach's .82 alpha in the current sample.

Social Competences. A Polish tool, the *Social Competences Questionnaire (SCQ)* by Matczak (2007), was implemented to measure social competences understood as social, emotional, and intellectual skills and behaviors needed for success as a member of society. In addition to the general index of social competences the questionnaire also provides three scales: assertiveness, coping with social exposition, and management of close peer interactions. The questionnaire consists of 90 items. The subject is asked to assess his or her performance on a 4-point Likert-type scale (from 1 = definitely well to 4 = definitely poor). Internal consistency has been very good, with Cronbach's .93 alpha of in the current sample.

Procedure

The procedure was closely connected to, and dependent on, the design of the PISA study which took place in Poland in March 2009. The national option, which has been conducted as an additional element of PISA 2009 on a representative sample of 200 schools constituted the study group in this project. Participants from this sample took part in the next two waves of the assessment. Six months later, in October 2009, three psychometric instruments measuring psychological control variables were applied in the following order: *Raven's Standard Progressive Matrices,* the *Social Competences Questionnaire* and the *Hope for Success Questionnaire.* The assessment session was conducted in two parts. Firstly students were

asked to complete the RSPM and then after a 15 minute break they were asked to fill in two questionnaires: the Social Competences Questionnaire and the Hope Scale. During the third wave of the survey in April 2010 an additional measurement of academic performance was carried out using PISA instruments. During the first and second measurement, subjects were given different booklets, so that the tasks were never repeated. Individuals were asked to solve a two-hour skills test. After a 15 minute break *The Rosenberg Self-Esteem Scale* and *The State-Trait Anxiety Inventory* were applied. Participants were tested in class groups.

Results

Statistical analysis of the data was conducted according to the PISA methodology, consisting of weightings (probability weights combined with post-stratification on the number of pupils in the particular school type) to ensure proper inference of population statistics, use of Balanced Repeated Replication to compute robust standard errors, and use of Plausible Values to adjust for errors in measurement of PISA attainment (OECD 2009b). The number of degrees of freedom in the statistical test were computed with respect to the number of Balanced Repeated Replication pseudostrata and not the number of observations (however, with 102 pseudostrata it makes little difference in p-values). Although there is no general agreement whether or not it is appropriate to use survey weights in regression analysis (e.g. DuMouchel & Duncan 1983, Lumley, 2010, p. 104-105), we decided to apply them to be consistent with the PISA methodology (OECD, 2009b).

Correlates of Academic Performance

Correlations between anxiety and control variables are shown in Table 1. All correlations but one (that between intelligence and social competences) were significant. Trait and state anxiety were highly positively associated. All control variables were weakly negatively related to state and trait-anxiety. In Table 2 correlations between anxiety, control variables and academic performance measured in 2009 and 2010 are presented. Only social competences were not associated with science assessed in 2009 and 2010, nor with math performance in 2010. All other variables were associated in the way predicted for academic performance in the first as well as in the second assessment. The teenagers with higher hopes for success, global self-esteem and nonverbal intelligence had the better performance results. Conversely higher anxiety (state and trait) was associated with poorer academic performance (in 2009 and 2010).

Anxiety as a predictor of Academic Performance

Standardized regression coefficients and associated p-values for models predicting academic performance in 2009 and 2010 are presented in Table 3. Sex, intelligence, hope for success, social competences and self-esteem were first entered to the 2009 model followed by state-anxiety in 2010. In the next step trait-anxiety was entered in both models to establish whether it would predict academic performance over and above all the control variables. Six regression analyses were run separately for mathematical, reading and scientific literacy in 2009 and 2010. Contrary to our prediction, all regression coefficients for trait-anxiety and first academic competences assessment were insignificant, indicating that trait-anxiety was not a significant predictor of academic performance controlling for sex, intelligence and related psychological constructs. Yet when state-anxiety was entered to the model predicting 2010 academic performance, its impact on PISA 2010 performance was significant. Other significant predictors were sex (boys scored better in math and girls in reading) and intelligence. Also self-esteem explained a significant, but small amount of variance in our models, while hope for success and social competences did not account for a substantial part of the variability in PISA performance.

Trait-anxiety as a moderator of Academic Performance improvement

To find out whether trait-anxiety moderates the performance change in PISA, a change regression between the 2009 and 2010 performances was conducted for three literacy areas: mathematics, reading and science. Anxiety was included in the model as a continuous variable.

Tests of three regression models showed that change in performance was significantly moderated by trait-anxiety only for math ($R^2 = .004$, $\beta = -.06$, $t = -2.41$, $p = .017$), but not for science or reading. Analysis revealed that in mathematics low anxious individuals improved more than highly anxious students because only the linear relation was significant.

Discussion

The present study assessed the relationship between trait and state-anxiety and academic performance improvement. It explored the possibility that trait-anxiety will moderate the change in academic performance observed after one year of education. We also wanted to investigate whether state-anxiety would mediate the relationship between trait-anxiety and academic performance. Along with our expectations, and as expected from many other study results (e. g. Hattie, 2009;

Seipp & Heinrich, 1991), trait and state-anxiety measured in 2010 were negatively related to mathematical, reading and scientific literacy in the first measurement in 2009, and in the second assessment conducted one year later. All psychological control variables with the exception of social competences -- global intelligence, hope for success, and self-esteem -- were related to academic performance in 2009. Similar associations were established for the 2010 performance. The results were in line with literature showing that higher intelligence and self-esteem lead to better school achievement (Rosenberg, Schoder & Schoenbach, 1989; Rosenberg, Schoder, Schoenbach & Rosenberg, 1995; Trembley, Inman & Willms, 2000; Strahan, 2003; Laidra, Pullman & Allik, 2007; Snyder et al., 2002).

However, trait anxiety did not determine the 2009 performance in all three PISA domains over and above control variables (sex, non-verbal intelligence, social competences, hope for success and self-esteem). Trait anxiety is a construct weakly and moderately related to controlled variables (as our study showed) so the multicolinearity could influence this result. However, inclusion of state-anxiety in the 2010 performance model showed that the its effect on performance was significant. It seems that it is rather a transitional mood state evoked by the testing situation that impairs the performance, as distraction theories propose (Eysenck, 2009; DeCaro et al., 2011).

This result is not fully consistent with the literature (Spielberger, 1966, 1972, Beck & Emery, 1985; Diaz, Glass, Arnkoff & Tarnofsky-Kraff, 2001; Siddique, La Salle-Rici, Glass, Arnkoff & Diaz, 2006; Eysenck & Cavalo, 1992), which suggests that high trait-anxiety fosters state-anxiety in a stressful situation which in turn impairs processing efficiency and performance by intensifying worries and redirecting attention from the task to the affective state. State anxiety may therefore disrupt performance through its debilitating effect on cognitive processes (Wine, 1980; Benjamin, McKeachie, Lin & Holinger, 1981; Paulman & Kennely, 1984). Indeed trait and state anxiety were highly correlated in our study, but it was only the state anxiety which explained the substantial amount of variance in performance over control variables.

Nevertheless, the effect of trait-anxiety was evident in the magnitude of change in math and performance but not for reading or science literacy. The result obtained for change in mathematics scores was compatible with the hypothesis that high anxiety would have a debilitating effect on performance growth (long term learning and not only a one-time test performance). Highly anxious participants did not develop their mathematical skills during the year as well as less anxious students, probably due to elevated levels of state anxiety experienced during the course of education. This mechanism by which trait-anxiety may impair the performance improvement could not be assessed in the present results. Others have suggested

(as already described above) that high state-anxiety intensifies negative thinking, negative expectations and worries thereby impairing processing efficiency and, through that, the long-term learning process.

Contrary to our expectations, the level of trait anxiety did not affect science and reading skills growth. Spielberger (1972) has suggested that anxiety may have stronger effects when tasks are perceived as more difficult or important because it is an additional stress factor. Mathematics and are key skills in all educational systems, with the most attention directed to them in the learning process as reflected in the number of hours devoted to them during the week (even up to 6 in Polish schools). Not surprisingly the stress experienced during math lessons would be stronger than that experienced during less important and sometimes even optional subjects related to science (usually 1-2 hours during the week). Another explanation is offered if we refer to the Processing Efficiency Theory (Eysenck & Cavalo, 1992). It can be assumed that science and reading are not only less important but also less difficult subjects. According to PET anxiety reduces cognitive efficiency, but less efficiency is needed to properly solve easy rather than difficult tasks ; so even highly anxious participants could perform sufficiently well. Yet another explanation refers to working memory. Tasks that use more working memory, like math, are the ones that suffer the most in stressful situations (Beilock & Ramirez, 2011).

Conclusions and limitations

In summary, our study extends previous research on the relationship between anxiety and academic performance providing more insight into performance change over time. In most research only grade point average, SAT scores or mid-term test scores were used to evaluate performance. This kind of assessment repeated over time does not provide an adequate level of similarity between the academic skills measured, so the change in skills improvement cannot be assessed. Instead, only prediction of future achievement based on previous performance is possible. In the current study we were able to examine skills development during the year by implementing PISA procedures and measures at both times of assessment. The study was also conducted on a general, national sample of adolescents, making generalization of our results to the relevant population more acceptable. The results highlighted the notion that the level of trait-anxiety moderates the academic progress of adolescents in mathematics and reading but not in science. We have speculated that trait-anxiety was a causal factor, but our study design does not allow us to draw so definite a conclusion. Unfortunately our study design was not longitudinal since anxiety was measured only once after the second

academic performance assessment. A longitudinal study is needed with anxiety measurement carried out some time before the first academic performance assessment in order to establish a causal relationship, and future studies should take this into account. Nevertheless regarding trait-anxiety as a relatively stable personality characteristic, we may assume that it was also stable during the year of our study. If this was so, we may argue that high or even moderate levels of anxiety diminish academic skills development during the whole year, working continuously to the disadvantage of more anxious students. Our study has implications for adolescents experiencing anxiety as well as for school authorities interested in furthering the welfare of their students. Stress management programs should be initiated as well as tutoring and study-skills training to help anxious students overcome their learning problems. Improved academic performance and lower levels of anxiety could make the school experience a more positive and valuable one for the many adolescents who now experience the educational environment as difficult, stressful, and debilitating.

References:

Allen, G. J. (1970). Effect of three conditions of administration on "trait" and "state" measures of anxiety. *Journal of Counseling and Clinical psychology, 34*, 3, 355-359.

Allen, G. J., Giat, L., & Cherney, R. J. (1974). Locus of control, test anxiety, and student performance in a personalized instruction course. *Journal of Educational Psychology, 66*, 6, 968-973.

Anson, O., Bernstein, J., & Hobfoll, S. E. (1984). Anxiety and performance in two ego threatening situations. *Journal of Personality Assessment, 48*, 2, 168-172.

Beck, A. T., & Emery, G. (1985). *Anxiety disorders and phobias: A cognitive perspective.* New York: Basic Books.

Beilock, S. L., Ramirez, G. (2011). On the interpray of emotion and cognitive control: implications for enhancing academic achievement. In: J. P. Mestre, B. H. Ross, (Ed.) *The psychology of learning and motivation*. San Diego, CA, US: Elsevier Academic Press, Vol. 55, 137-169.

Benjamin, M., McKeachie, W., Lin. Y., & Hollinger, D. (1981). Test anxiety: Deficits in information processing. *Journal of Educational Psychology, 73*, 816-824.

Byron, K., & Khazanchi, S. (2011). A meta-analytic investigation of the relationship of state and trait anxiety to performance on figural and verbal creative tasks. *Personality and Social Psychology Bulletin, 37*, 2, 269-283.

Calapoglu, M., Sahin-Calapoglu, N., Karacop, A., Soyoz, M., & Avsaroglu, S. (2011). Serotonin transporter bi- and triallelic genotypes and their relationship with anxiety and academic performance: A preliminary study. *Neuropsychobiology, 63*, 2, 103-111.

Chapell, M. S., Blanding, Z. B., Silverstein, M. E., Takahashi, M., Newman, B., Gubi, A., & McCann, N. (2005). Test anxiety and academic performance in undergraduate and graduate students. *Journal of Educational Psychology, 97*, 2, 268-274.

DeCaro, M. S., Thomas, R. D., Albert, N. B., Beilock, S. L. (2011). Choking under pressure: multiple routes to skill failure. *Journal of Experimental Psychology: General, 140*, 3, 390-406.

Derakshan, N., Eysenck, M. W. (2009). Anxiety, processing efficiency and cognitive performance. New developments from Attentional Control Theory. *European Psychologist, 14*, 2, 168-176.

Diaz, R. J., Glass, C. R., Arnkoff, D. B., Tarnofsky-Kraff, M. (2001). Cognition, anxiety, prediction of performance in 1st-year law students. *Journal of Educational Psychology, 93*, 2, 420-429.

DuMouchel, W. H., & Duncan, G. J. (1983). Using sample survey weights in multiple regression analyses of stratified samples. *Journal of the American Statistical Association, 78,* 535-543.

Dwyer, C. A. (1973). Sex differences in reading: an evaluation and a critique of current theories. *Review of Educational Research, 43*, 4, 455-467.

Dzwonkowska, I., Lachowicz-Tabaczek, K., & Łaguna, M. (2008). *Skala samooceny Rosenberga.* Warszawa: Pracownia Testów Psychologicznych. [*Rosenberg's Self-esteem Scale*.]

Eum, K. & Rice, K. (2011). Test anxiety, perfectionism, goal orientation, and academic performance. *Anxiety, Stress & Coping, 24*, 2, 167-178.

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion, 6*, 409-434.

Federowicz, M. (Eds.). (2010). *PISA. Wyniki badania 2009 w Polsce*. Warszawa: IFiS PAN. [*PISA. Results of the 2009 study in Poland.*]

Feingold, A. (1994). Gender differences in personality: a meta-analysis. *Psychological Bulletin, 116*, 3, 429-456.

Fernandez-Casillo, A., & Guterrez-Rojas, M. E. (2009). Selective attention, anxiety, depressive symptomatology and academic performance in adolescence. *Electronic Journal of Research in Educational Psychology, 7*, 1, 49-76.

Gates, A. (1961). Sex differences in reading ability. *Elementary School Journal, 61*, 8, 431-434.

Grinnell, R. M. Jr., & Kyte, N. S. (1979). Anxiety level as an indicator of academic performance during first semester of graduate work. *The Journal of Psychology, 101*, 199-201.

Hattie, J. A. C. (2009). *Visible Learning. A synthesis of over 800 meta-analysis relating to achievement.* London & New York: Routledge.

Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. *Review of Educational Research, 58*, 47-77.

Hulse, J. A., Chenowith, T., Lebedovych, L., Dickinson, P., Cavanaugh, B., & Garrett, N. (2007). Predictors of student success in the US Army Graduate Program in Anesthesia Nursing. *AANA Journal, 75*, 5, 339-345.

Hunslay, J. (1985). Test anxiety, academic performance, and cognitive appraisals. *Journal of Educational Psychology, 77*, 6, 678-682.

Hyde, J. S., & Linn, M. C. (1988). Gender differences in verbal ability: A meta-analysis. *Psychological Bulletin, 104*, 1, 53-69.

Jaworowska, A., & Szustrowa, T. (2000). *Test Matryc Ravena. Wersja Standard. Podręcznik.* Warszawa: Pracownia Testów Psychologicznych. [*The Raven's Matrices. Standard Version. The manual.*]

King, F. J., Heinrich, D. L, Stephenson, R. S., & Spielberger, C. D. (1976). An investigation of the causal influence of trait and state anxiety on academic achievement. *Journal of Educational Psychology, 68*, 3, 330-334.

Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin, 125*, 4, 470-500.

Laidra, K., Pullman, H., & Allik, J. (2007). Personality and intelligence as predictors of academic achievement: A cross-sectional study from elementary to secondary schools. Journal of *Personality to Individual Differences, 42*, 3, 441-451.

Liebert, R. M., Morris, L. W. (1967). Cognitive and emotional components of test anxiety. A distinction and some initial data. *Psychological Reports, 20*, 957-978.

Lumley, T. (2010). *Complex Surveys. A Guide to Analysis Using R*. New Jersey: Wiley.

Łaguna, M., Trzebiński, J., & Zięba, M. (2005). *Kwestionariusz nadziei na sukces. Podręcznik.* Warszawa: Pracownia Testów Psychologicznych. [*Hope for Succes Questionaire. The manual*.]

Margalit, M. & Eysenck, S. (1990). Prediction of coherence in adolescence: Gender differences in social skills, personality, and family climate. *Journal of Research in Personality, 24*, 4, 510-521.

Matczak, A. (2007). *Kwestionariusz Kompetencji Społecznych. Podręcznik.* Warszawa: Pracownia Testów Psychologicznych [*Social Competencies Questionaire. The manual*.]

Mellanby, J., & Zimdars, A. (2011). Trait anxiety and final degree performance at the University of Oxford. *Higher Education: The International Journal of Higher Education and Educational Planning, 61*, 4, 357-370.

Morris, L. W., Smith, L. R., Andrews, E. S., & Morris, N. C. (1975). The relationship of emotionality and worry components of anxiety to motor skills performance. *Journal of Motor Behavior, 7*, 2, 121-130.

Muntz, D. C., Costello, C. T., & Korabik, K. (1975). A further test of the inverted-U hypothesis relating achievement anxiety and academic test performance. *The Journal of Psychology, 89*, 39-47.

Nathan, J. S., & Fordham, U. (2000). The impact of test anxiety on metacognitive knowledge monitoring. *Dissertation Abstracts International: Section B: The Sciences and Engineering, 61* (6-B), 3302

OECD. (2009a). *PISA PISA 2009 Assessment Framework*. Paris: OECD.

OECD. (2009b). *PISA Data Analysis Manual: SPSS, Second Edition*. Paris: OECD.

Owens, M., Stevenson, J., Norgate, R., & Hadwin, J. (2008). Processing efficiency theory in children: Working memory as a mediator between trait anxiety and academic performance. *Anxiety, Stress, & Coping, 21*, 4, 417-430.

Paulman, R. G. & Kennely, K. J. (1984). Test anxiety and ineffective test taking: Different names, same construct. *Journal of Educational Psychology, 76*, 279-288.

Petrie, T. A., & Russel, R. K. (1995). Academic and psychosocial antecedents of academic performance for minority and nonminority college football players. *Journal of Counseling and Development, 73*, 615-620.

Raven, J., Raven, J. C., & Court, J. H. (2003). *Manual for Raven's Progressive Matrices and Vocabulary Scales.* San Antonio, TX: Harcourt Assessment.

Raffety, B. D.,Smith, R. E., Ptacek, J. T. (1997). Facilitating and debilitating trait anxiety, situational anxiety, and coping with and anticipated stressor: A process analysis. *Journal of Personality and Social Psychology, 72*, 4, 892-906.

Robins, A. S., Spence, J. T., & Clark, H. (1991). Psychological determinants of health and performance: The tangled web of desirable and undesirable characteristics. *Journal of Personality and Social Psychology, 61*, 5, 755-765.

Rosenberg, M. (1965). *Society and the adolescent self-image.* Princeton, NJ: Princeton University Press.

Rosenberg, M., Schooler, C., & Schoenbach, C. (1989). Self-esteem and adolescent problems: Modeling reciprocal effects. *American Sociological Review, 54*, 1004–1018.

Rosenberg, M., Schoder, C., Schoenbach, C., & Rosenberg, F. (1995). Global self-esteem and specific self-esteem: different concepts, different outcomes. *American Sociological Review, 60,* 141-156.

Sarason, I. G. (1960). Empirical findings and theoretical problems in the use of anxiety scales. *Psychological Bulletin, 57*, 403-415.

Schwarzer, R. (1990). Current trends in anxiety research. In P. J. D. Drenth, & J. A. Sergeant (Eds), *European perspectives in psychology* (pp. 225-244). Oxford, England: John Wiley & Sons.

Seipp, B. & Heinrich, H. (1991). Anxiety and academic performance: A meta-analysis of findings. *Anxiety Research, 4*, 1, 27-41.

Siddique, H. I., LaSalle-Ricci, V. H., Glass, C. R., Arncoff, D. B., & Diaz, R. J. (2006). Worry, optimism, and expectations as predictors of anxiety and performance in the first year of law school. *Cognitive Theory Research*, *30*, 667-676.

Sneider, H. S., Shorey, H. S., Cheavens, J., Pulvers, K. M., Adams, V. H. III, & Wiklund, C. (2002). Hope and academic success in college. *Journal of Educational Psychology, 94*, 820-826.

Snyder et al. (1991). The Will and the Ways: development of and validation of an individual-differences measure of Hope. *Journal of Personality and Social Psychology*, 60, 570-585.

Spielberger, C. D. (1966). Theory and research on anxiety. In: C. D. Spielberger (Eds.), *Anxiety and behavior*. New York: Academic Press.

Spielberger, C. D., Gorsuch, R. L., & Lushene. R. E. (1970). *Manual for the Anxiety Inventory.* Palo Alto, CA: Consulting Psychologists Press

Spielberger, C. D. (1972). *Anxiety: Current trends in theory and research*. New York: Academic Press.

Stewart, S. M., Lam, T. H., Betson, C. L., Wong, C. M., & Wong, A. M. P. (1999). A prospective analysis of stress and academic performance in the first two years of medical school. *Medical Education, 33*, 243-250.

Strahan, E. Y. (2003). The effects of social anxiety and social skills on academic performance. *Personality and Individual Differences, 34*, 2, 347-366.

Trembley, M. S., Inman, J. W., & Willms, J.D. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. *Pediatric Exercise Science, 12*, 312-323.

Wine, J. (1971). Test anxiety and direction of attention. *Psychological Bulletin, 76*, 2, 92-104.

Wine, J. (1980). Cognitive-attentional theory of test anxiety. In: I.G. Sarason (Ed.) *Test anxiety: theory, research, and applications*. Hilsdale, NJ: Erlbaum.

Wrzesniewski, K., Sosnowski, T., Jaworowska, A, & Fecenec, D. (2006*). Inwentarz Stanu i Cechy lęku. Polska adaptacja STAI. Podręcznik.* Warszawa: Pracownia Testów Psychologicznych [*State and Trait Anxiety Inventory. Polish adaptation of STAI. The manual*.]

Table 1. *Correlations (r) between anxiety and control variables*

Variables	1	2	3	4	5	6
(1) Raven Matrices	-	.118**	.034	.123**	-.110**	-.122**
(2) Hope for Success		-	.559**	.356**	-.295**	-.218**
(3) Social Competences			-	.295**	-.245**	-.189**
(4) Self-Esteem				-	-.641**	-.451**
(5) Trait-Anxiety					-	.619**
(6) State-Anxiety						-

Note. ** $p < 0.01$

Table 2. *Correlations (r) between anxiety, control variables and academic performance*

	PISA 2009			PISA 2010		
Variables	Math	Reading	Science	Math	Reading	Science
Measured in 2009						
Raven Matrices	.680**	.625**	.607**	.686**	.624**	.621**
Hope	.121**	.121**	.121**	.119**	.105**	.094**
Social Competences	.049*	.084**	.039	.017	.076*	.027
Measured in 2010						
Self-Esteem	.160**	.135**	.145**	.162**	.136**	.132**
Trait-Anxiety	-.128**	-.930**	-.122**	-.149**	-.106**	-.124**
State-Anxiety	-.141**	-.134**	-.147**	-.191**	-.175**	-.166**

Note. * $p < .05$; ** $p < .001$

Table 3. *Standardized regression coefficients (*β*) in the models predicting performance in PISA 2009 and 2010*

	PISA 2009			PISA 2010		
Predictors R^2	Math 09 .47	Reading 09 .43	Science 09 .37	Math 10 .48	Reading 10 .44	Science 10 .39
Sex	-.18***	.40***	-.04	-.13**	.44***	.00
RSPM	.67***	.60***	.59***	.67***	.60***	.61***
HS	.03	.02	.04*	.03	.01	.01
SCQ	.00	.01	-.02	-.04*	-.02	-.02
RSQ	.07**	.06**	.05*	.05**	.05*	.03
Trait-A	.01	-.01	-.01	.03	.03	.02
State-A	-	-	-	-.10***	-.10***	-.09***

Note. * $p < .05$; ** $p < .01$; * $p < .001$; Sex: 0 - M, 1 – F (RSPM – Raven Standard Progressive Matrices, HS – Hope Scale, SCQ – Social Competencies Questionnaire, RSQ – Rosenberg Self-esteem Questionnaire, Trait/State-A – Trait/State-anxiety)