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Further evidence for the deficit account of the test anxiety–test performance relationship from a high-stakes admission testing setting

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ABSTRACT

Based on meta-analytic evidence of a moderate negative correlation between test anxiety and test performance some researchers hypothesized that trait test anxiety may induce measurement bias. Two competing models have been advanced to account for the observed test anxiety–test performance relationship: the deficit hypothesis and the interference hypothesis. The interference hypothesis predicts that trait test anxiety induces measurement bias in items of intermediate difficulty, while the deficit hypothesis claims that test anxiety has no causal effect on test performance. Despite the practical relevance of this topic only few studies directly tested these predictions and none of them was conducted in real life high-stakes settings, which may limit the ecological validity of their findings. Therefore we tested these competing predictions in a high-stakes admission testing situation by means of structural equation modeling and item response theory analyses. A total of N = 1768 applicants to a medical university participated in the present study. After completing four cognitive ability tests as part of the admission test respondents filled a trait test anxiety questionnaire, which measured trait worry, trait task-irrelevant thinking and trait emotionality. In line with previous findings the results indicated that none of the trait test anxiety components induced measurement bias across different levels of trait test anxiety. Thus, the present findings were most consistent with a deficit account of the test anxiety–test performance relationship.

1. Introduction

Due to the increased use of high-stakes admission testing there have been renewed concerns about the fairness of admission tests. Test fairness is compromised, if two groups of test-takers of equal level of ability, who differ in construct-irrelevant factors (e.g. test anxiety), do not have identical expected item- and/or test scores (e.g. Drasgow, 1987; Millsap, 2011; Mislevy et al., 2013; Rajo, Laffine, & Byrne, 2002). If this is the case, the admission test exhibits measurement bias. Consequently, within- and between group differences in test performance cannot be attributed to the same latent trait (Lubke, Dolan, Kelderman, & Mellenbergh, 2003) and the test scores reflect individual differences in construct-irrelevant factors in addition to individual differences in the latent ability trait(s) of interest.

Based on the meta-analytic evidence of a moderate negative (meta-analytic mean r = −.23 to −.33) correlation between test anxiety and test performance (cf. Ackerman & Heggestad, 1997; Hembree, 1988) some researchers (e.g. Hembree, 1988) hypothesized that test anxiety may induce measurement bias, which leads to a systematic underestimation of the cognitive ability of more test-anxious test takers. Despite its practical relevance only few studies directly tested this hypothesis (Halpin, da-Silva, & De Boeck, 2014; Reeve & Bonaccio, 2008; Sommer & Arendasy, 2014) and none of them was conducted in a real-life admission test setting even though the likelihood of measurement bias due to test anxiety might be even larger in these settings than in low-stakes testing situations.

1.1. Definition of test anxiety

Test anxiety refers to a situation-specific anxiety experienced in evaluative situations, which consists of *cognitive components*, such as worry and test-irrelevant thinking, and *affective components*, such as emotionality and bodily symptoms (Putwain, 2008; Zeidner, 1998). The distinction between cognitive and affective components of the test anxiety construct has been confirmed in several factor analytic studies (e.g. Benson & Bandalos, 1992; Hodapp & Benson, 1997; Keith, Hodapp, Schermelleh-Engel, & Moosbrugger, 2003; Lowe, 2015; Sarason, 1984; Sommer & Arendasy, 2014; Wacker, Jaunzeme, & Jaksztat, 2008). The cognitive component *worry* refers to negative thoughts and concerns about the outcome of the assessment, while *task-irrelevant thinking* denotes interfering thoughts unrelated to the content and outcome of the assessment. The affective component, on the other hand, comprises *physiological reactions*

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(e.g. increased heart rate and headache) and the feeling of being nervous and tense (*emotionality*).

1.2. Relation between test anxiety components and test performance

Research indicated that the cognitive components of test anxiety are more strongly correlated with test performance than the affective components (cf. Cassady & Johnson, 2002; Hembree, 1988; McCarthy & Goffin, 2005; Powers, 1986). In addition, the correlation between the affective components of test anxiety (emotionality) and test performance has been shown to decrease, when individual differences in the cognitive components (worry and task-irrelevant thinking) were controlled for. By contrast, controlling for individual differences in the affective component essentially left the correlation between the cognitive component and test performance unchanged (cf. Hembree, 1988; Powers, 1986). These findings corroborate the factor analytic evidence on the separability of affective and cognitive components and indicate that the test anxiety–test performance relationship is mainly driven by the cognitive components.

1.3. Factors affecting the test anxiety–test performance relationship

Research indicated that the size of the correlation coefficient between test anxiety and test performance depends on characteristics of the cognitive ability tests and situational factors.

1.3.1. Effect of test characteristics and cognitive ability domain

One meta-analysis (Ackerman & Heggestad, 1997) showed that more g-saturated cognitive ability domains were more strongly correlated with test anxiety than less g-saturated cognitive ability domains. This finding is consistent with results indicating that test anxiety primarily correlated with psychometric g (cf. Reeve & Bonaccio, 2008; Salthouse, 2012; Sommer & Arendasy, 2014). This conclusion is further corroborated by findings (cf. Goetz, Preckel, Pekrun, & Hall, 2007; Johnson & Gronlund, 2009), which indicated that test anxiety is more strongly correlated with test performance in samples of less capable test-takers than in samples of more capable test-takers. This may either indicate that test anxiety has a larger causal effect on more g-saturated cognitive ability test, or that less cognitive able test-takers are more prone to experience test anxiety. Furthermore, the difficulty of the test items has also been shown to affect the size of the test anxiety–test performance relationship (cf. Hembree, 1988; Hong, 1999). Test anxiety was more closely linked to test performance for tests of intermediate to higher difficulty (meta-analytic mean $r = -.45$) than for tests of lower difficulty (meta-analytic mean $r = -.07$). Again, this may indicate that test anxiety has a more pronounced causal effect on harder test items, or that harder test items are generally more anxiety provoking.

1.3.2. Effect of situational factors

Research also indicated that the size of the test anxiety–test performance relationship is higher if test anxiety is measured after completing the cognitive ability test battery (cf. Stohbeck-Kühner, 1999; Zeidner, 1991). A possible explanation for this finding is that test anxiety experienced during test-taking primes emotion-congruent memories which affect test-takers' answers to the post-test test anxiety questionnaire (c.f. Zeidner, 1998). Alternatively, less competent test-takers may simply elevate their test anxiety scores in an attempt to maintain their self-worth (cf. Smith, Snyder, & Handelsman, 1982). Furthermore, there is evidence that test-takers experience more test anxiety in high- than in low-stakes settings, which potentially affects the size of the correlation between test anxiety and test performance if test anxiety is causally related to test performance (cf. Bonaccio & Reeve, 2010; Nie, Lau, & Liau, 2011; Powers, 1986; Reeve, Bonaccio, & Charles, 2008).

2. Explaining the test anxiety–test performance relation

Two competing classes of theoretical models have been advanced to explain the test anxiety–test performance relationship: the *deficit models* and the *interference models* (cf. Hembree, 1988; Reeve & Bonaccio, 2008; Sommer & Arendasy, 2014; Wicherts & Scholten, 2010; Zeidner, 1998).

2.1. Deficit models

The *deficit model* posits that test performance and test anxiety are merely correlated but test anxiety has no causal effect on test performance. In this model the observed test anxiety–test performance relationship is hypothesized to be the result of test-taker reporting higher levels of test anxiety because they are becoming increasingly aware of their deficits during test-taking (cf. Bishop, 2009; Cassady, 2004; Klinger, 1984; Paulman & Kennelly, 1984; Smith et al., 1982; Stohbeck-Kühner, 1999; Tobias, 1985; Zeidner, 1991, 1998). Thus, test anxious test-takers can be characterized by specific deficits in the cognitive ability domains measured (e.g. Klinger, 1984; Paulman & Kennelly, 1984; Smith et al., 1982; Tobias, 1985; Zeidner, 1991, 1998), or by more general deficits in attentional control processes involved in various cognitive abilities (e.g. Bishop, 2009; Stohbeck-Kühner, 1999). In both cases the deficit model predicts, that individual difference in trait test anxiety does not induce measurement bias (cf. Halpin et al., 2014; Reeve & Bonaccio, 2008; Sommer & Arendasy, 2014; Wicherts & Scholten, 2010).

2.2. Interference models

The *interference model* argues that test anxiety prevents test anxious respondents from performing at their true level of ability. This implies that test anxiety has a causal detrimental effect on test performance and should induce measurement bias (cf. Halpin et al., 2014; Reeve & Bonaccio, 2008; Wicherts & Scholten, 2010). Wine (1971; Sarason, 1984) hypothesized, that less trait test anxious test-takers solely focus on the task at hand, while more trait test anxious test-takers also engage in worrisome cognitions and task-irrelevant thoughts, which shift their focus of attention away from the test item and increasingly decreases their probability to solve the test items as the items become more demanding. Eysenck and associates (e.g. Eysenck & Calvo, 1992; Eysenck & Derakshan, 2011) proposed two alternative interference models, which have been referred to as processing efficiency theory and attentional control theory. Both models predict that test anxiety temporarily reduces the cognitive resources available to problem solving due to interfering worrisome cognitions and task-irrelevant thoughts during test taking, or the need to regulate ones emotions during test-taking (cf. Bertrams, Englert, & Dickhäuser, 2010; Schutz, Di Stefano, Benson, & Davis, 2004). This leads to a reduction in the efficiency at which the cognitive component processes involved in solving the test items can be carried out. For easier items this reduction in processing efficiency should have no effect on test performance because test-takers have sufficient cognitive resources available to solve them. This may explain, why test anxiety is less strongly related to test performance for easier tests (cf. Section 1.3.1). Similarly, items that are way too difficult should not be affected either, because solving these items already exceeds the test-takers' capacity limits. However, in case of items of intermediate difficulty the reduction in processing efficiency should detrimentally affect the test-takers' solution probability because these items require attentional control and mental effort to ensure that the cognitive component processes involved in solving these items are carried out accurately (cf. Section 1.3.1. and a recent fMRI study conducted by Dunst et al., 2014). Thus, processing efficiency theory and attentional control theory predict that trait test anxiety induces measurement bias and items of intermediate difficulty should be affected the most