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STATISTICAL PERFORMANCE

The Relationship between Statistics Anxiety and Statistical Performance

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Background. Many students experience statistics anxiety, which is a feeling of worry that is experienced when statistics are encountered in any form. Self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits seem to be related to statistics anxiety, which in turn seems to have a negative effect on performance in statistics. **Aim.** The aim of this study was to investigate 1) the relationship between statistics anxiety and statistical performance, 2) the relationship between self-efficacy, previous academic experience, attitudes towards statistics, the big five personality traits conscientiousness, openness, neuroticism, agreeableness and extraversion, and statistics anxiety, and 3) the role of statistics anxiety as mediator between self-efficacy, previous academic experience, attitudes towards statistics, big five personality traits and statistical performance. **Method.** The sample consisted of 50 undergraduate psychology students. Questionnaires were used to assess the different study concepts. Data were analysed using multiple regression. **Results.** Statistics anxiety is not related to statistical performance. Self-efficacy and the big five personality traits neuroticism and agreeableness are related to statistics anxiety. However, previous academic experience, attitudes towards statistics and the big five personality traits conscientiousness, openness and extraversion are not related to statistics anxiety. Statistics anxiety does not mediate the relationship between self-efficacy, previous academic experience, attitudes towards statistics, big five personality traits and statistical performance. **Discussion.** This study found self-efficacy and the big five personality traits neuroticism and agreeableness to be related to statistics anxiety, but other factors to be unrelated. These results differ from some other studies, although there are studies with similar results. Possible explanations for the different results might be differences in study design, small sample size, and its non-randomised sample.

Keywords: Statistics anxiety, statistical performance, mediation

The Relationship between Statistics Anxiety and Statistical Performance

Students who experience test anxiety are likely to have lower overall academic results compared to students who experience no test anxiety (Eum & Rice, 2011). The feeling of worry that students experience in relation to their performance on examinations can result in lower grades. Students that experience test anxiety are not only more likely to have lower grades, but are also more likely to drop out of their studies or take longer to graduate (Macher et al., 2013). When it comes to the subject of statistics, this problem is especially pronounced. Statistics anxiety is a widespread problem amongst social sciences students: 80 percent of graduate students experience statistics anxiety (Macher et al., 2013; Onwuegbuzie, 2004).

Statistics anxiety can be defined as the feeling of worry that individuals experience when they encounter statistics in any form (Onwuegbuzie, 2004). Statistics anxiety seems to have a negative effect on performance in statistics; several studies have shown that a higher level of statistics anxiety causes performance on examinations to decrease (Keeley, Zaiac, & Correia, 2008; Macher, Paechter,

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Papousek, & Ruggeri, 2012; Macher et al., 2013; Macher, Papousek, Ruggeri, & Paechter, 2015). Furthermore, statistics anxiety is believed to be associated with study problems such as procrastination and the use of less effective learning strategies. These are possible mechanisms through which statistics anxiety could decrease performance on statistics examinations (Macher et al., 2013; Onwuegbuzie, 2004).

Factors related to statistics anxiety

When it comes to statistics anxiety, several factors seem to be related to the amount of statistics anxiety that students experience. Self-efficacy is one of the factors that influences statistics anxiety amongst students (Perepiczka, Chandler, & Becerra, 2011). Self-efficacy could be described as how someone perceives his or her own abilities. More specifically for statistics, that would be how students perceive their own abilities to be able to deal with statistical tasks, and how students perceive their ability to learn the necessary skills to deal with these tasks (Finney & Schraw, 2003). There seems to be a negative relationship between self-efficacy and statistics anxiety. The more self-efficacy someone possesses (i.e. the more capable of dealing with statistical tasks someone feels), the less statistics anxiety they experience. However, this topic has not been studied extensively (Perepiczka et al., 2011).

Besides how students perceive their own statistical abilities, their previous academic experiences are also related to the amount of statistics anxiety that they experience (Baloğlu, 2003). Previous academic experiences indicate the students' academic background in statistics. The students' background in mathematics seems to be a good predictor of statistics anxiety (Baloğlu, 2003). Students with less previous mathematical experiences seem to have more statistics anxiety. Besides, students with less previous mathematical experiences have more problems following a statistics course, and might think of statistics as an irrelevant subject or something that is too hard for them (Baloğlu, 2003).

In line with self-efficacy and previous academic experiences, attitudes towards statistics have been linked to statistics anxiety. Attitudes towards statistics are related to the amount of anxiety that students experience, and in turn also to students' statistical performance (Chiesi & Primi, 2010). Attitudes towards statistics are the ideas and beliefs that someone has towards the subject of statistics. Negative attitudes towards statistics are related to a higher level of statistics anxiety (Chiesi & Primi, 2010). Negative attitudes that students had before the start of a statistics course are specifically associated with a higher anxiety level (Chiesi & Primi, 2010).

Just like students' attitude, their personality is also associated with statistics anxiety (Komarraju, Karau, & Schmeck, 2009). More specifically, big five personality traits seem to be related to statistics anxiety. The big five personality traits are conscientiousness, openness to new experiences, neuroticism, agreeableness and extraversion. Higher scores on neuroticism have been associated with more perfectionistic behaviour and anxiety in general (Bienvenu et al., 2004; Cuijpers, Van Straten, &

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Donker, 2005; Komarraju et al., 2009). This might also mean that students scoring higher on neuroticism experience a higher level of statistics anxiety. Lower levels of conscientiousness, agreeableness and extraversion have also been associated with general anxiety. Openness was not found to be related to anxiety. As conscientiousness, neuroticism, agreeableness and extraversion are related to general anxiety, they are thought to be related to statistics anxiety (Bienvenu et al., 2004; Cuijpers et al., 2005).

As said before, statistics anxiety is thought to be negatively related to statistical performance (Keeley et al., 2008; Macher et al., 2012; Macher et al., 2013; Macher et al., 2015). Thus, it is important to investigate factors that play a role in this relationship. Self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits are all factors that seem to be related to statistics anxiety. As statistics anxiety seems to be related to statistical performance and these factors seem to be related to statistical anxiety, statistics anxiety may mediate the relationship between self-efficacy, previous academic experiences, attitudes towards statistics and big five personality traits on the one side, and statistical performance on the other side.

To the best of our knowledge there are no studies up to date that have included both self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits as possible factors related to statistical performance and mediated by statistics anxiety, even though research seems to indicate these are important factors in this relationship. Furthermore, studies examining the link between statistics anxiety and statistical performance have not always provided conclusive evidence. Even though most studies have found relationships between statistics anxiety, statistical performance and the aforementioned factors, some studies have only found weak relationships, and none of these studies have looked at all of these variables together included in one conceptual model (Macher et al., 2015).

The current study

The aim of the present study is therefore to investigate 1) if statistics anxiety is related to statistical performance, 2) if self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits (conscientiousness, openness, neuroticism, agreeableness and extraversion) are related to statistics anxiety; and 3) if statistics anxiety mediates the relationship between self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits on the one hand and statistics performance on the other hand.

Based on previous studies, the hypothesis is that a higher level of statistics anxiety is associated with a lower statistics examination result (Keeley, et al., 2008; Macher et al., 2012; Macher et al., 2013; Macher et al., 2015). Lower self-efficacy, less previous academic experience and less positive attitudes towards statistics are expected to be related to more statistics anxiety. Lower levels of neuroticism and higher levels of conscientiousness, agreeableness and extraversion are expected to be related to less statistics anxiety, openness is expected to be unrelated to statistics anxiety. As these

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factors are related to statistics anxiety, which seems to be related to statistical performance, statistics anxiety is hypothesized as a mediator in the relationship between these factors and performance on statistics examinations (Baloğlu, 2003; Bienvenu et al., 2004; Chiesi & Priemi, 2010, Cuijpers et al., 2005; Komarraju et al., 2009; Perepickza et al., 2011).

It is important to get to know more about the relationship between statistics anxiety and statistical performance, because this relationship has important implications for educational practices. Statistics anxiety is a key factor that interferes with development of statistical knowledge (Field, 2014). In consequence, if more is known about how the relationship between statistics anxiety and statistical performance works and how statistics anxiety mediates the relationship with the aforementioned factors, valuable insight into ways to reduce statistics anxiety and its related concepts can be obtained. This is meaningful for statistics as an educational field, and can benefit both students and teachers.

Method

Sample, procedure and design

The sample of this study consisted of psychology students taking part in the ‘Discovering Statistics’ module, taught at the University of Sussex in the autumn term. Approximately 250 students took this module, all of whom were asked to complete questionnaires online. Students were granted research credits when they participated in the study. The sample consisted of 50 students. The ‘Discovering Statistics’ module is a second year university module, which means that the age of the respondents is approximately 19-20 years, with possible outliers due to young students, or students retaking the module. With some possible exceptions, all of these students are undergraduate psychology students. Students have a variety of nationalities, as both UK students and international students are taking the module. Although students were not asked to provide their gender, a majority of the students is probably female, as 83,58% of undergraduate psychology students is female (National Center for Education Statistics, 2013). This study has a cross-sectional research design.

During this study, ethical responsibility was important. Students were asked to give informed consent before they were able to participate. Students were also asked to allow access to their exam grades, so performance could be studied in relationship to the other study concepts. The students’ information was treated confidentially and students were made aware that if at any point they no longer wanted to participate, they could ask for their answers not to be used in the study. Participation was on students’ own initiative, students were reminded about the study throughout the module.

Measures

Statistics anxiety. Statistics anxiety was assessed with the Statistic Anxiety Rating Scale (STARS; Cruise & Wilkins, 1980). The anxiety scale (23 items) was used. Participants were asked to respond to different statements on a 5-point ordinal Likert scale (1=no anxiety, 5=strong anxiety). An

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example of a statement that students had to respond to is 'walking into the classroom to take a statistics examination'. Chronbach's alpha was .93 for the anxiety scale.

Statistics performance. Statistics performance was measured by administering a statistical knowledge examination to the students. This examination consisted of open ended questions. An example of a question is to judge if the assumption of homogeneity of variance of a study is met, after looking at a research description and table with results. The result of this test is a number between 0 and 100, which represents a percentage that states the proportion of right versus wrong answers. Therefore, this is a ratio scale. Reliability for this scale could not be calculated, as this was a non-standardised exam with different types of questions.

Self-efficacy. Self-efficacy was measured using the general self-efficacy scale (GSS; Schwarzer & Jerusalem, 1995). The GSS consists of 10 items. Students were asked to respond to questions on a 4-point ordinal Likert scale (1=not at all true, 4=exactly true). A sample item of the GSS is 'if I am in trouble, I can usually think of a solution'. Chronbach's alpha was .82 for the GSS.

Previous academic experience. Previous academic experience was measured with the Statistics Anxiety Rating Scale as well (STARS; Cruise & Wilkins, 1980). The previous academic experience scale was used (16 items), which is an integrated part of the STARS with additional questions. From these questions, eleven are yes/no questions and are thus nominal, one question requires a numerical answer (amount of completed years in school math) and has a ratio scale and four questions have a 7-point ordinal Likert scale (1=*strongly disagree*, 7=*strongly agree*). An example of a question is 'Have you ever taken a statistics course before?'. The amount of math years is kept as a separate question that is a part of the previous academic experience scale, all analyses were performed with math experience separately. All of the other questions were combined into one variable by extracting one factor using factor analysis. Chronbach's alpha was .64 for the previous academic experiences scale.

Attitudes towards statistics. Attitudes towards statistics was measured with the Statistics Anxiety Rating Scale (STARS; Cruise & Wilkins, 1980). The attitudes scale (58 items) was used. For some questions students were asked to respond to statements on a 5-point ordinal Likert scale (1=strongly agree, 5=strongly disagree), for other questions students were asked to respond on a 7-point ordinal Likert scale (1=strongly disagree, 7=strongly agree). After rescaling the separate scales, a sum score was calculated for every individual by multiplying the mean for every scale with the amount of answer options from the other scale. A higher score indicates a more positive attitude. An example of a question is 'I wonder why I have to do all these things in statistics when in actual life I'll never use them'. Chronbach's alpha was .92 for the attitudes scale.

Big five personality factors. Big five personality factors were assessed using the Neo Five Factor Inventory Revised (NEO-FFI; Costa & McCrae, 1992). All scales from this questionnaire were used, namely the conscientiousness scale (12 items), openness to new experiences scale (12 items),

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neuroticism scale (12 items), agreeableness scale (12 items) and extraversion scale (12 items). Participants were asked to respond on a 5-point ordinal Likert scale (1=strongly disagree, 5=strongly agree). An example of a question for the conscientiousness scale is 'I strive for excellence in everything I do', for the openness to new experiences scale 'I often try new and foreign foods', for the neuroticism scale 'I often feel tense and jittery', for the agreeableness scale 'I generally try to be thoughtful and considerate' and for the extraversion scale 'I really enjoy talking to people'. Chronbach's alpha was .85 for the conscientiousness scale, .69 for the openness to new experiences scale, .79 for the neuroticism scale, .84 for the agreeableness scale and .66 for the extraversion scale. For agreeableness results are shown after removal of outliers, this was the only scale that showed outliers.

Analysis

For the analysis of data, all scales were assumed to be of interval level because a combination of questions on ordinal level were used to calculate the scales. Regression was used to analyse the relationship between the different concepts. Due to an error in the online questionnaire system, some data are missing for the variables statistics anxiety and attitudes towards statistics. These missing data were excluded listwise in SPSS and bootstrapping was performed on all analyses.

Results

Table 1 shows descriptive statistics for all of the variables that were measured in this study. Before performing any analyses, the assumptions of normality, linearity and homoscedasticity were tested using the Shapiro-Wilk test for normality and simple scatter plots. The variable openness to new experiences did not meet the criteria for normality, but was still included in analyses because this was the only variable affected and a violation of normality in a sample of 30 or over tends to not alter results (Pallant, 2013). An inspection of boxplots and Mahalanobis distance showed no outliers, except for the variable agreeableness. Therefore, analyses for this variable were performed without the outliers. Tolerance values were assessed to check for multicollinearity, which was not present in these data.

Table 1

Descriptive Statistics for all Included Variables

| | n | M | SD | min | max |
|------------------------------|----|-------|-------|-------|-------|
| Statistics anxiety | 37 | 65.08 | 16.12 | 36.00 | 98.00 |
| Statistical performance | 50 | 61.16 | 14.95 | 29.00 | 93.00 |
| Self-efficacy | 50 | 27.00 | 4.14 | 19.00 | 36.00 |
| Previous academic experience | 50 | 0.00 | 1.00 | -2.29 | 1.67 |
| Previous math experience | 50 | 12.14 | 2.17 | 5.00 | 15.00 |
| Attitudes towards statistics | 37 | 45.41 | 2.94 | 39.24 | 54.03 |
| Conscientiousness | 50 | 41.64 | 8.17 | 22.00 | 56.00 |
| Openness to new experiences | 50 | 42.36 | 6.09 | 29.00 | 53.00 |
| Neuroticism | 50 | 39.44 | 9.53 | 18.00 | 56.00 |
| Extraversion | 50 | 38.70 | 5.62 | 25.00 | 50.00 |
| Agreeableness | 50 | 40.88 | 7.96 | 21.00 | 58.00 |

Research question 1: Statistics anxiety and statistical performance

The first research question of this study was ‘is statistics anxiety related to statistical performance?’. Regression was used to analyse this question. The regression analysis showed that statistics anxiety did not have a statistically significant effect on statistical performance ($\beta = -.13$, $p = .44$; $F(1, 35) = .62$). Statistics anxiety accounts for 2% of variance in statistical performance ($R^2 = .02$). An additional analysis was ran to test for a curvilinear relationship, but this analysis also showed no significant relationship ($\beta = .00$, $p = .91$; $F(2, 34) = .30$). So, statistics anxiety is not related to statistical performance.

Research question 2: Factors related to statistics anxiety

Research question 2 was ‘are self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits (conscientiousness, openness, neuroticism, agreeableness and extraversion) related to statistics anxiety? Multiple regression was used to analyse this question. The results of the regression analyses are presented in Table 2 and 3. For previous academic experience years of math experience was analysed separately. The regression analysis showed that self-efficacy is significantly negatively related to statistics anxiety ($\beta = -.35$, $p < .05$), but previous academic experience and attitudes towards statistics did not have a statistically significant effect on statistics anxiety. Self-efficacy, previous academic experience and attitudes towards statistics together account for 20% of variance in statistics anxiety ($R^2 = .20$).

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Table 2

Multiple Regression of the Effect of Self-efficacy, Previous Academic Experience, Attitudes towards Statistics on Statistics Anxiety (N=37)

| | B | SE B | β | R ² |
|------------------------------|-------|------|---------|----------------|
| Self-efficacy | -1.31 | .98 | -.35* | |
| Previous academic experience | 1.03 | 2.80 | .06 | |
| Math experience | -1.16 | 1.17 | -.17 | |
| Attitudes towards statistics | -1.03 | .39 | -.19 | |
| | | | | .20 |

Note: F (4, 32) = 2.02, p= .12. * $p < .05$, ** $p < .01$.

As for big five personality traits, the regression analyses showed neuroticism ($\beta = .33$, $p < .05$), and agreeableness ($\beta = -.35$, $p < .05$), were respectively positively and negatively related to statistics anxiety, but that the other factors were unrelated. Students who scored higher on neuroticism or lower on agreeableness reported more statistics anxiety. Big five personality traits together account for 18% of variance in statistics anxiety ($R^2 = .18$).

Table 3

Multiple Regression of the Effect of the Big Five Personality Traits Conscientiousness, Openness, Neuroticism, Agreeableness and Extraversion on Statistics Anxiety (N=37)

| | B | SE B | β | R ² |
|-----------------------------|-------|------|---------|----------------|
| Conscientiousness | -.23 | .34 | -.12 | |
| Openness to new experiences | -.15 | .48 | -.06 | |
| Neuroticism | .51 | .24 | .33* | |
| Extraversion | -1.03 | .45 | -.35 | |
| Agreeableness | -.15 | .49 | -.05* | |
| | | | | .18 |

Note: F (5, 29) = 1.37, p= .26. * $p < .05$, ** $p < .01$.

In conclusion, self-efficacy and agreeableness are significantly negatively related to statistics anxiety and neuroticism is significantly positively related to statistics anxiety. Previous academic experience, attitudes towards statistics, conscientiousness, openness and extraversion are not related to statistics anxiety however.

Research question 3: Statistics anxiety as mediator

Research question 3 was ‘does statistics anxiety mediate the relationship between self-efficacy, previous academic experience, attitudes towards statistics and the big five personality traits conscientiousness, openness, neuroticism, agreeableness and extraversion on the one hand and statistics performance on the other hand?’. The previous analyses have shown that statistics anxiety is not significantly related to statistical performance. Therefore, the requirements for mediation are not met. In conclusion, statistics anxiety does not mediate the relationship between self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits on the one hand and statistics performance on the other hand.

Discussion

The aim of this study was to answer the following questions: 1) is statistics anxiety related to statistical performance?, 2) are self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits (conscientiousness, openness, neuroticism, agreeableness and extraversion) related to statistics anxiety?, and 3) does statistics anxiety mediate the relationship between self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits on the one hand, and statistical performance on the other hand?

Previous research has shown statistics anxiety to be negatively related to statistical performance (Keeley, et al., 2008; Macher et al., 2012; Macher et al., 2013; Macher et al., 2015). Therefore, it was hypothesized that a higher level of statistics anxiety is associated with a lower statistics examination result (Keeley, et al., 2008; Macher et al., 2012; Macher et al., 2013; Macher et al., 2015). However, our analyses showed that statistics anxiety was not significantly related to statistical performance. This result is not as hypothesized and differs from most other studies. However, studies by Chiesi and Primi (2010) and Nasser (2004) also failed to find a statistically significant relationship between statistics anxiety and statistical performance. Chiesi and Priemi (2010) pointed out this could be the result of measuring anxiety mid-course, with weeks to go until the examination. Nasser (2004) also argued that it might be hard to measure direct effects of anxiety when also measuring concepts likely to be related to it such as attitudes towards statistics. Both of these design issues are also applicable to the present study, which might explain the absence of a significant relationship. Keeley and colleagues (2008) propose another explanation, namely that the relationship might be better explained as a curvilinear function. According to their study, a level of statistics anxiety that was either too high or too low would decrease statistical performance. However, an additional curvilinear analysis on the current data showed no evidence of a curvilinear relationship between statistics anxiety and statistical performance. Future research should give more insight into the relationship between statistics anxiety and statistical performance and its possible curvilinear nature.

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Previous research has also shown self-efficacy, previous academic experience and attitudes towards statistics to be negatively related to statistics anxiety (Baloğlu, 2003; Chiesi & Priemi, 2010; Perepiczka et al., 2011). It was thus hypothesized that lower self-efficacy, less previous academic experience and less positive attitudes towards statistics are related to more statistics anxiety (Baloğlu, 2003; Chiesi & Priemi, 2010; Perepiczka et al., 2011). Analyses in the present study showed that self-efficacy was significantly negatively related to statistics anxiety as hypothesized. In line with research by Perpiczka and colleagues (2011) we found that students who believe they have poor statistical abilities, experience more statistics anxiety.

However, previous academic experience and attitudes towards statistics were not statistically significantly related to statistics anxiety, unlike the hypothesis stated. For previous academic experiences, another study by Murtonen (2005) found no statistically significant relationship between previous academic experience and statistics anxiety. Murtonen argues it is more so views and attitudes one develops towards statistics that affect how anxious a person might be, and not the experience itself. This corresponds with the previously mentioned study by Chiesi and Priemi (2010) linking attitudes towards statistics to statistics anxiety. However, the present study did not find this relationship, unlike other studies. An explanation for this can be found in how attitudes towards statistics were measured. Chiesi and Priemi (2010) measured both pre- and post-course attitudes, whereas only attitudes during the course were measured in the present study. This is an important difference, because attitudes towards statistics have shown to change during the course, which means that by only measuring students' attitudes at one point in time the fluid nature of this concept and possible relationship with statistics anxiety might be missed (Chiesi & Priemi, 2010). Thus, future research should look at attitudes both before and after the examination.

It was hypothesized that lower levels of neuroticism and higher levels of conscientiousness, agreeableness, openness and extraversion are related to less statistics anxiety and openness would be unrelated (Bienvenu et al., 2004; Cuijpers et al., 2005; Kommaraju et al., 2009). Analyses showed neuroticism and agreeableness to be respectively positively and negatively related to statistics anxiety and openness to be unrelated, which was as hypothesized. Conscientiousness and extraversion however, showed no relationship and thus did not correspond to the hypothesis. Our hypotheses were based on studies concerning the link between personality factors and general anxiety. Apparently, these patterns may be different for more specific types of anxiety, such as statistics anxiety. Conscientiousness and extraversion had only been linked to anxiety in general by previous studies, a direct relationship with statistical anxiety had not been found. Therefore, more research is needed to determine if these factors are also related to statistical anxiety.

Because previous research has shown self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits to be related to statistics anxiety, and statistics anxiety to be related to statistical performance, it was hypothesized that statistics anxiety mediates the

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relationship between these factors and statistics performance (Baloğlu, 2003; Bienvenu et al., 2004; Chiesi & Priemi, 2010, Cuijpers et al., 2005; Komarraju et al., 2009; Perepickza et al., 2011). However, statistics anxiety and statistical performance were found to be unrelated, and thus the prerequisites for mediation were not met. Therefore statistics anxiety does not mediate the relationship between self-efficacy, previous academic experience, attitudes towards statistics and the big five personality traits conscientiousness, openness, neuroticism, agreeableness and extraversion on the hand, and statistical performance on the other hand.

Besides the explanations we have already provided for our specific results, there are several explanations applicable to all results: sample size and sample type. The size of this study's sample was relatively small, which lowers power and increases chances of wrongfully concluding that there is no relationship when there actually is one (Vanvoorhis & Morgan, 2007). Furthermore, the sample was non-random as students signed up at their own initiative. Non-randomised samples provide a less sensitive measure of study characteristics (Field, 2013). This could have contributed to not finding a relationship between these concepts were other studies did find them.

There are some limitations to the present study. The first limitation is that for most of the study concepts, self-report questionnaires were used to measure the concepts. Self-report can promote bias in answers to questions and therefore a larger measurement error tends to be present in studies that have used self-report to measure concepts (Field, 2013). Another limitation is that a couple of students had to fill in the questionnaires twice, because of an error in the online questionnaire system. This might have altered the answers these students gave. Furthermore, the measure that was used for students' statistics performance was a non-standardised exam, thus reliability could not be calculated. Therefore it is not certain that this exam was the most accurate measure of students' performance.

However, this study also provided some new insights. It was the first study to include both self-efficacy, previous academic experience, attitudes towards statistics and big five personality traits in one conceptual model and include statistics anxiety as a mediator. Previous studies have looked at these concepts separately, but never combined them in one model. Combining all of these factors in one model gives a more holistic view, as there is not just one concept that seems to be linked to statistics anxiety, but several concepts that seem to be related to statistics anxiety and its relationship with statistical performance. This is important, because students and teachers deal with statistics anxiety and its related concepts on a day to day basis, therefore research that combines all of these concepts fits day-to-day practice better. Another strength of this study is that we used a statistical exam as a measure of statistical performance, instead of self-report. Most previous studies have used self-report, but self-report of performance tends to deviate from actual performance (Komarraju et al., 2009).

Furthermore, this study addressed a topic of important scientific and societal value. Statistics anxiety is a widespread problem amongst students and is associated with study problems and learning

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difficulties like procrastination, less effective learning strategies and less concentration and attention while learning (Macher et al., 2013; Onwuegbuzie, 2004). Despite the results of this study there are studies that indicate statistics anxiety does have a negative effect on statistical performance (Keeley et al., 2008; Macher et al., 2012; Macher et al., 2013; Macher et al., 2015; Onwuegbuzie, 2004). Statistics anxiety can cause study dropout or delayed graduation (Macher et al., 2013). Statistics anxiety also poses a problem for statistics teachers, as it makes teaching practices more difficult (Field, 2009). Memory efficiency of students decreases when they experience statistics anxiety, likewise development of quantitative method skills is inhibited (Field, 2014). Statistics anxiety seems to be related to performance and has important implications for educational practice, which means this study has given some insight into a topic with important educational implications. In light of future interventions regarding statistics anxiety, its relation with self-efficacy should be taken in mind. Improving students' self-efficacy could be a way of diminishing statistics anxiety. This study has also shown the big five personality factors neuroticism and agreeableness to be related to statistics anxiety, which is important to educational practice as students scoring higher on these factors might need a different teaching approach.

As this topic of statistics anxiety is an interesting and important topic, further research should be done to examine factors related to statistics anxiety and performance. Firstly, future research should ideally have a larger, random sample. This way, more accurate conclusions can be made based on the data that is gathered. Future research should also assess statistics anxiety and its related variables both before and after the moment of the statistics examination. Attitudes towards statistics have shown to change during the course, and therefore this might be the case for some of the other concepts too (Chiesi & Primi, 2010). By measuring these concepts before and after the examination, possible changes can be accurately reflected. A last recommendation for future research is to not only look at factors related to the students, but also situational factors like the teacher, class environment etc. For example, studies could look at how teachers deal with students' self-efficacy as this study has shown a relationship between self-efficacy and statistics anxiety. Looking at situational factors contributes to the previously mentioned holistic view and is important to improve statistics practice. When situational factors are also taken into account, statistics teachers and students can be advised on different levels related to statistics anxiety which will hopefully contribute to a solution for this problem.

In conclusion, this study provided evidence for a relationship between self-efficacy, neuroticism, agreeableness and statistics anxiety. None of the other factors were significant. This study was the first to look at all of these factors as part of one conceptual model. Some of the study characteristics (i.e. small sample size, non-random sample) could have contributed to finding these particular results, which should be taken into account when conducting future research. As statistics anxiety affects many students, and also seems to negatively affect the statistics learning environment,

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further research into this topic should be conducted. Future research should give more insight into statistics anxiety and factors related to statistics anxiety. This could contribute to an educationally more pleasant environment for both teachers and students.

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