



Statistics anxiety or statistics fear? A reinforcement sensitivity theory perspective on psychology students' statistics anxiety, attitudes, and self-efficacy

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Abstract

This research investigates the role of reinforcement sensitivity theory (RST) in statistics education among two distinct samples of undergraduate psychology students. In Study 1, 318 students in a third-year statistics course completed self-report measures of RST, anxiety, attitudes, and self-efficacy concerning the study of statistics. In Study 2, 577 students from first-, second-, and third-year statistics courses participated. Controlling for age and gender, both studies found students who were high in goal-drive persistence reported lower statistics anxiety, higher statistics self-efficacy and more favourable attitudes toward learning statistics, while students who were high in the tendency to avoid threat reported higher statistics anxiety. Those with a more sensitive behavioural inhibition system reported greater statistics anxiety and less favourable attitudes, in Study 2 but not Study 1. Results indicate that RST dimensions account for as much as 23% of additional variance in statistics anxiety, 18% in statistics self-efficacy, and 11% in attitudes, after controlling for age and gender. These studies highlight the utility of RST dimensions, notably goal-drive persistence, threat sensitivity, and behavioural inhibition, in providing critical information as to personality differences among students that need to be considered when developing programs targeting statistics anxiety, attitudes, and self-efficacy.

Keywords Reinforcement sensitivity theory · Statistics anxiety · Self-efficacy · Statistics attitudes · Personality

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Introduction

Despite the importance of statistics within the psychology curriculum, many students commonly report these courses as the most challenging, anxiety-inducing, and seemingly irrelevant to their future work (Barry, 2012; Murtonen et al., 2008). Importantly, research has found that negative attitudes toward statistics, statistics anxiety and low levels of statistics self-efficacy impact student well-being and overall academic performance (Ogbonnaya et al., 2019). It has been found that statistics anxiety, which is described as “a negative emotional state experienced when encountering statistics in any form” (Chew & Dillon, 2014b, p. 9) can have a detrimental effect on learning statistics (Macher et al., 2012). Self-efficacy, or an individual’s belief in their ability to successfully perform a behaviour (Bandura, 1977), plays a role in statistics learning, as it influences a student’s perception of their own capacity to comprehend and complete statistics tasks. Lastly, attitude, defined as the predisposition to react favourably or unfavourably towards an object, person, institution, or event (Ajzen, 2005) is important when it comes to statistics, referring to an individual’s inclination to either embrace or reject the process of learning statistics.

Students who start statistics courses with more positive attitudes toward statistics and greater statistics self-efficacy perform better compared to students with more negative attitudes and lower self-efficacy (Hoegler & Nelson, 2018; Mantooth et al., 2020). This highlights the critical role of these psychological factors in determining students’ success. Indeed, statistics anxiety and attitude have been found to account for almost a third (31%) of the variance in performance within a psychology statistics course, and self-efficacy accounting for 23% (Ogbonnaya et al., 2019). Therefore, gaining a deeper understanding of these factors is crucial for effectively addressing the diverse educational needs of students (Siew et al., 2019).

Extensive research has demonstrated that personality traits have a substantial impact on university academic performance and can account for up to 30% of the variance in student learning outcomes (Chamorro-Premuzic & Furnham, 2003b; Mammadov, 2022). Furnham and Chamorro-Premuzic (2004) found the personality traits of conscientiousness, introversion, and to a lesser extent, openness to experience, to predict better statistics exam performance, even after controlling for instructor evaluation and cognitive ability. However, when looking specifically at statistics anxiety and attitudes, the associations with personality traits have been inconclusive. Of the two studies located, Chew & Dillon (2014a) found extraversion, but not neuroticism, to be associated with greater statistics anxiety, whereas de Vink (2017) found the opposite pattern. These inconsistent findings may be attributed to three factors. Firstly, there is surprisingly limited research investigating personality and statistics anxiety, attitudes, or statistics self-efficacy. Secondly, the existing research predominantly focuses on general, broad-level traits, such as neuroticism and conscientiousness, which may not capture the complexities of these constructs. For example, dimensions of neuroticism such as anxiety and impulsiveness have been linked to academic performance, while dimensions like depression affect or hostility have not shown the same association. Additionally, conventional descriptive personality traits fall short of explaining the underlying causal systems associated with each trait (Corr & McNaughton, 2008). To enhance knowledge in this area, it is critical to refine our methods and explore these dimensions and their impact on statistics anxiety, attitudes, and self-efficacy in greater depth.

To bridge this knowledge gap, the present research draws upon Reinforcement Sensitivity Theory (RST; Gray & McNaughton, 2000), a framework that explores the underlying causes and mechanisms that drive personality traits, particularly those related to fear and

anxiety. This theory stands out as offering a unique perspective in this area due to its foundation on the neuropsychology of emotion, motivation, and learning. It explicitly examines how emotional and motivational processes interact to influence behaviour. Given that statistics anxiety is tied to emotional responses, such as fear and anxiety, and attitudes and self-efficacy are closely related to motivation, RST provides an ideal basis to explore these psychological constructs within the context of statistics education.

Reinforcement Sensitivity Theory

RST comprises three motivational systems: the Behavioural Approach System (BAS), the Behavioural Inhibition System (BIS), and the Fight Flight Freeze System (FFFS; Gray & McNaughton, 2000). The BAS facilitates approach towards potential rewards, while the FFFS promotes defensive reactions in response to perceived or actual threat. When faced with a threat, individuals may either try to avoid it (resulting in flight or avoidance behaviour) or feel paralysed (leading to freeze behaviour). Those who score high in FFFS tend to be more sensitive to threats and are prone to panic and avoidance.

The BIS mediates conflicts between and within the BAS and the FFFS (i.e., threat-reward, reward-reward, and threat-threat conflicts; Corr, 2008). For example, the BIS is activated in situations when two opposing behaviours lead to the presence of a potential threat (e.g., perceiving possible exam failure) and a potential reward (e.g., exam success and passing the course), or the presence of two potential threats or two potential rewards. The activation of BIS can lead to rumination, worry, risk assessment, and increased arousal (Corr, 2008). People with a more sensitive BIS tend to be worry-prone and engage in anxious rumination, leading the individual to be continually vigilant for possible threats (Corr, 2008; Corr & Cooper, 2016). Importantly, based on the principle of 'defensive direction', FFFS promotes *movement away* from a threat based on its actual or psychological distance to the threat, while BIS can lead to *movement towards* a threat (e.g., approaching the threat but experiencing high anxiety).

BIS and FFFS

According to Macher et al. (2015), statistics anxiety affects performance due to the tendency to avoid course material and poor studying behaviours, thereby interfering with the learning process. However, previous studies into the effect of statistics anxiety and performance do not distinguish between FFFS-mediated avoidance and BIS-mediated arousal. While on the surface fear and anxiety may appear to be facets of a single underlying construct (often conceptualised as neuroticism), studies have demonstrated that FFFS and BIS have distinctly separate neural substrates, leading to different behaviours (Gray & McNaughton, 2000; Perkins et al., 2007). Consequently, the revised RST brought a significant change by clearly differentiating between the FFFS (fear/panic/avoidance behaviour) and the BIS (anxiety/cautious approach behaviour), which was not present in the original theory.

Based on the premises of RST, understanding individual differences in FFFS and BIS can have significant implications for how students experience and effectively manage their anxieties. Extending the principles of RST to the context of studying statistics, more FFFS-sensitive students may simply avoid attending classes, studying course materials, or statistics altogether or, if unable to avoid these courses, may freeze in statistics related activities.

Conversely, those more BIS-sensitive may still attend classes and study the assigned materials (to pass the course), albeit with high levels of anxiety.

Clinically, FFFS is linked to phobias and panic disorder, while BIS is linked to anxiety-based disorders (Corr & Cooper, 2016). Therefore, fear-based disorders, such as specific phobias, may require a different treatment approach compared to anxiety-based disorders, such as generalised anxiety disorder (Sylvers et al., 2011). Furthermore, the effectiveness of interventions can vary depending on individual's personally traits. For example, mindfulness interventions may be less beneficial for addressing disordered eating in individuals with a more sensitive BIS (Wilson & O'Connor, 2017). Consequently, understanding the system related to statistics anxiety can contribute to the development of more tailored interventions.

To date, RST (original or revised) has not been used in the study of statistics anxiety to test these differences. However, two studies have used RST to investigate general test anxiety in undergraduate psychology students. Krupić and Corr (2014) found students who scored high on a BIS measure from the original theory (that includes items reflecting FFFS and BIS) reported higher levels of test anxiety (operationalized as negative affect prior to an exam). When using a measure that differentiates FFFS and BIS, and a validated measure of test anxiety, Nob (2013) found high FFFS (specifically the tendency to freeze), but not BIS, to be uniquely associated with test anxiety when controlling for BIS (although there was a significant bivariate correlation between BIS and test anxiety). These findings underscore the necessity for additional research in understanding the roles of BIS and FFFS in educational contexts, particularly in relation to statistics anxiety, attitudes, and self-efficacy.

BAS

The BAS has recently been argued to consist of four distinct dimensions involved in the detection, approach, and affective response to reward: 1) Reward Interest (tendency to seek new rewarding situations or activities), 2) Goal-Drive Persistence (capacity to maintain effort and persistence to reach the desired goals), 3) Reward Reactivity (tendency to react positively to rewards), and 4) Impulsivity (fast engagement of unplanned behaviours; Corr, 2008; Corr & Cooper, 2016). Krupić & Corr (2014) found students higher in goal-drive persistence reported greater positive affect after receiving positive test feedback and had higher levels of interest for their courses, suggesting that the BAS dimension of goal-drive persistence may be associated with a more favourable attitude to learning generally. Goal-drive persistence is also associated with conscientiousness, which has been found to be predictive of better exam grades and overall academic performance, including greater class attendance (Chamorro-Premuzic & Furnham, 2003a, 2003b). Goal-drive persistence is positively associated with mastery, which is characterized by high self-efficacy, effort, and persistence (Shahzadi & Walker, 2019). Therefore, goal-drive persistence may be linked with high statistics self-efficacy and more positive attitudes towards statistics due to the tendency to maintain effort to reach desired goals and may act as a protective factor against statistics anxiety. Although considered a BAS facet, impulsivity appears to be distinct from the other BAS scales and has been found to be associated with extraversion and low conscientiousness (Dawe & Loxton, 2004; Corr et al., 2013) – which is associated with less favourable attitudes to learning statistics. Additionally, research indicates that impulsivity is associated with lower science self-efficacy (Marriott et al., 2019) and higher trait anxiety in students (Yeo & Lee, 2017). Thus, those high on impulsivity may have a less

favourable attitude and given their tendency to act in an unplanned manner, may be less likely to engage in effective learning strategies, such as setting goals, setting aside study time, organizing their learning environment, leading them to experience higher statistics anxiety and lower self-efficacy.

The current research

Despite previous interventions, high statistics anxiety, low self-efficacy and less favourable attitudes are still problematic. Understanding the specific personality traits underlying these factors, particularly those from RST, may inform tailored interventions, teaching approaches, and support systems, ultimately enhancing students' educational experiences and outcomes in this vital area of their curriculum. However, there is a lack of empirical research examining relationships between RST dimensions and statistics anxiety, attitude, or self-efficacy. Studies investigating this relationship are needed to establish a foundation for future research in this domain.

The aim of the current research is to extend the literature into personality factors that play key roles in the study of statistics by investigating the associations between RST dimensions with statistics anxiety, attitudes toward statistics, and statistics self-efficacy in undergraduate psychology students across two studies. The first study samples psychology students in a third-year statistics course, while the second study includes a broader sample from the first, second, and third year.

Study 1

This study aims to investigate statistics anxiety, attitudes toward statistics, and self-efficacy in undergraduate psychology students from a third-year statistics course by using RST as a framework. Based upon previous studies it is hypothesized that 1) higher goal-drive persistence will be associated with lower statistics anxiety, more favourable attitudes toward statistics, and higher self-efficacy, 2) higher impulsivity will be associated with greater statistics anxiety, less favourable attitudes, and lower self-efficacy, and 3) FFFS will be positively associated with statistics anxiety. As one study using a measure based on the original RST found an association between BIS and test anxiety and the other found a bivariate correlation (but no relationship when controlling for FFFS), it is not known if BIS will be uniquely associated with statistics anxiety, attitude, or self-efficacy. However, given that the affective output of BIS is heightened arousal and anxiety, it hypothesized that, 4) BIS would be positively associated with statistics anxiety. Finally, given the limited research using the BAS dimensions, the role of reward interest and reward reactivity will be exploratory.

Method

Participants and Procedure

A total of 317 psychology students (72% female) in a third-year undergraduate statistics course completed the online survey at the beginning of their first computer class in the second week of the teaching term. Mean age was 25.01 years ($SD=6.83$, range 20–48). To enrol in this course students must have completed at least one course in introductory

statistics with the majority expected to have completed a second-year statistics course. The course is taught at two campuses within the same psychology school, using the same course materials. No demographic or variable differences were found between the campuses, so their data were combined. Participation was anonymous and voluntary. Participants did not receive compensation for participation. The study was granted ethical approval by the University's Human Ethics committee.

Measures

Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985). The 51-item STARS was used to measure statistics anxiety and attitudes and consists of six subscales. Each subscale is measured on a 5-point Likert scale. Three subscales assess level of statistics anxiety: Test and Class Anxiety (e.g., “Studying for an exam in a statistics course”), Interpretation Anxiety (e.g., “Interpreting the meaning of a table in a journal article”), Fear of asking for help (e.g., “Asking someone for help in understanding a print-out”). The participants were asked to indicate how much anxiety they would experience from 1 (*no anxiety*) to 5 (*strong anxiety*). The remaining three scales assess students' attitudes about learning statistics: Worth of statistics (e.g., “Statistics is a grind, a pain I could do without”); Fear of statistics teachers (e.g., “Statistics teachers talk so fast you cannot logically follow them”); Computational Self-concept (e.g., “I don't have enough brains to get through statistics”). The participants were asked to rate their level of agreement, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A statistics anxiety composite score is created with the mean of the test anxiety, interpretation anxiety, and fear of asking for help subscales and a statistics attitude composite score is created using the mean of the worth, fear of statistics teacher and computational self-concept subscales (Papousek et al., 2012). Scores on each composite can range from 1 – 5 with higher scores indicating greater statistics anxiety and less favourable attitudes, respectively.

Current Statistics Self-Efficacy Scale (CSSE; Finney & Schraw, 2003). The CSSE is a 13-item self-report measure where students rate their level of confidence in completing a variety of statistical tasks, such as the ability to “Identify the scale of a measurement for a variable” from 1 (*no confidence*) to 6 (*complete confidence*). Scores are summed to create a scale ranging from 13 to 78.

Reinforcement Sensitivity Theory Personality Questionnaire – BAS (RST-PQ-BAS; Corr & Cooper, 2016). The RST-PQ was designed to assess the four RST BAS dimensions. The 32-item BAS scale comprises four subscales: reward interest (7 items; e.g., “I get carried away by new projects”), goal-drive persistence (7 items; e.g., “I often overcome hurdles to achieve my ambitions”), reward reactivity (10 items; e.g., “I love winning competitions”), and impulsivity (8 items; e.g., “I think the best nights out are unplanned”). Responses are recorded on a 4-point scale from 1 (*not at all*) to 4 (*highly*) and summed to create four subscales. The RST-PQ-BAS scales were used to allow tests of specific BAS dimensions.

Jackson-5 (Jackson, 2009). The Jackson-5 was used to measure BIS and FFFS sensitivity. The Jackson-5 consists of 30 items rated on a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*) deriving a single BAS score, a BIS score, and three Fight/Flight/Freeze scores. However, only three subscales (totalling 18 items) were used from this measure: BIS, flight, and freeze subscales. The 6-item BIS scale assesses individual

differences in detecting and addressing goal-conflicts (e.g., “I want to avoid looking bad”). The 6-item flight (e.g., “If a dog barks at me, I would run away”) and 6-item freeze (e.g., “In a crowd, my mind freezes and then I never know what to say”) scales assess the tendencies to notice and respond to threat by fleeing or freezing, respectively. The Jackson-5 FFFS scales were used to allow tests of specific FFFS dimensions. This scale was previously validated in a sample of university students and reported internal reliability of 0.76 (BIS), 0.74 (flight), and 0.70 (freeze; Jackson, 2009).

Results

Data were examined for outliers and tests of assumptions for analysis. Based on Cook’s Distance and tests of leverage, two cases were identified as being potentially influential and were removed from the analyses.

Descriptives and correlations

To test the associations between personality and statistics anxiety, attitude, and self-efficacy, bivariate correlations were performed. Given the large number of correlations (12 variables) an alpha of <0.004 was considered significant, based on the Bonferroni correction. As shown in Table 1, female students reported greater statistics anxiety, less favourable attitudes, and less self-efficacy than non-female counterparts. Older students had lower anxiety and more favourable attitudes. Goal-drive persistence was associated with lower statistics anxiety, more favourable attitudes, and greater self-efficacy. Impulsivity was associated with greater statistics anxiety, and less favourable attitudes. There was no association between reward interest or reward reactivity and the criterion variables. Both flight and freezing were associated with greater statistics anxiety, less favourable attitudes, and lower self-efficacy. There was no association between BIS and any of the criterion variables.

Regressions

To account for the correlations between the traits and to control for age and gender, three hierarchical multiple regression analyses were performed with personality as predictors on the criterion variables (statistics anxiety, attitude, self-efficacy). Only traits that showed significant bivariate associations were included in each of the regression analyses. No issues with multicollinearity were detected among the independent variables. Age and gender were entered in the first step, and personality traits in the second step. As shown in Table 2, after controlling for age and gender, the personality variables accounted for 16% of the variance in statistics anxiety $F_{\text{chg}}(4, 294) = 16.67, p < 0.001$, 8% of the variance in attitudes $F_{\text{chg}}(4, 294) = 7.34, p < 0.001$, and 8% of the variance in self-efficacy $F_{\text{chg}}(2, 296) = 14.17, p < 0.001$.

Goal-drive persistence was a negative predictor, while impulsivity and freeze were positive predictors of statistics anxiety. Freezing was the strongest predictor, accounting for 4% of unique variance in statistics anxiety, followed by impulsivity (3.7%) and goal-drive persistence (2.5%).

Higher goal-drive persistence and lower impulsivity were associated with more favourable attitudes. Goal-drive persistence was the strongest predictor, accounting for 4.9% of unique variance in attitudes, following by impulsivity (2.5%).

Table 1 Correlations for Study 1 Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	—											
2. Gender	-0.09	—										
3. RI	0.03	-0.02	0.82									
4. GDP	0.12	0.08	0.49***	0.90								
5. RR	-0.03	0.22***	0.51***	0.38***	0.86							
6. Impulsivity	-0.08	0.10	0.49***	0.13	0.50***	0.81						
7. Flight	-0.12	0.31***	-0.04	-0.02	0.11	0.06	0.68					
8. Freeze	-0.25***	0.29***	-0.24***	-0.26***	-0.03	0.05	0.52***	0.71				
9. BIS	-0.11	-0.02	0.01	0.10	0.28***	0.08	0.13	0.19***	0.72			
10. Stats Anx	-0.24***	0.30***	-0.06	-0.20***	0.11	0.22***	0.29***	0.45***	0.08	0.95		
11. Stats Att	-0.20***	0.22***	-0.12	-0.25***	0.03	0.17**	0.18***	0.23***	0.01	0.59***	0.96	
12. Self-efficacy	0.06	-0.19***	0.14	0.26***	0.05	-0.10	-0.12	-0.22***	0.02	-0.54***	-0.47***	0.94
Mean	25.01	—	18.70	22.26	28.37	18.28	15.06	17.69	20.45	2.89	2.16	38.93
SD	6.83	—	22.26	4.36	5.59	5.14	4.19	4.75	4.00	0.81	0.77	12.87

Gender was dummy-coded with 1 = female, 0 = not female, RI = Reward Interest; GDP = Goal-drive Persistence; RR = Reward Reactivity; BIS = Behavioural Inhibition System; Stats Anx = statistics anxiety, Stats Att = statistics attitudes (higher scores indicate less favourable attitudes). Cronbach's alpha in diagonals

** $p < 0.004$. *** $p < 0.001$

Table 2 Study 1 Hierarchical Multiple Regressions

Variable	<i>B</i>	95% CI		SE <i>B</i>	β	<i>R</i> ²	ΔR^2
		LL	UL				
Statistics Anxiety						0.14	0.14***
Step 1							
Age	-0.03*	-0.04	-0.01	0.01	-0.22		
Female	0.52***	0.33	0.71	0.10	0.29		
Step 2						0.30	0.16***
GDP	-0.03**	-0.05	0.01	0.01	-0.17		
Impulsivity	0.03***	0.02	0.05	0.01	0.19		
Flight	0.01	-0.01	0.04	0.01	0.08		
Freeze	0.04***	0.02	0.06	0.01	0.26		
Statistics Attitude						0.09	0.09***
Step 1							
Age	-0.02*	-0.03	-0.01	0.01	-0.18		
Female	0.34***	0.19	0.57	0.10	0.22		
Step 2						0.17	0.08***
GDP	-0.04***	-0.06	-0.02	0.01	-0.24		
Impulsivity	0.02**	0.01	0.04	0.01	0.16		
Flight	0.01	-0.01	0.04	0.01	0.06		
Freeze	0.01	-0.02	0.03	0.01	0.03		
Statistics Self-Efficacy							
Step 1							
Age	-0.07	-0.15	0.29	0.11	0.04	0.04	0.04**
Female	-5.72***	-8.99	-2.45	1.66	-0.20		
Step 2						0.12	0.08***
GDP	0.75***	0.41	1.10	0.17	0.25		
Freeze	-0.29	-0.61	0.04	0.17	-0.10		

N = 301, CI = confidence interval; *LL* = lower limit; *UL* = upper limit; GDP = goal-drive persistence. Higher scores on statistics attitude indicate less favourable attitudes

p* < 0.05. *p* < 0.01. ****p* < 0.001

Goal-drive persistence was a positive predictor and accounted for 5.5% of unique variance in statistics self-efficacy.

Discussion

This first study investigated the associations between RST dimensions and statistics anxiety, attitudes toward statistics and statistics self-efficacy, in third-year undergraduate psychology students. As hypothesized, (low) goal-drive persistence, impulsivity, and FFFS (notably the Freeze dimension) were associated with greater statistics anxiety, even when accounting for age and gender. Also as predicted, goal-drive persistence was associated with more favourable attitudes and greater self-efficacy, while impulsivity was associated with less favourable attitudes. There were no associations with reward interest nor reward reactivity and any criterion.

Contrary to the hypothesis, BIS was not significantly associated with any criterion. Similarly, using the same BIS/FFFS measure, Nob (2013) found BIS to be associated with test anxiety, but to be non-significant after controlling for FFFS. The absence of association with BIS may be attributed to students' heightened sensitive to treats (FFFS) compared to conflicts (BIS). This sensitivity might lead students to perceive learning statistics more as a treat than as a combination of treat and reward (which would trigger BIS activation). Alternatively, the lack of association could be due to the measure of BIS employed. The Jackson-5 FFFS scales were used because they distinguish FFFS into separate flight/freeze dimensions and the Jackson-5 BIS scale was primarily based on its conciseness—consisting of 6 items, compared with the 23-item RST-PQ-BIS scale. This deliberate choice was to reduce participant burden. Although widely used and validated in university students (Harnett et al., 2013; Jackson, 2009; Kramer & Rodriguez, 2018), lower than desirable levels of internal reliability were found in this study (Cronbach's α ranging from 0.68 to 0.72). The Jackson-5 BIS has previously faced criticism for lacking face validity and focusing on social comparison and competition (Corr, 2016; Krupić et al., 2016). These reliability and validity issues suggest that alternative measures should be employed in subsequent studies.

Given the importance of understanding the relative contributions of BIS and FFFS on statistics anxiety, further investigation is essential to determine whether the outcomes of Study 1 are attributed to measurement issues or whether reframing statistics “anxiety” as statistics “fear” is a more accurate representation. This has critical practical and theoretical implications. Conceptualising statistics anxiety as fear would shift the emphasis to address fear-based responses, targeting the students' tendencies to freeze and avoid statistics related materials by incorporating exposure-related techniques. Additionally, this reframing would lay the groundwork for further exploration into the impact of fear on engagement levels, using more objective measures.

Furthermore, this study focused on advanced third level students, limiting its generalisability to those in introductory or intermediate courses who are typically the recipients of interventions. Despite the importance of investigating statistics anxiety, attitudes, and self-efficacy in advanced statistics students (when they have more experience and stronger opinions about statistics), exploring these factors at earlier levels enables interventions to target these issues from the beginning. Additionally, comparing these constructs across academic years facilitates identifying moments in the academic program when the students have more problems, guiding interventions to prioritise critical stages. Future studies should consider including samples from a broader range of statistics education levels to address these questions.

Study 2

The aims of the second study were to: 1) address limitations of the findings from Study 1 by using alternative BIS and FFFS scales, 2) replicate the findings from Study 1 in new samples across the first three year levels of an undergraduate psychology program (where the studies were performed, the undergraduate psychology degree consists of three years of study, with a statistics course in each year), and 3) explore the possible nuances or variations that might emerge based on the roles of RST in different levels of statistics experience.

Study 1 assessed BIS/FFFS with the Jackson-5 measure, which demonstrated low reliability. To mitigate possible misleading interpretations of the results due to

psychometric issues, this study used the BIS and Flight-Freeze scales of the RST-PQ (Corr & Cooper, 2016) along with the BAS dimensions. The RST-PQ has been recently validated in a population of psychology students with good to excellent reliability (Gomez et al., 2021). In Study 1, statistics self-efficacy was assessed using the CSSE, which focuses on statistics knowledge and content (current ability to complete statistics tasks). Study 2 uses the Statistics Self-Efficacy Scale (SSES) that assesses the confidence in learning and applying statistics more generally. This choice aimed to mitigate potential influences related to the variability of statistical knowledge due to the inclusion of students from three distinct statistical course levels. Based on the findings of Study 1, it is hypothesized that 1) goal-drive persistence will be associated with (lower) statistics anxiety, more favourable attitudes, and greater self-efficacy, 2) impulsivity will be associated with greater statistics anxiety and less favourable attitudes, and 3) when using an alternative measure, FFFS, rather than BIS, will be a significant positive predictor of statistics anxiety. The role of reward interest and reward reactivity will be exploratory.

Method

Participants and Procedure

A total of 577 undergraduate psychology students completed the online survey. From those, 154 (62% female) were students from an introductory statistics course (first year), 122 (55.7% female) from a second-year statistics course, and 301 (70.8% female) from a third-year statistics course (a different cohort from Study 1). The age range for the three samples were: first-year from 18 to 56 ($M=24.7$ years, $SD=9.8$), second-year from 19 to 58 ($M=27.1$ years, $SD=9.6$), and third-year from 19 to 58 ($M=24.4$ years, $SD=6.6$).

The same procedure was followed as in Study 1, with students completing the online survey at the beginning of their face-to-face computer class in the second week of the teaching term, across two campuses. Course materials and assessments did not vary across campuses. Participation was voluntary and anonymous.

Measures

RST-PQ (Corr & Cooper, 2016). In addition to the BAS scales used in Study 1, the 23-item BIS scale (e.g., “I worry a lot”) and the 10-item FFFS (e.g., “There are some things that I simply cannot go near”) were administered.

SSES (Bandalos et al., 2003). The 10-item SSES was used to assess participants perceived confidence in their own ability to learn statistical content, complete statistics tasks and achieve good grades in the statistical course (e.g., “Learning statistics is easy for me”). The SSES is rated on a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*) and summed to create a single scale.

Other Measures. Measures of statistics anxiety and attitudes (STARS) were the same as in Study 1. All showed good internal consistency (see Table 3).

Table 3 Means and SDs across Year Level

Variable	Year 1	Year 2	Year 3	<i>F</i>
Reward Interest	18.83 (4.18)	18.88 (4.19)	18.97 (4.20)	0.06
Goal-Drive Persistence	21.72 (4.57)	22.40 (4.57)	22.53 (4.42)	1.54
Reward Reactivity	28.74 (5.36)	28.44 (6.00)	28.78 (5.35)	0.16
Impulsivity	18.73 (4.37)	18.50 (4.94)	18.60 (5.07)	0.08
FFFS	22.99 (5.55)	22.63 (6.39)	22.11 (6.06)	1.00
BIS	59.46 (15.20)	58.66 (16.05)	61.31 (15.07)	1.44
Statistics Anxiety	3.16 (0.90)	3.04 (0.97)	3.06 (0.90)	0.81
Statistics Attitude	2.32 (0.84)	2.40 (0.83)	2.17 (0.80)	3.95*
Statistics Self-Efficacy	39.47 (11.90)	40.77 (13.84)	41.40 (13.31)	0.93

FFFS = Flight/Freeze System; BIS = Behavioural Inhibition System; Higher scores on attitude indicate less favourable attitudes

* $p < 0.05$

Results

Differences across year level

Between-subjects one-way analyses of variance (ANOVA) were performed to assess for differences across the three year-levels, with year level as the independent variable (first, second, third year) for all variables. As shown in Table 3, there were no significant differences in personality, statistics anxiety, nor self-efficacy across the three course levels. There was significant overall difference of attitudes, $F(2,574) = 3.95$, $p = 0.020$, $\eta^2 = 0.014$. Bonferroni Post Hoc analysis showed a significant difference between second and third-year courses ($p = 0.026$). The third-year course level reported more favourable attitudes than the second-year level. Given that the only difference across year level data was very small, data from the three courses were combined for subsequent analyses.

Descriptives and Correlations

Descriptives and bivariate correlations are shown in Table 4. An alpha of < 0.005 was used for significance based on the Bonferroni correction for 11 variables. Again, female students reported greater statistics anxiety, less favourable attitudes, and less self-efficacy than non-female counterparts. Older students again reported less anxiety, more favourable attitudes, and in this study, greater self-efficacy. Goal-drive persistence was again associated with lower statistics anxiety, more favourable attitudes, and greater self-efficacy. Unlike in Study 1, reward interest and reward reactivity were both associated with greater self-efficacy. Impulsivity was associated with greater statistics anxiety and less favourable attitudes. Both BIS and FFFS were associated with statistics anxiety, less favourable attitudes, and lower self-efficacy.

Regressions

To assess the unique contribution of RST traits to statistics anxiety, attitudes, and self-efficacy, controlling for age and gender, hierarchical regression analyses are performed with

Table 4 Correlations for Study 2 Variables

	1	2	3	4	5	6	7	8	9	10	11
1. Age	—										
2. Gender	-0.10	—									
3. RI	0.09	-0.02	0.79								
4. GDP	0.16***	0.12	0.55***	0.90							
5. RR	-0.05	0.18***	0.50***	0.51***	0.84						
6. Imp	-0.11	0.13**	0.32***	0.08	0.44***	0.77					
7. FFFS	-0.17***	0.24***	-0.12	0.01	0.19***	0.16***	0.95				
8. BIS	-0.29	0.13**	-0.17	-0.21***	0.08	0.24***	0.53***	0.79			
9. Stats Anx	-0.16***	0.30***	-0.07	-0.15***	0.11	0.20***	0.40***	0.49***	0.96		
10. Stats Att	-0.15***	0.18***	-0.11	-0.17***	0.02	0.16***	0.28***	0.29***	0.66***	0.96	
11. Self-efficacy	0.13**	-0.18***	0.21***	0.37***	0.14**	-0.08	-0.14**	-0.27***	-0.63***	-0.62***	0.95
Mean	24.97	—	18.92	22.31	28.70	18.60	60.35	22.42	3.08	2.26	40.83
SD	8.10	—	4.19	4.47	5.48	4.87	15.32	6.02	0.92	0.82	13.11

Gender was dummy-coded with 1 = female, 0 = not female; RI = Reward Interest; GDP = Goal-Drive persistence; RR = Reward Reactivity; BIS = Behavioural Inhibition System; FFFS = Fight/Flight/Freeze System; Stats Anx = statistics anxiety; Stats Att = statistics attitudes—higher scores indicate less favourable attitudes. Cronbach's alpha in diagonals

** $p < 0.005$. *** $p < 0.001$

RST dimensions as predictors. Only traits that showed significant bivariate associations were included in each regression analyses. No problems of multicollinearity were identified among the independent variables. Age and gender were entered in the first step, and personality variables in the second step. After controlling for age and gender, personality variables accounted for 23% of the variance in statistics anxiety, $F_{\text{chg}}(4, 498)=42.15, p<0.001$, 11% in attitudes, $F_{\text{chg}}(4, 498)=16.73, p<0.001$, and 18% in self-efficacy, $F_{\text{chg}}(5, 497)=23.20, p<0.001$.

As shown in Table 5, when controlling for age and gender, (low) goal-drive persistence, BIS and FFFS were significant unique predictors of statistics anxiety. BIS was the strongest

Table 5 Study 2 Hierarchical Multiple Regressions

Variable	B	95% CI		SE B	β	R^2	ΔR^2
		LL	UL				
Statistics Anxiety						0.11	0.11***
Step 1							
Age	-0.02	-0.04	-0.01	0.01	-0.13**		
Female	0.60***	0.43	0.77	0.09	0.29***		
Step 2						0.34	0.23***
GDP	-0.03***	-0.05	-0.01	0.01	-0.12**		
Impulsivity	0.01	-0.01	0.03	0.01	0.06		
BIS	0.02***	0.02	0.03	0.00	0.35***		
FFFS	0.02***	0.01	0.04	0.01	0.16***		
Statistics Attitude							
Step 1						0.06	0.06***
Age	-0.01**	-0.05	0.33	0.00	-0.13**		
Female	0.34***	-7.49	-2.34	0.81	0.18***		
Step 2						0.17	0.11***
GDP	-0.03***	-0.05	-0.02	0.01	-0.18***		
Impulsivity	0.02*	0.00	0.03	0.01	0.09*		
BIS	0.01**	0.00	0.01	0.00	0.16**		
FFFS	0.02*	0.00	0.03	0.01	0.13*		
Statistics Self-efficacy							
Step 1						0.05	0.05***
Age	0.19**	0.05	0.33	0.07	0.12**		
Female	-4.91***	-7.49	-2.34	1.31	-0.16***		
Step 2						0.23	0.18***
Reward Interest	-0.11	-0.42	0.21	0.16	-0.04		
GDP	1.06***	0.75	1.35	0.15	0.36***		
Reward Reactivity	0.06	-0.18	0.30	0.12	0.03		
BIS	-0.17***	-0.25	-0.08	0.04	-0.19***		
FFFS	-0.04	-0.25	0.17	0.11	-0.02		

$N=505$, CI=confidence interval; LL=lower limit; UL=upper limit; GDP=goal-drive persistence; BIS=Behavioural Inhibition System; FFFS=Fight/Flight/Freeze System. Higher scores on statistics attitude indicate less favourable attitudes

* $p<0.05$. ** $p<0.01$. *** $p<0.001$

predictor, accounting for 7.4% of unique variance in statistics anxiety, followed by FFFS (1.7%), and goal-drive persistence (1.4%).

Goal-drive persistence, impulsivity, BIS and FFFS were significant unique predictors of attitudes. Goal-drive persistence was the strongest predictor, accounting for 2.8% of unique variance in attitudes, followed by BIS (1.6%), FFFS (1.1%), and impulsivity (0.7%).

Finally, goal-drive persistence and BIS were significant unique predictors of self-efficacy. Goal-drive persistence was the strongest predictor, accounting for 7.5% of the unique variance in self-efficacy, followed by BIS (2.4%).

Discussion

This second study replicated and addressed limitations of Study 1 as well as extending to all three year-levels. As hypothesised, goal-drive persistence was a significant predictor of lower statistics anxiety, more favourable attitudes, and greater self-efficacy. Similarly, in line with the hypotheses, FFFS was a significant unique predictor of statistics anxiety. Additionally, impulsivity was associated with less favourable attitudes. In contrast to Study 1, the use of an alternative measure in this study revealed that BIS was uniquely associated with statistics anxiety, less favourable attitudes, and lower self-efficacy. Additionally, unlike Study 1, reward interest and reward reactivity were associated with self-efficacy (but became non-significant in the regression analysis). Although not hypothesised, there were no differences in statistics anxiety or self-efficacy across the three-year levels.

General Discussion

The purpose of the current research was to explore the role of a personality theory based on learning and motivation in understanding individual differences in statistics anxiety, attitude, and self-efficacy in undergraduate psychology students.

High goal-drive persistence was protective of statistics anxiety across both studies with high scores associated with less anxiety, more favourable attitudes, and greater self-efficacy. Chew & Dillon (2014a) found statistics attitude, but not statistics anxiety, to be associated with conscientiousness – a trait that have been linked with goal-drive persistence (Corr & Cooper, 2016). Goal-drive persistence is related to planning behaviour and striving to achieve the goal and so may be useful in identifying those who thrive in their statistics courses. Whether goal-drive persistence accounts for additional variance beyond conscientiousness would need to be empirically tested by administering measures of both traits. These findings supports Shahzadi & Walker (2019), which found a positive association between goal-drive persistence and mastery (characterised by high self-efficacy, effort and persistence).

Although impulsivity was uniquely associated with statistics anxiety and attitude in Study 1 (only with third-year students), impulsivity was not uniquely associated with statistics anxiety in Study 2 (with students from three years). Impulsivity has been argued to be less aligned with traditional conceptualizations of BAS and is typically associated with low conscientiousness (Dawe & Loxton, 2004; Corr & Cooper, 2016). It is plausible that goal-drive persistence remains a predictor of statistics self-efficacy across the undergraduate years, while impulsivity plays a role only in the final year of the degree. Chew & Dillon (2014a) propose that students with poor impulse control may not have developed the pre-requisite study habits to persist when learning a subject that

they perceive as challenging, thereby increasing their anxiety and poor impulse control. A history of poor study habits may become more apparent in their final year of study.

Of particular interest to the studies were the potential differential roles of BIS and FFFS. Contrary to expectations, in Study 1, BIS sensitivity was not associated with statistics anxiety, attitudes, nor self-efficacy, while FFFS (specifically the freeze subscale) was associated with statistics anxiety. This matches the findings of Nob (2013) who also found FFFS (freeze scale) to be the strongest unique predictor of general test anxiety. This finding is not surprising given that some students report “freezing” or “going blank” during exams (Sommer & Sommer, 2009). When using a different measure in Study 2, BIS was uniquely associated with statistics anxiety, attitudes, and self-efficacy, and accounted for more variance in all outcome variables than FFFS – especially in statistics anxiety. Study 2 findings suggest that students with higher statistics anxiety, lower self-efficacy and less favourable attitudes tend to have more sensitive BIS (characterized by high levels of anxiety, anxious rumination, and worry-proneness), and to a lesser extent, fear sensitivity (which may lead to avoidance behaviours).

The different findings between Study 1 and Study 2 suggest that RST measures provide distinct insights into the effects of BIS on statistics anxiety, self-efficacy, and attitudes. Notably, the emergence of BIS as a significant predictor in Study 2 suggests that the BIS scale employed in Study 1 (Jackson-5), which appears to assess social threats, may be less pertinent in comprehending academically-related threats. Further research in this topic should consider adopting the more comprehensive RST-PQ-BIS scale.

Study 2 examined statistics anxiety, attitudes, and self-efficacy across students from three levels of statistics courses. No differences were found in statistics anxiety, aligning with prior research (DeVaney, 2017; Ruggeri et al., 2008). There was no difference in statistics self-efficacy across year levels, contrary to Walker & Brakke (2017) who found students from advanced statistics courses reported higher self-efficacy than those from an introductory course at the beginning of the course, albeit no difference at the end of these courses. One reason for the statistics self-efficacy failing to increase from introductory to advanced courses could be due to the rising complexity of activities in advanced courses, despite the students’ increased exposure to statistics.

Conversely, students from the third year demonstrated more positive attitudes towards statistics compared to students from the second year. This result may be attributed to students’ evolving experiences. It is important to note that attitudes were assessed at the beginning of each course, reflecting students’ attitudes before entering the course. First-year students may form their initial attitudes based on hearsay from peers and pre-existing attitudes toward mathematics. In contrast, second-year students have their attitudes based on their experience from the introductory course, including exposure to statistics terminologies, new software tools (e.g., SPSS), and manual calculations. However, the third-year students have already undergone to more experience to base their attitudes. During the second-year course students shift their focus from learning basic concepts, to more practical application of the analysis learnt, which may help them to see the relevance of statistics within psychology. Exploring the empirical reasons for this difference in future research could inform interventions aiming to enhance attitudes toward statistics.

Implications

In the current studies, RST dimensions accounted up to 23% of the variance in these factors, after accounting for age and gender, supporting the value of understanding

personality influences in statistics education and that approaches to managing statistics anxiety and increasing statistics self-efficacy need to account for these influences. Rather than developing one-size-fits-all intervention programs, these findings suggest that students with different personality traits perceive their study of statistics quite differently and may require distinctly different approaches to learning. Indeed “personality-targeted” approaches has dramatically changed psychological intervention approaches (e.g., Edalati & Conrod, 2019) and should be explored in the statistics education. These findings suggest that some students may need specific support to manage their tendency to freeze and avoid by using lessons from the treatment of phobias (i.e., exposure-based therapy) while others may benefit from managing heightened anxiety and physiological arousal using lessons from the treatment of anxiety (i.e., metacognitive therapy). Moreover, knowing that goal-drive persistence can be a protective factor, students low in this personality trait may benefit from interventions fostering the motivation to persist to reach goals, such as motivational interviewing.

Limitations and conclusion

Due to the naturalistic approach, the data collection was limited to the students who attended the first computer class in the courses, potentially introducing selection bias. However, based on enrolments at the time approximately 87% completed the survey for Study 1, the sample appears reasonably representative, although it is possible that the 13% who did not complete the survey were the most fearful, anxious or the less goal-driven who either failed to attend the computer labs or declined to participate. Additionally, the cross-sectional design in these studies prevents drawing causal inferences. Furthermore, given the anonymous nature of the studies, only group differences between the year levels were analysed rather than change over time in Study 2. Future studies could explore changes in statistics anxiety, attitudes, and self-efficacy across different time points within a course and over different course levels to examine the longitudinal impact of RST traits in these psychological constructs. Moreover, future research may benefit from measuring course engagement and attendance while assessing RST components to empirically demonstrate the relationship between avoidance in the context of statistics courses.

Overall, the results demonstrated that after controlling for age and gender, personality traits still account for a significant proportion of statistics anxiety, attitudes, and self-efficacy. Students high in goal-drive persistence trait reported lower statistics anxiety, higher statistics self-efficacy, and more favourable attitudes towards the study of statistics. Results from Study 1 suggested that fear (FFFS), but not anxiety (BIS), was associated with statistics anxiety. However, when using a different measure, Study 2 found both fear and anxiety-prone traits associated with statistics anxiety and less favourable attitude, with anxiety being the strongest predictor. Finally, this study found that despite years of exposure to statistics, the students continue experiencing the same levels of statistics anxiety and self-efficacy in the third year. These findings support calls to develop personality-targeted support programs to address factors that impact on performance in the study of statistics.

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Declarations

Data Sharing The datasets generated during and/or analysed during the current study are not publicly available due to University approved ethics restrictions on data storage and availability.

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Current themes of research:

Statistics anxiety, statistics teaching, personality, synchronous and asynchronous learning, student performance.

Relevant Publications:

- Stuart, J., O'Donnell, A. W., Scott, R., O'Donnell, K., Lund, R., & Barber, B. (2022). Asynchronous and synchronous remote teaching and academic outcomes during COVID-19. *Distance Education*, *43*(3), 408–425. <https://doi.org/10.1080/01587919.2022.2088477>
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