The Possible Mediation of State and Trait Self-Control: The Effects of Self-Control on the Relationship between State Anxiety and Cognitive Performance

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Abstract

Classification in modern society relies heavily on academic performance on cognitive tests. For instance, attaining a university degree requires an individual to undergo academic testing. Thus, the results of these tests often dictate future job opportunities. Anxiety is often present in the testing environment and therefore it is important to understand the relationship between anxiety and cognitive performance. Drawing on the tenets of Attentional Control Theory, the present study hypothesised that trait and state self-control may influence the effects of state anxiety on performance. Undergraduate psychology students were matched across four conditions on their scores of trait self-control. They were placed in conditions where state anxiety (absent or present) and state self-control (intact or depleted) were manipulated prior to cognitive testing. Thus the four conditions were absent-intact (n = 39), absent-depleted (n = 38), present-intact (n = 46), and present-depleted (n = 42). The outcome measure was scores on memory and arithmetic tasks. Analyses detected no significant between-condition differences on performance in state self-control intact and state self-control depleted conditions for both levels of the anxiety manipulation. Moreover, a multiple regression analysis showed that trait self-control did not have a significant effect on the relationship between state anxiety and cognitive performance. However, state self-control score added significant unique variance to the regression model in anxiety-present conditions, indicating that state self-control may affect cognitive performance in anxiety-provoking conditions. There were various limitations in the present study that may have undermined the significance of results. Thus, future research should aim to address these limitations in order to further understand the relationship between anxiety, self-control and performance.

Keywords: state anxiety; state self-control; trait self-control; Attentional Control Theory; State-Trait Anxiety Inventory; Brief Self-Control Scale; working memory; free recall

The Possible Mediation of State and Trait Self-Control: The Effects of Self-Control on the Relationship between State Anxiety and Cognitive Performance

Performance on cognitive tests is an important yardstick of functioning in contemporary society. Often, such performance is used as a basis for educational and vocational classification. However, anxiety during test situations may lead to poor performance and, consequently, inaccurate classification (Bertrams, Englert, & Dickhäuser, 2013). Hence, research into the relationship between anxiety and cognitive test performance is important and has relevance for the potential educational and career paths of schoolchildren, adolescents, and young adults (Owens, Stevenson, Hadwin, & Norgate, 2014). The long-term detrimental effects of anxiety-affected performance might include premature school-leaving and an inability to pursue tertiary education (Andrews & Wilding, 2004; Breslau, Lane, Sampson, & Kessler, 2008; Lee et al., 2009; Van Ameringen, Mancini, & Farvolden, 2003).

Anxiety can be defined as an emotional state that features high levels of arousal, worrisome thoughts, and nervousness (Spielberger & Vagg, 1995), all experienced in a situation involving a perceived threat (Egloff & Hock, 2001; Eysenck & Byrne, 1992; Fox, Russo, & Dutton, 2002; Mogg & Bradley, 1998; Mogg et al., 2000; Wilson & MacLeod, 2003). There is a particular distinction between *trait anxiety* and *state anxiety*. The former is an inherent personality trait, invariant across situations, whereas the latter describes anxiety that is influenced by environmental stressors and that occurs in a particular stressful situation. Thus, state anxiety varies in intensity across the lifespan (Eysenck, 1992; Spielberger, 1983; Spielberger, Gorsuch, & Lushene, 1970). State anxiety is often coupled with *worry*, a term describing an affective state in which performance is impacted negatively because an

excessive preoccupation with potential failure or negative evaluation disrupts optimal working memory functioning (Borkovec, 1994).

Currently, the literature describing the effects of state anxiety on test performance is fairly inconclusive (Blankstein, Flett, Boase, & Toner, 1990; Blankstein, Toner, & Flett, 1989; Brook, 1976; Calvo, Alamo, & Ramos, 1990; Calvo & Ramos, 1989; Díaz, Glass, Arnkoff, & Tanofsky-Kraff, 2001; Endler, Kantor, & Parker, 1994; Kantor, Endler, Heslegrave, & Kocovski, 2001). Although folk wisdom suggests that state anxiety hinders performance (Sarason, 1988), several empirical studies have suggested that individuals with higher levels of state anxiety may, in fact, outperform those with lower levels (Byrne & Eysenck, 1995; Spence, Farber, & McCann, 1956; Spence, Taylor, & Ketchel, 1956; Standish & Champion, 1960). Hence, some researchers hypothesise that a third variable – self-control and the ability to keep worrying thoughts out of the conscious processing stream – may be responsible for the seemingly erratic relationship between state anxiety and cognitive performance (Bertrams et al., 2013; Seipp, 1991).

Just as one can distinguish between trait and state anxiety, so one might distinguish between trait and state self-control. In general, *self-control* is defined as an active and deliberate process whereby an individual attempts to adjust or countermand certain responses (Muraven & Baumeister, 2000; Schmeichel & Vohs, 2009). *Trait self-control* is an inherent personality trait, invariant across different contexts (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). *State self-control*, in contrast, refers to the self-control resources available to the individual within a particular situation; hence, it is influenced strongly by environmental conditions (Bertrams et al., 2013). Both forms of self-control affect the functioning of working memory by influencing the amount of resources dedicated to anxiety-inducing thoughts.

The concept of *working memory* refers to a cognitive function that allows an individual to process and manipulate task-relevant stimuli (Baddeley & Hitch, 1974; Miyake & Shah, 1999). For instance, a student might use working memory when performing mental arithmetic, a task that requires numbers to be held in the conscious processing stream and to be manipulated while there. Working memory capacity is positively associated with academic performance, in that poorer working memory skills predict poorer performance (Alloway, Gathercole, Kirkwood, & Elliott, 2009; Gathercole, Pickering, Knight, & Stegmann, 2004). Furthermore, empirical studies indicate that trait anxiety disrupts working memory performance in adults (Eysenck & Calvo, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007) and in children (Ng & Lee, 2010; Owens, Stevenson, Norgate, & Hadwin, 2008; Visu-Petra, Cheie, Benga, & Alloway, 2011).

In terms of the relevance of working memory to the focus of this paper, it seems that, when anxious, individuals with better working memory capacity have better efficiency of performance than individuals with poorer working memory capacity. Working memory capacity does not, however, affect the effectiveness of processing when anxious (Eysenck et al., 2007). Thus, high levels of cognitive resources, which can also be conceptualised as high working memory capacity, are particularly important for cognitive performance in anxiety-provoking situations.

At this point, then, it is important to distinguish between effectiveness and efficiency in performing cognitive tasks. *Effectiveness* can be conceptualised as the number of correct responses, or the general accuracy of performance, on a task. In contrast, *efficiency* refers to the relationship between task effectiveness and the resources used to complete the task (Eysenck et al., 2007). According to Processing Efficiency Theory (Eysenck & Calvo, 1992), state anxiety has a more detrimental impact on efficiency than on effectiveness of task performance. This detrimental impact is induced through worry, which interferes with task-

related processing and diverts working memory resources to attend to anxious thoughts (Eysenck et al., 2007).

Processing Efficiency Theory further suggests that supporting processes are necessary for effective performance while anxious. These processes may help reduce the number of worrisome thoughts that occupy working memory, and might therefore make available more resources for task-relevant processing.

Building on Processing Efficiency Theory, Attentional Control Theory has been developed through key empirical research (Derryberry & Reed, 2002; Fox, 1993; Fox et al., 2002; Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998; Mathews & Mackintosh, 1998). Within this latter theoretical framework, researchers postulate that anxiety emerges when an individual perceives a goal to be threatened, and resources are concentrated on attempting to remove the perceived threat (Power & Dalgleish, 1997). An important consequence of anxiety, conceptualized thus, is *attentional bias*, which involves an individual attending closely to threatening stimuli and thereby leaving less attention available for neutral or task-beneficial processing (Egloff & Hock, 2001; Eysenck & Byrne, 1992; Fox et al., 2002; Mogg & Bradley, 1998; Mogg et al., 2000; Wilson & MacLeod, 2003).

Recently, Bertrams et al. (2013) conducted a study to test the prediction that self-control might mediate the relationship between effectiveness and anxiety by acting on efficiency. Thus, they aimed to highlight state self-control as an important component of Attentional Control Theory. Within this theoretical framework, the mediation of the relationship between state anxiety and cognitive performance is achieved through the influence of self-control on attentional bias. Specifically, Bertrams and colleagues conducted three studies aimed at assessing the role of state self-control in the relationship between state anxiety and cognitive performance. In each of the studies, they compared cognitive performance in participants with depleted state self-control (i.e., those who had to perform

task manipulations designed to operate against automatic modes of processing) against that in participants with intact state self-control. All participants were told that they were completing an important intelligence test and that they would receive personal feedback on their performance. Measures of cognitive performance included number of nonsense syllables recalled shortly after a learning phase, and number of mathematical equations solved correctly. The results of this study indicated that state anxiety had a negative effect on cognitive performance in conditions of depleted state self-control. However, in conditions of intact self-control, there was no significant relationship between state anxiety and cognitive performance.

In short, these data provided compelling evidence for the notion that state self-control has a significant effect on cognitive performance in anxiety-provoking situations through its impact on attention and efficiency. These results, then, support the tenets proposed by Attentional Control Theory.

Both Processing Efficiency Theory and Attentional Control Theory emphasise the importance of working memory capacity for effective cognitive processing. Although the focus of each theory is different, each nevertheless emphasises the importance of auxiliary functions that may free up working memory space and facilitate processing under anxiety-provoking conditions. However, whereas Processing Efficiency Theory postulates that efficiency can be improved through unspecified auxiliary processes, Attentional Control Theory postulates that the key auxiliary process is the ability to direct attention to performance on a task and inhibit attention shifts away from the task. Building on this theory, I hypothesise that self-control is one such auxiliary process that influences attention in anxiety-provoking situations. Thus, self-control may play a key role in directing and maintaining attention towards a task (Baumeister, Vohs, & Tice, 2007). That is to say, within the framework of Attentional Control Theory, self-control may fulfil a supportive role in

cognition by directing attention away from worrisome thoughts, thus allowing attention to be focused on a specific task.

Rationale, Aims, and Hypotheses

Previously published literature on associations between anxiety, performance, and self-control has focused on state self-control as a mediating factor between state anxiety and cognitive performance (Bertrams et al., 2013). No published studies have, however, examined the possible effect of trait self-control on the relationship between state anxiety and cognitive performance. There is, however, extensive evidence that self-control is a relatively stable personality characteristic (de Ridder et al., 2012; Mischel, Shoda, & Rodriguez, 1989). Hence, a valid and potentially fruitful avenue of research would be to test this construct when examining potential mediators of the relationship between anxiety and test performance.

The current study examines how *both* state and trait self-control impact on the relationship between state anxiety and performance. It aims to refine the tenets of Attentional Control Theory by (a) examining state and trait self-control as specific components of cognitive functioning that affect attention, and (b) asking whether high levels of self-control allow for more efficient processing.

I derived four hypotheses from Attentional Control Theory and the literature reviewed above:

1. Under conditions that do not provoke anxiety, participants with depleted and intact self-control will perform similarly.
2. Under anxiety-provoking conditions, participants with intact self-control will perform better than those with depleted self-control.
3. Under conditions that do not provoke anxiety, levels of trait self-control will have no effect on cognitive performance.

4. Under anxiety-provoking conditions, participants with high levels of trait self-control will perform better than those with low levels of trait self-control.

Methods

Design and Setting

The study, which used a quasi-experimental matched-groups design, assessed the separate mediating effects that trait and state self-control have on the relationship between state anxiety and cognitive test performance. The predictor variables were state anxiety, state self-control, and trait self-control. State anxiety was a continuous variable, measured by the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; see Appendix A), and was manipulated in the experimental setting. State self-control was also manipulated in the experimental setting, with depleted state self-control and intact state self-control constituting its two levels. Trait self-control was a continuous variable, measured by the Brief Self-Control Scale (Tangney, Baumeister, & Boone, 2004; see Appendix B). Outcome measures were performance on a free recall memory test and on an arithmetic task.

The study took place over two sessions. The first was an online screening survey, and the second was held in a research laboratory in the Department of Psychology at the University of Cape Town. Each participant was assigned to one of four experimental conditions: (1) absent state anxiety with intact state self-control (absent-intact); (2) absent state anxiety with depleted state self-control (absent-depleted); (3) present state anxiety with intact state self-control (present-intact); or (4) present state anxiety with depleted state self-control (present-depleted).

All sessions took place in the morning, between 9am and 12pm, to control for possible state self-control depletion caused by normal everyday activities (e.g., attending lectures and controlling the urge to talk).

Participants

Participants (N = 165; 145 women, 20 men) were recruited from the University of Cape Town's Department of Psychology undergraduate student population. Based on the mean effect size produced in previous studies (r = .168; $N_{studies}$ = 6; Bertrams et al., 2013; Schmeichel, Vohs, & Baumeister, 2003), and an alpha level of .05, the power of this sample size was calculated to be .73. This is slightly lower than a power of .80, which is conventionally regarded as the minimum level to be reached if one is to have the statistical power to detect an effect in the population (Cohen, 1992). Thus, it may have been more difficult to detect an effect with the current sample size, should this effect be present outside of the laboratory setting. The power analysis was conducted using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009).

Although sampling was not random and I had no direct control over who volunteered for the experiment, it is assumed that those who volunteered did not differ significantly from their peers on the relevant measures. This assumption holds because Student Research Participation Program (SRPP) points are necessary to pass most psychology courses, and therefore those who did not participate in this study would likely have participated in other studies. Furthermore, participants in the four groups were matched on trait self-control to control for the effects of non-random sampling.

There were no eligibility criteria related to sociodemographic variables. All participants were fluent English speakers. Furthermore, all participants were between the ages of 18 and 25 years (M = 20.41, SD = 1.34). Most undergraduate students are aged within this range, and so this is a suitable sample for assessing state anxiety, self-control, and cognitive performance in the student population (e.g., Greenberger, Lessard, Chen, & Farruggia, 2008). Participants were from a number of different racial groups (n_{White} = 94,

n_{Black} = 26, $n_{Coloured}$ = 29, n_{Indian} = 13, n_{Asian} = 2) and the range of education competed, in years, was 12-17 (M = 13.22, SD = 1.05).

The one exclusion criterion that was applied pertained to trait anxiety. Potential participants with clinically high levels of trait anxiety (a score > 60 on the STAI-Trait form; Addolorato et al., 1999; Knight, Waal-Manning, & Spears, 1983) were excluded. This was done, because it is possible that those with clinical levels of trait anxiety may have unduly influenced results.

Self-Report Measures

State-Trait Anxiety Inventory (STAI). This instrument is a subjective, self-report questionnaire that is able to assess both state and trait anxiety levels in a respondent (Spielberger et al., 1983). It is widely used in studies examining the effects of anxiety on cognitive test performance (see, e.g., Bertrams et al., 2013; Hopko, Hunt, & Armento, 2005).

The STAI consists of two sections: Form Y-1, which measures state anxiety, and Form Y-2, which measures trait anxiety. Both forms are comprised of 20 statements which participants are required to rate according to how accurately each pertains to them. As shown in Appendix A, these ratings are given on a 4-point Likert-type scale. Some of the items are reverse scored in order to control for response sets.

In the present study, I used the full Form Y-2, but used a 6-item short version of Form Y-1. This substitution was made in order to reduce potential participant fatigue in the laboratory sessions.

Regarding psychometric properties, the STAI has high internal consistency (α > .89), high test-retest validity (r = .88), and adequate convergent and divergent validity (Barnes, Harp, & Jung, 2002). The internal consistency of the 6-item STAI-State form is high (α = .82), and the correlation between the full form and the 6-item version is high (r = .91; Marteau & Bekker, 1992). The STAI has been used frequently in South African research

studies, suggesting that it is cross-culturally valid and is appropriate for use in this study (see, e.g., Beard et al., 2005; Hofmeyr, Nikodem, Wolman, Chalmers, & Kramer, 1991; Spangenberg & Campbell, 1999).

In the present study, Form Y-2 was used in order to exclude participants with high levels of trait anxiety, and Form Y-1 was used as a state anxiety manipulation check.

Brief Self-Control Scale. This instrument is a self-report questionnaire that attempts to provide an accurate measure of trait self-control (Tangney et al., 2004). Although the scale is relatively new and therefore does not have a long history of use in the self-control literature, it has been used in some recent studies and has proven to be a reliable and valid measure of trait self-control (see, e.g., Finkenauer, Engels, & Baumeister, 2005; Vohs, Finkenauer, & Baumeister, 2011).

The Brief Self-Control Scale is comprised of 13 statements that address issues such as goal-directed behaviour, discipline, and impulsivity. As shown in Appendix B, participants are required to respond to each statement using a 4-point Likert-type scale, indicating how applicable each item is to their general behaviour.

Regarding psychometric properties, this instrument has high internal consistency (α = .84), high test-retest reliability (r = .93), and adequate convergent and divergent validity (Tangney et al., 2004). Although this scale has not yet been used in South African research, it has been used globally in a number of different populations, suggesting adequate cross-cultural validity (see, e.g., Friese & Hofmann, 2009; Ghorbani, Watson, Rezazadeh, & Cunningham, 2011).

In the present study, scores on this measure were used to match participants across the four experimental conditions.

Procedure

Figure 1 provides a graphic representation of the procedure. I have included subheadings within the Procedure section to outline the experiment more clearly and for the purpose of fully explaining the experimental manipulations.

Online survey and screening. At the screening stage, 278 potential participants completed an online survey comprised of three sections. The first section recorded sociodemographic information. Sex and race were particularly important pieces of information gathered by this section of the survey as subsequent statistical analyses sought to control for possible stereotype threat that may have affected performance (Steele, 1997). The second section was the STAI-Trait questionnaire. The third section was the Brief Self-Control Scale.

Of those 278 participants, 13 were excluded because their STAI-Trait score was > 60. I contacted the remaining 265 participants via email. They were provided with a number of time slots and were asked to indicate the sessions that would suit their timetable. Of these 265 participants, 203 replied to the email, indicating their availability for particular time slots. This information was integrated with their screening results, and I emailed them back with a final time slot. The participant then confirmed that the time slot was suitable. Each participant was assigned to one of four experimental conditions in such a way that there was aggregate matching on the trait self-control measure across the four groups. Before the second session of the study, 38 participants dropped out, leaving a total of 165 participants who completed the entire study. Of these 165 participants, 39 were assigned to the absent-intact condition, 38 to the absent-depleted condition, 46 to the present-intact condition, and 42 to the present-depleted condition.

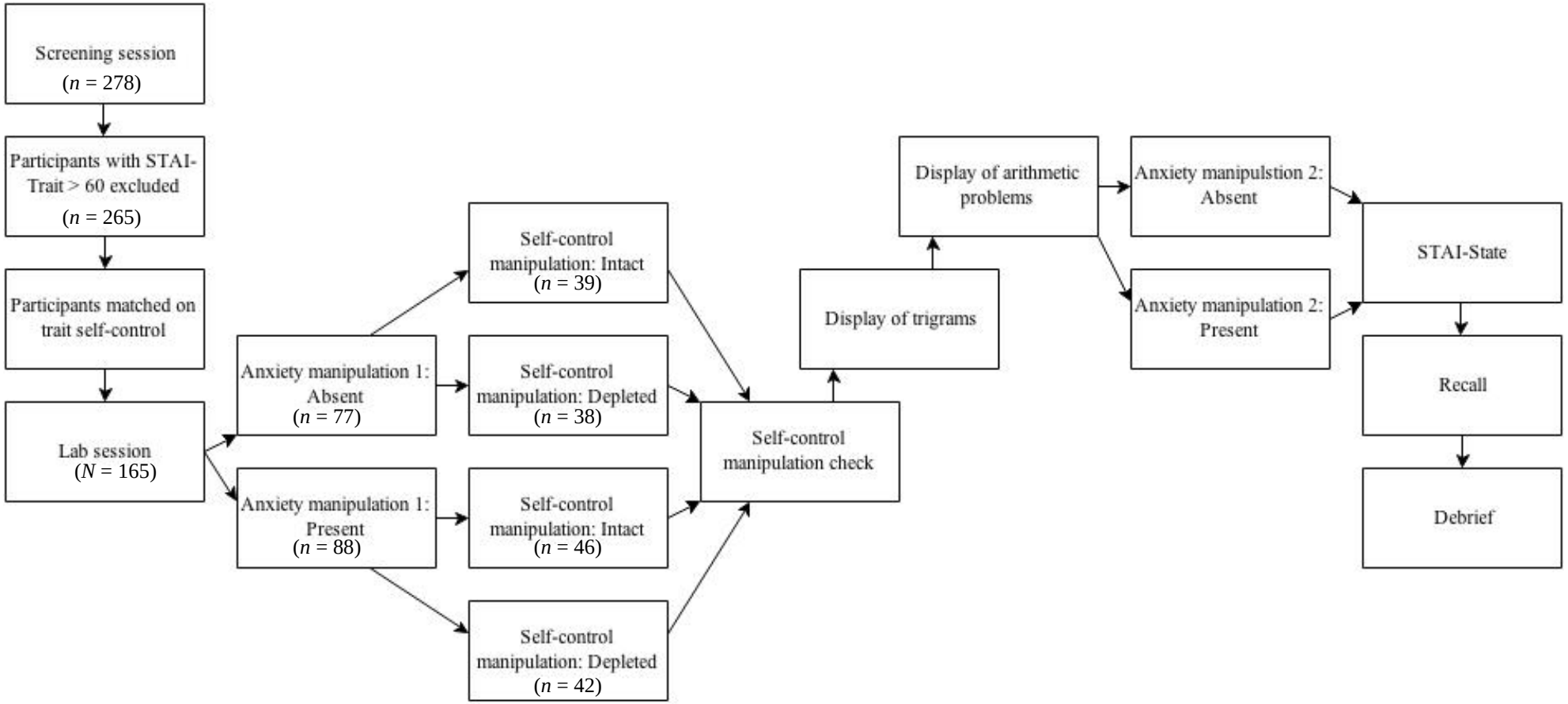

Figure 1. Graphic representation of the experimental procedure.

Laboratory Session. The laboratory session was held in a seminar room in the Department of Psychology at the University of Cape Town. The room featured 7 desks, with space to fit 2-3 participants at each one. Altogether, the room could hold up to 15 participants. Desks were approximately 1-3 metres from the screen at the front of the room. The desks were arranged in three rows; with the front desk located approximately 1 metre from the screen and the back desk located approximately 3 metres from the screen. There were 5-15 participants in each laboratory session. In total, 19 sessions were run between 29 July and 1 October 2014.

Upon arrival at the laboratory, participants were given a small piece of paper with a number on it. Numbers ranged from 1 to 15, and desks were numbered in the same way. Participants were then told to sit at the desk corresponding to the number they were given. This strategy ensured that friends were unable to sit next to each other. The importance of this strategy will become apparent below, in the description of the anxiety manipulation.

On each desk was a pack of papers arranged in the order that they would be needed. The researcher told participants not to skip ahead nor page through the pack, and to deal with each task as and when instructed. Following this, participants were told to read and sign a consent form. This was the first document in the pack and gave information appropriate to the individual's group assignment (see Appendix C).

Anxiety manipulation stage 1. The anxiety manipulation consisted of two stages. The first stage occurred at the beginning of the laboratory session, after participants had read and signed consent forms.

In the *anxiety-present conditions*, the researcher told participants that they would be completing a brief IQ test that had been developed recently. They were then told that the person next to them would be marking their work, that they would receive an IQ score at the end of the session, and that all were required to disclose these scores to the rest of the group

for a comparative discussion. These factors have been shown to be important in eliciting anxiety (Zeidner, 1998). In the *anxiety-absent conditions*, the researcher told participants that they were going to be completing a few cognitive tasks.

In both anxiety conditions, the researcher gave the information for the anxiety manipulation both in the consent form and as well as orally.

State self-control manipulation. The state self-control manipulation followed the anxiety manipulation stage 1 and included two documents: one with text describing the history of the telephone ("Telephone History", 2012; see Appendix D), and one blank sheet of lined paper. I chose this specific text, because it consists of an emotionally neutral topic; hence, emotional arousal should have had no influence on the manipulation. To manipulate state self-control, I used an adjusted version of the paradigm described by Bertrams and colleagues (2013). Each condition had the appropriate instructions typed in bold at the top of the typed text. Participants were told to read this document carefully, and to ask any questions that they may have had before beginning the task.

Those participants assigned to the *intact state self-control conditions* copied out the text exactly as it is. Those assigned to the *depleted state self-control conditions* copied out the text, but were told to omit the letters 'e' and 'n'. So, for instance, these participants would have written the word "telephone" as "tlpho". This exercise goes against an automatic inclination to use these letters when writing out words, and therefore self-control is required in order to complete the task. For both conditions, the state self-control manipulation was 6 minutes long. The idea is that after 6 minutes of copying, state self-control in the depletion condition should be exhausted enough to affect performance on the subsequent cognitive task.

Following Bertrams et al. (2013), all participants were then required to answer a set of four questions according to a 4-point Likert-type scale. These questions were used as a manipulation check for the state self-control manipulation (see Appendix D).

After the session, the researcher examined the copied texts to ensure that participants had followed instructions correctly. This step was important as any deviations from the instructions would have led to the self-control manipulation being invalid.

Cognitive tasks. Following the state self-control manipulation and manipulation check questions, 15 three-letter nonsense syllables were projected onto a screen at the front of the laboratory for 1 minute (see Appendix E). Participants were told to remember as many trigrams as possible during this time. The distractor task of arithmetic problems (e.g., 1+7x2; see Appendix E) was displayed on the screen after the minute had passed. The researcher instructed participants to write the answers on the blank paper that was next in their pack. The arithmetic task was used to bolster the beliefs of participants in the anxiety-present conditions that this was an important intelligence test with a number of cognitive domains involved. The researcher displayed the trigrams and the arithmetic problems using Microsoft Office Powerpoint 2007. At the conclusion of this step, stage 2 of the anxiety manipulation commenced.

Anxiety manipulation stage 2. In stage 2 of the anxiety manipulation, participants in the *anxiety-present conditions* were told to switch their arithmetic answers with the person next to them. They were told that this switch would occur after each stage of the test to ensure that they did not cheat. The switching happened according to the following pattern: The participant seated at desk one handed his/her paper to the participant at desk two, desk two handed his/her paper to desk three, and so forth until the final desk handed his/her paper to desk one. While this was happening, the researcher projected a set of inflated “marking guidelines” onto the board at the front of the laboratory (see Appendix F). That is, a mark that

would usually fall within the average range of performance would be labelled “poor” in the marking guidelines. The researcher drew participants’ attention to the board by telling them that they would be marking each other’s work according to these guidelines, and cited the example that they would need to get 11-13 answers correct in order to achieve an average IQ of 100. The researcher then reinforced that each participant would have to disclose his/her results to the rest of the group, that results would be compared, and that each participant would receive individual feedback on his/her scores. This aspect of the manipulation took approximately 30 seconds.

To keep the time delay before recall constant across conditions, participants in *anxiety-absent conditions* were lead through a 30-s deep breathing exercise at this point in the study.

The second stage of the state anxiety manipulation was intended to simulate test conditions (i.e., because anxiety is usually prevalent during recall in the test situation).

After allowing 1 minute for the completion of the STAI-State form, all participants were asked to recall and write down as many of the nonsense syllables as they could. They were allowed 2 minutes to do so.

Debrief. Finally, participants received debriefing forms (see Appendix G), and then the STAI-State form was re-administered. This step was taken to ensure that debriefing had successfully reduced state anxiety. The researcher then completed the debriefing process by explaining that this final questionnaire was intended to measure their level of anxiety upon leaving the laboratory.

Ethical Considerations

The study adhered to ethical stipulations outlined by the University of Cape Town’s Codes for Research. Ethical approval was received from the UCT Department of Psychology’s Research Ethics Committee before any data collection began.

All participants were required to sign informed consent documents indicating that their participation was entirely voluntary. The consent forms also provided important information about the study.

To manipulate anxiety levels, a measure of deception was necessary. Although deception is problematic in that participants are unable to make a decision based on all possible information about the study, the informed consent document in this instance outlined more risks than were actually present in the study. Therefore, those who consented to the procedure would likely have been just as willing to participate knowing that feedback and peer comparisons would not occur.

The anxiety manipulation itself was a stressor that may have impacted negatively on participants. However, the anxiety induced by this manipulation is likely comparable to the levels experienced in other university settings (e.g., when studying for an exam), and therefore the stress caused was likely not disproportionate to levels experienced regularly by university students (Sivonova et al., 2004).

Following the laboratory sessions, participants were debriefed. The researcher indicated that deception had taken place, but had been necessary for the purposes of the study. The debriefing form contained the contact details of a counselling service should the anxiety manipulation have caused any lasting distress.

Additionally, participants' state anxiety was measured after debriefing to ensure that debriefing had reduced anxiety effectively. From these results, it was determined that the study had had no adverse effect on any participant.

Data Management and Statistical Analyses

All inferential statistical analyses were conducted using SPPS version 22.0. Before running the primary analyses, I ran one-way ANOVAs on continuous data and chi-squared contingency analyses on categorical data to determine whether sociodemographic variables

and laboratory characteristics were equally distributed across conditions. Furthermore, these analyses were used to determine whether participants had been adequately matched on trait self-control. I also conducted two independent-samples *t*-tests to verify that the state self-control and state anxiety manipulations were successful.

The primary inferential analyses then tested the four hypotheses for each of the three outcome variables (trigrams, arithmetic, and combined).

Testing Hypothesis 1. I ran a one-way ANOVA using only data from the anxiety-absent conditions, and with state self-control as the independent variable (with two levels, intact and depleted). Preliminary analyses indicated that the assumptions for ANOVA were upheld.

Testing Hypothesis 2. I ran a one-way ANOVA using only data from the anxiety-present conditions, and with state self-control as the independent variable (with two levels, intact and depleted).

Testing Hypothesis 3. I ran three separate hierarchical multiple regression models using only participants in the anxiety-absent conditions. Before constructing the models, I conducted a set of standard analyses (focused on casewise diagnostics, Mahalanobi's distance, Cook's distance, and leverage statistics) to determine whether there were any influential cases within the dataset. In addition, analyses indicated that the assumptions for multiple regression were upheld. The predictor variables were entered in the following order: (1) age, sex, race, years of education, and time and day of laboratory session, (2) STAI-State score, (3) state self-control score, and (4) trait self-control score. The outcome variables were (a) number of trigrams recalled, (b) arithmetic problems solved correctly, and (c) number of trigrams recalled plus arithmetic problems solved correctly (combined).

Testing Hypothesis 4. I ran a three hierarchical multiple regression models using only data from the anxiety-present conditions. The predictor variables were entered in the

same order as the models used to test Hypothesis 3, and the outcome variables were the same as above.

Estimates of effect size were calculated for all analyses. Following the stipulations outlined by Cohen (1992), r = .10 was interpreted as a small effect, r = .30 was interpreted as a medium effect, and r = .50 was interpreted as a large effect. In addition, partial eta squared (η_p^2) =.01 was interpreted as a small effect, η_p^2 =.06 was interpreted as a medium effect, and η_p^2 = .14 was interpreted as a large effect (Cohen, 1988).

Results

Final Sample Characteristics: Trait Anxiety and Trait Self-Control

The STAI-Trait score ranged from 20-59 (M = 40.12, SD = 8.54). This score was representative of the general population of university students, as was indicated by a non-significant result on a one-sample t-test comparing the current data to those from the normative sample reported by the test developer (t = 0.94, p = .35; Spielberger et al., 1983). For the sample as a whole, scores on the Brief Self-Control Scale ranged from 22-52 (M = 38.16, SD = 7.24). As with the STAI-Trait, I performed a one-sample t-test comparing these statistics to the population norm reported by the test developers (Tangney et al., 2004). Again, a non-significant result suggested that the current sample was representative of the general population of university students, t = 0.34, p = .74.

Matching Participants across Conditions

A series of one-way ANOVAs and chi-squared contingency analyses detected no significant between-condition differences in terms of age, sex, race, education, STAI-Trait score, and Brief Self-Control Scale score (see Tables 1 and 2). The latter result was expected because, by design, participants were matched on trait self-control across the four conditions. All effect sizes associated with these between-group comparisons were small.

Table 1

*Sample Characteristics: Sociodemographic variables and scores on measures of trait anxiety and trait self-control (*N *= 165)*

	Condition					
Variable	Absent-Intact (n = 39)	Absent-Depleted (n = 38)	Present-Intact (n = 46)	Present-Depleted (n = 42)	F / χ^2	p	ESE
Age (years)	20.67 (1.40)	20.55 (1.18)	20.09 (1.15)	20.38 (1.58)	1.53	.21	0.03
Sex (M:F)	8: 31	4: 34	5: 41	3: 39	3.71	.99	.15
Race (B:W:C:I:A)[a]	5:22:10:2:0	7:26:2:3:0	5:20:12:6:2	9:26:5:2:0	19.55	.76	.69
Education (years)	13.42 (0.89)	13.49 (0.84)	13.26 (1.04)	13.23 (0.93)	0.68	.57	0.01
STAI-Trait score[b]	18.26 (8.20)	20.42 (9.23)	20.74 (9.00)	20.90 (7.66)	0.83	.48	0.02
Brief Self-Control Scale score[c]	40.41 (5.75)	38.21 (8.33)	37.04 (6.98)	37.26 (7.50)	1.86	.14	0.03

Note. For continuous variables (Age, Education, STAI-Trait score, and Brief Self-Control Scale score), data are presented as means, with standard deviations in parentheses. For categorical variables (Sex and Race), data presented are raw numbers. ESE = effect size estimate; in this case, η_p^2 for F-tests and Cramer's V for chi-squared tests.

[a]B = Black, W = White, C = Coloured, I = Indian, A = Asian.

[b]Minimum possible score = 20. Maximum possible score = 60.

[c]Minimum possible score = 12. Maximum possible score = 52.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Manipulation Checks

A pooled variance independent samples *t*-test detected significant between-condition differences on the STAI-State measure (see Table 2). Specifically, participants in the anxiety-absent conditions scored, on average, significantly higher than did those in the anxiety-present conditions. This between-condition difference was associated with a small effect size.

Table 2
*Manipulation Check for State Anxiety (*N *= 165)*

	State Anxiety Condition						
	Absent		Present				
Variable	(*n* = 77)		(*n* = 88)		*t*	*p*	ESE
STAI-State score[a]	12.01	(3.68)	13.52	(4.09)	2.48	.007**	.19

Note. Data are presented as means, with standard deviations in parentheses. STAI = State-Trait Anxiety Inventory. ESE = effect size estimate; in this case, *r*.
[a]Minimum possible score = 6. Maximum possible score = 24.
*$p < .05$, **$p < .01$, ***$p < .001$.

A second pooled variance independent samples *t*-test detected significant between-condition differences on the scores of the state self-control manipulation check questions (see Table 3). Specifically, participants in the depleted state self-control conditions scored significantly lower than did those in the intact state self-control conditions. This between-condition difference was associated with a moderate effect size.

Table 3
*Manipulation Check for State Self-Control (*N *= 165)*

	Self-Control Condition						
	Intact		Depleted				
Variable	(*n* = 85)		(*n* = 80)		*t*	*p*	*ESE*
State self-control score[a]	12.09	(2.23)	9.86	(2.14)	6.55	< .001***	.45

Note. Data are presented as means, with standard deviations in parentheses. ESE = effect size estimate; in this case, *r*.
[a]Score on state self-control manipulation check questions. Minimum possible score = 4. Maximum possible score = 16.
*$p < .05$, **$p < .01$, ***$p < .001$

The results of these analyses indicate that both state self-control and state anxiety manipulations were successful.

Testing Hypothesis 1: State Self-Control Differences in Anxiety-Absent Conditions

Hypothesis 1 stated that participants with depleted and intact state self-control will perform similarly under conditions that do not provoke anxiety. This hypothesis was confirmed. A one-way ANOVA detected no significant difference between performance of participants in the absent-intact and absent-depleted conditions on trigrams, arithmetic, or combined (see Table 4). These between-group comparisons were all associated with small effect sizes.

Table 4
*Comparison of Anxiety-Absent Conditions on Different Dependent Variables (*N = *77)*

	Anxiety-Absent Condition						
	Intact State Self-Control		Depleted State Self-Control				
Outcome Variable	(*n* = 38)		(*n*=39)		*F*	*p*	ESE
Trigrams[a]	5.49	(2.23)	5.21	(2.73)	0.24	.63	.003
Arithmetic[a]	5.23	(2.28)	5.87	(2.21)	1.56	.22	.02
Combined[b]	10.72	(3.29)	11.08	(3.47)	0.22	.64	.003

Note. Data are presented as means, with standard deviations in parentheses. ESE = effect size estimate; in this case, η_p^2.
[a]Minimum possible score = 0. Maximum possible score = 15.
[b]Minimum possible score = 0. Maximum possible score = 30.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Testing Hypothesis 2: State Self-Control Differences in Anxiety-Present Conditions

Hypothesis 2 stated that, under anxiety-present conditions, those participants with intact state self-control will perform better than those with depleted state self-control. This hypothesis was disconfirmed. A one-way ANOVA detected no significant difference between the performance of participants in the present-intact and present-depleted conditions on trigrams, arithmetic, or combined (see Table 5). These between-group comparisons were all associated with small effect sizes.

Table 5
*Comparison of Anxiety-Present Conditions on Different Dependent Variables (*N = *88)*

	Anxiety-Present Condition						
	Intact State Self-Control		Depleted State Self-Control				
Outcome Variable	(*n* = 42)		(*n* = 46)		*F*	*p*	ESE
Trigrams[a]	6.22	(2.59)	5.81	(2.40)	0.58	.45	.00
Arithmetic[a]	5.35	(1.83)	6.10	(2.69)	2.37	.13	.03
Combined[b]	11.57	(3.21)	11.90	(3.67)	0.21	.64	.00

Note. Data are presented as means, with standard deviations in parentheses. ESE = effect size estimate; in this case, η_p^2.
[a]Minimum possible score = 0. Maximum possible score = 15.
[b]Minimum possible score = 0. Maximum possible score = 30.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Testing Hypothesis 3: Trait Self-Control Differences in Anxiety-Absent Conditions

Hypothesis 3 stated that participants in anxiety-absent conditions would perform similarly, regardless of their score on the Brief Self-Control Scale.

I constructed a plausible model based on a priori hypotheses and ran a hierarchical regression using only data from participants in the anxiety-absent conditions. The sociodemographic variables (i.e., age, sex, race, education) as well as the study session conditions (i.e., day of study, time of study) were entered into the first block of the regression in order to control for possible effects of these extraneous variables. Score on the STAI-State was entered into the second block and score on state the self-control manipulation check was entered into the third block. These entries sought to control for the effects that these variables may have had on the outcome variables. The Brief Self-Control Scale was entered into the fourth and final block as the predictor variable of primary interest. This model was tested on data from three different outcome variables: (a) trigrams recalled, (b) arithmetic problems solved correctly, and (c) trigrams plus arithmetic combined.

Tables 6, 7, and 8 show that the regression analysis detected no significant *F* change score for any of the models. Although none of the models show a significant *p*-value, all models have medium/large effect sizes.

Table 6
*Model Summary (Anxiety-Absent Conditions) for Dependent Variable: Trigrams (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.47	.22	2.43	.22	1.32	.23
Step 2[b]	.48	.23	2.43	.01	0.98	.33
Step 3[c]	.49	.24	2.44	.01	0.49	.49
Step 4[d]	.49	.24	2.46	.00	0.10	.75

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 7
*Model Summary (Anxiety-Absent Conditions) for Dependent Variable: Arithmetic (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.46	.21	2.18	.21	1.25	.27
Step 2[b]	.46	.21	2.20	.00	0.00	.99
Step 3[c]	.46	.21	2.21	.00	0.28	.60
Step 4[d]	.48	.23	2.21	.02	1.17	.28

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 8
*Model Summary (Anxiety-Absent Conditions) for Dependent Variable: Combined (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.38	.14	3.44	.14	0.79	.67
Step 2[b]	.39	.15	3.45	.01	0.49	.49
Step 3[c]	.40	.16	3.46	.01	0.69	.41
Step 4[d]	.42	.17	3.47	.01	0.83	.37

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Testing Hypothesis 4: Trait Self-Control Differences in Anxiety-Present Conditions

Hypothesis 4 stated that, under anxiety-present conditions, participants with higher scores on the Brief Self-Control Scale would perform better than those with lower scores on that measure.

I ran three hierarchical multiple regression models using only data from participants in the anxiety-present conditions (see Tables 9, 10, and 11). Step 3 in all three models had a significant result in terms of change in R^2 value. This was the step with (1) sociodemographic variables and laboratory session characteristics, (2) STAI-State score, and (3) state self-control score as predictors. Additionally, the models were associated with a large effect size.

Table 9
*Model Summary (Anxiety-Present Conditions) for Dependent Variable: Trigrams (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.51	.26	2.44	.26	1.44	.15
Step 2[b]	.53	.28	2.43	.02	1.74	.19
Step 3[c]	.59	.34	2.34	.06	5.50	.02*
Step 4[d]	.59	.34	2.36	.00	0.03	.87

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 10
*Model Summary (Anxiety-Present Conditions) for Dependent Variable: Arithmetic (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.47	.22	2.17	.22	1.14	.34
Step 2[b]	.49	.24	2.16	.02	1.36	.25
Step 3[c]	.55	.30	2.09	.06	5.34	.02*
Step 4[d]	.56	.31	2.09	.01	1.18	.28

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 11
*Model Summary (Anxiety-Present Conditions) for Dependent Variable: Combined (*N = *77)*

Model	*R*	R^2	Std. Error of Estimate	ΔR^2	ΔF	Sig. *F* Change
Step 1[a]	.45	.20	3.34	.20	0.99	.48
Step 2[b]	.45	.20	3.37	.00	0.04	.84
Step 3[c]	.57	.32	3.13	.12	10.88	.002**
Step 4[d]	.57	.33	3.14	.01	0.71	.40

[a]Predictor variables: Age, sex, race, year of study, day of study, time of study.
[b]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State.
[c]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check.
[d]Predictor variables: Age, sex, race, year of study, day of study, time of study, score on STAI-State, score on state self-control manipulation check, score on Brief Self-Control Scale.
*$p < .05$, **$p < .01$, ***$p < .001$.

Discussion

Previously published literature suggests that state self-control may mediate the relationship between state anxiety and performance (Bertrams et al., 2013). I wanted to extend this hypothesis by including trait self-control as a possible mediator between state anxiety and cognitive performance. In particular, the present study investigated how state and trait self-control affect the relationship between state anxiety and cognitive performance by manipulating both self-control and anxiety in a between-subjects experimental design. Contrary to predictions, state self-control condition and trait self-control score did not appear to affect cognitive performance in high-anxiety situations. However, state self-control score did have a significant effect on performance in anxiety-provoking conditions. I discuss various limitations of the present study which may explain the non-significant role of the state self-control condition, and offer some directions for future research.

Because the study used a between-subjects design, it was important to determine that there were no significant between-group differences in extraneous variables. Preliminary analyses detected no significant difference between trait self-control scores across conditions. Thus, in terms of this variable, participants were adequately matched across conditions. In addition, there were no significant between-condition differences in terms of age, sex, race, education, or trait anxiety. Therefore, these extraneous variables were largely evenly distributed across conditions. That is, should variations in these factors have influenced performance, this influence would have been distributed equally across conditions, minimising its effect on results.

Before examining the research hypotheses, it was important to determine whether the state self-control and state anxiety manipulations were successful. An independent samples *t*-test indicated that participants in the depleted and intact self-control conditions scored

significantly differently on the state self-control manipulation check questions. Specifically, state self-control scores were lower in the depleted compared to the intact self-control conditions. The state self-control manipulation was associated with a moderate effect size, indicating that there was a moderate difference between the participants in intact and depleted conditions in terms of state self-control during the experimental procedures.

In addition, an independent samples *t*-test detected a significant difference in STAI-State scores between participants who were in the anxiety-absent conditions versus those in the anxiety-present conditions. Specifically, those in the latter condition scored significantly higher, indicating a relatively elevated level of state anxiety. From these analyses, I conclude that both state self-control and state anxiety manipulations were successful. That is, in anxiety-present conditions, participants had elevated STAI-State scores indicating greater state anxiety in these conditions when compared to participants in anxiety-absent conditions. It is important to note here, however, that between-condition differences arising from the anxiety manipulation were associated with a small effect size, and although there was a significant between-group difference on STAI-State scores, the mean scores for both anxiety-absent and anxiety-present participants on this measure were both within the moderate range. That is to say, the anxiety manipulation was not successful in elevating the scores of the participants in anxiety-present conditions to within the range conventionally defined as “high anxiety” (Spielberger et al., 1983).

Hypotheses 1 and 2 were tested using one-way ANOVAs. These analyses detected no significant between-condition differences in performance on the three outcome variables. Hypothesis 1 stated that, under anxiety-absent conditions, participants with intact and depleted state self-control should perform similarly. Thus, Hypothesis 1 was confirmed by the non-significant ANOVA result. That is to say, when state anxiety was absent, participants

with intact state self-control and depleted state self-control did not differ significantly in their cognitive performance.

In contrasting, hypothesis 2 was disconfirmed by the ANOVA result. This hypothesis stated that, under anxiety-present conditions, participants with depleted state self-control would perform more poorly than those with intact state self-control. Participants in anxiety-provoking conditions did not differ significantly in their cognitive performance, despite variation in their state self-control conditions. Effect sizes for calculations involving both anxiety-absent and anxiety-present conditions were small. Thus, the magnitude of the difference between intact and depleted self-control was small when state anxiety was absent and when state anxiety was present.

However, when comparing the *p*-values for the effect of state self-control across anxiety-absent and anxiety-present conditions, it is evident that anxiety-present conditions have marginally lower *p*-values. In particular, the effect of state self-control condition on arithmetic performance in anxiety-present conditions is nearing significance. This statistic is slightly higher in the anxiety-absent conditions. It is possible that this effect would have been more pronounced had the anxiety manipulation been more successful. That is, because both anxiety-absent and anxiety-present conditions were within the moderate range on participants' STAI-State scores, the effect of anxiety on performance efficiency would have been less evident. Thus, higher levels of state self-control, functioning as an auxiliary process, may not have been necessary for better performance. Put simply, lower state anxiety means that one would not require as many self-control resources in order to complete a task adequately.

Hypotheses 3 and 4 were tested using hierarchical multiple regression analyses. These analyses showed that trait self-control levels, as measured by the Brief Self-Control Scale, did not affect performance in anxiety-absent conditions. This result confirms Hypothesis 3,

which stated that variations in trait self-control would have no effect on performance in conditions where anxiety was absent. Therefore, participants with varying levels of trait self-control would perform similarly. The effect sizes for the regression models for anxiety-absent conditions were within the medium-to-large range. However, these effects were largely established in the first step (when demographic and time-of-day variables were entered) of each model.

Hypothesis 4 stated that trait self-control scores would affect cognitive performance in anxiety-provoking conditions. That is, those with higher levels of trait self-control would perform better than those with lower levels of trait self-control. However, trait self-control did not affect performance in anxiety-present conditions, as was indicated by a non-significant result for step 4 of all regression models. Thus, Hypothesis 4 was disconfirmed. When anxiety was present, participants with varying levels of trait self-control performed similarly. Although effect sizes for the regression model for anxiety-present conditions were large, the main contributing predictors to this large effect size were demographic and laboratory session variables and state self-control score, as measured by the state self-control manipulation check. The unique variance provided by trait self-control in anxiety-provoking conditions was particularly low, as indicated by a small effect size. This result further affirms that trait self-control does not affect performance in conditions where anxiety is present.

Interestingly, state self-control score added significantly to the model in anxiety-provoking conditions, but not in conditions where anxiety was absent. Therefore, in anxiety-present conditions, a higher score on the state self-control manipulation check was associated with better performance on all three outcome measures. Moreover, the effect sizes for models including state self-control score were large in anxiety-provoking conditions. This result supports the hypothesis that state self-control may play a role in the relationship between anxiety and cognitive performance.

To conclude that state self-control condition plays a role in the relationship between state anxiety and performance, it is necessary for both Hypotheses 1 and 2 to be confirmed. That is, it is not meaningful to achieve a non-significant result in anxiety-absent conditions if this result is not coupled with a significant result when anxiety is present. In the same way, Hypotheses 3 and 4 would have needed to both be supported to reach the conclusion that trait self-control may mediate the relationship between state anxiety and cognitive performance.

Although Hypothesis 2 was not supported by the results of the present study, I cannot definitively conclude that state self-control does not play a mediating role in the relationship between state anxiety and cognitive performance. Given the inadequate success of the anxiety manipulation and the near-significant effect of state self-control, as well as the significant effect of state self-control score in the regression model for anxiety-present conditions, the contrary appears to be true. That is, the results suggest that state self-control may, in fact, play a role in the relationship between state anxiety and performance.

The tenets of Attentional Control Theory posit that anxiety causes an attentional shift away from task-beneficial processing (Derryberry & Reed, 2002; Fox, 1993; Fox et al., 2002; Hopko et al., 1998; Mathews & Mackintosh, 1998). This shift would thus result in poorer performance on cognitive tasks. Importantly, within the present study, state self-control can be conceptualised as a possible factor that influences the direction of attention. That is, higher levels of state self-control may improve performance because of the ability to shift attention away from worry and focus attention on the appropriate task (Egloff & Hock, 2001; Eysenck & Byrne, 1992; Fox et al., 2002; Mogg & Bradley, 1998; Mogg et al., 2000; Wilson & MacLeod, 2003). The results of the present study, then, suggest that state self-control may be an important component of Attentional Control Theory. However, this link cannot be definitively made because of various limitations within the present study.

Limitations and Directions for Future Research

Trait anxiety and self-control have high variability across individuals. These factors are influenced by a number of variables outside of experimental control. Thus, in a study involving these factors, it is difficult to control all extraneous variables.

Because of the high variability in these factors, a large sample size was necessary to detect an effect in the data. According to a power calculation, a sample size of 215 was needed to achieve power of .80. Therefore, the sample of 165 participants may not have been adequate to detect an effect as it exists in the population. For future research, I recommend investigating a larger sample size. This would increase the power of the study and thus increase the likelihood that, should an effect truly be present in the population, the sample would be adequate to detect this effect.

In addition, I only sampled from one population, that is, undergraduate psychology students from the University of Cape Town. This sampling strategy impacts negatively on the generalisability of the study. Moreover, psychology students may be particularly aware of deception in research as learning about deception comprises part of their syllabus. However, I attempted to control for this potential confound by including the STAI-State as a manipulation check for state anxiety. The moderate scores on the STAI-State for anxiety-present conditions suggest that some participants may not have believed the deception present within the study. Thus, future studies may find it useful to sample from a number of different populations in order to determine whether anxiety manipulations may be more successful in certain populations than in others. Moreover, I would recommend more severe anxiety manipulations in order to achieve a larger difference between STAI-State scores of participants in anxiety-present and anxiety-absent conditions. For instance, a public speaking task may be included within the anxiety manipulation and participants could be led to believe

that they would be videotaped during the study for the purposes of behavioural coding (see e.g., Elliott & O'Donohue, 1997; Kirschbaum, Pirke, & Hellhammer, 1993).

Sex and race are important variables in terms of stereotype threat. *Stereotype threat* occurs when a stereotype about the performance of a certain group exists (Spencer, Steele, & Quinn, 1999; Steele & Aronson, 1995). When a member of this group has an awareness of the stereotype that exists, he/she may become significantly more anxious than individuals of the same group who are not aware of this stereotype. This anxiety would then cause poorer performance on the relevant task (Steele, 1997). The results of chi-squared contingency analyses indicated no significant differences between conditions on the distribution of sex and race. Thus, the problem of stereotype threat has been largely controlled for in the present study.

Secondary analyses indicated some interesting patterns in the performance of participants based on demographic variables. Although these were not central to the study and thus were not included within the main analyses, future research may benefit from further analysing how individual difference variables play a role in the relationship between state anxiety and cognitive performance. In particular, it may be useful to recruit a large age range and equal samples of the sexes and races in order to establish whether these variables, or interactions between these variables, may affect performance.

Participants knew that their marks on the test within the experiment would not be reflected on any academic transcript, and this knowledge made it difficult to simulate actual test conditions. Thus, participants may have been less motivated to put effort into the task. I attempted to control for this potential lack of motivation by stipulating that the task was an IQ test. IQ scores are a well-known method of academic classification, and thus I hoped that this would increase motivation to expend a similar amount of effort as would be expended in an actual test situation. This strategy came with added limitations, however. Because only those

participants in the anxiety-present conditions believed the test to be a measure of IQ, it is possible that they would have put more effort into the task compared to those in the anxiety-absent conditions.

In the same vein, the marking guidelines that were displayed on the screen for the anxiety-present conditions have not been used in previous research, and thus it is difficult to determine the effect they may have had on performance. Although they likely increased anxiety, having a goal score displayed on the screen may have motivated participants in the anxiety-present conditions to write down more words than those in the anxiety-absent conditions.

However, in an attempt to correct for this problem, I used three different dependent variables in my calculations. Therefore, number of arithmetic problems solved provides a measure of performance before the marking guidelines were displayed. According to the analysis, using arithmetic rather than trigrams as the dependent variable did not drastically alter results.

In addition to performing analyses on three outcome variables, I recommend that future research examine the relationship between state anxiety, state self-control, and cognitive performance through field experiments. This approach would improve ecological validity and control for the level of effort expended on the cognitive task. In such a study, students' state self-control and state anxiety would be measured before an actual examination or test. Their scores on the state self-control measure and STAI-State could then be compared to their results on the test. However, a field experiment would be unable to determine causation, and thus experimental and quasi-experimental designs are also necessary to fully understand this relationship.

Significance of the Present Study

The present study aimed to investigate whether state and trait self-control may mediate the relationship between state anxiety and cognitive performance. In so doing, I aimed to add to existing literature by identifying individuals who may be at risk of being affected by test anxiety (i.e., those with inherently lower self-control coupled with high state anxiety brought about by the test situation). However, trait self-control does not appear to impact on this relationship.

Importantly, the current study partially supported the hypotheses of Bertrams et al. (2013), who proposed that state self-control may mediate the relationship between anxiety and performance. Thus, I was able to refine Attentional Control Theory to include state self-control as a particularly important auxiliary process that reduces attentional bias.

Conclusions

Based on the results of the present study, trait self-control does not appear to mediate the relationship between state anxiety and performance. However, state anxiety may be important in diverting attention away from anxious thoughts in order to adequately attend to a cognitive task. In the present study, state self-control score significantly affected performance in anxiety-provoking conditions. Coupled with this set of findings, neither state self-control condition nor state self-control score significantly impacted on performance in anxiety-absent conditions. For this reason, I tentatively conclude that state self-control may have a mediating role in the relationship between state anxiety and cognitive performance.

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Appendix A

State-Trait Anxiety Inventory (STAI)

STAI – Trait Form

A number of statements that people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *generally feel*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	Almost always	Often	Sometimes	Almost never
1. I feel pleasant				
2. I feel nervous and restless				
3. I feel satisfied with myself				
4. I wish I could be as happy as others seem to be				
5. I feel like a failure				
6. I feel rested				
7. I am “calm, cool, and collected”				
8. I feel that difficulties are piling up so that I cannot overcome them				
9. I worry too much over something that doesn’t really matter				

10. I am happy				
11. I have disturbing thoughts				
12. I lack self-confidence				
13. I feel secure				
14. I make decisions easily				
15. I feel inadequate				
16. I am content				
17. Some unimportant things run through my mind and bother me				
18. I take disappointments so keenly that I can't put them out of my mind				
19. I am a steady person				
20. I get in a state of tension or turmoil as I think over my recent concerns and interests				

STAI – State Form

A number of statements that people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Very much so	Moderately so	Somewhat	Not at all
1. I feel calm				
2. I am tense				
3. I feel upset				
4. I am relaxed				
5. I feel content				
6. I am worried				

Appendix B

Brief Self-Control Scale

Using the scale provided, please indicate how much each of the following statements reflects how you typically are.

	Very much so	Moderately so	Somewhat	Not at all
1. I am good at resisting temptation.				
2. I have a hard time breaking bad habits.				
3. I am lazy.				
4. I say inappropriate things.				
5. I do certain things that are bad for me, if they are fun.				
6. I refuse things that are bad for me.				
7. I wish I had more self-discipline.				
8. People would say that I have iron self- discipline.				
9. Pleasure and fun keep me from getting work done.				
10. I have trouble concentrating.				
11. I am able to work effectively toward long-term goals.				

12. I can't stop myself from doing something, even if I know it is wrong.				
13. I often act without thinking through all the alternatives.				

Appendix C
Informed Consent Document

Consent Form

University of Cape Town

The Relationship between State and Trait Self-Control and Cognitive Performance

Purpose

I am a Psychology Honours student from the University of Cape Town and am conducting a study looking at how state and trait self-control may influence cognitive performance. The purpose of this study is to identify possible risk factors that may predispose a person to lowered scores in cognitive testing. This study aims to build on existing hypotheses about different risk factors that affect performance by looking at trait and state self-control as additional risk factors.

Procedure

If you decide to participate in this study, you will be asked to complete two questionnaires online and a number of cognitive tasks during a follow-up lab session. The online session should take approximately 30 minutes and the lab session will take approximately one hour.

Possible Risks (Anxiety-Present Groups Version)

Because the cognitive tasks provide an important measure of intelligence, it is natural for you to feel anxious when completing these tasks. In addition, once you have finished the tasks, you will be given specific feedback and will be asked to compare your results with the other participants present in the session. Again, this may cause some anxiety.

Possible Risks (Anxiety-Absent Groups Version)

There are no known risks involved in this study.

Possible Benefits

I hope that this experience will provide you with important information on whether your performance may be affected by your levels of state and trait self-control. This may help you with future academic work, because you will be provided with advice on how to enhance self-control should this lower your scores. Therefore, you may be able to take action, for instance you may be able to put this advice into practice before writing a test. More generally, I hope that this work will provide information on a possible additional risk factor that may impact on performance and therefore workshops can be developed that aim to improve levels of self-control in the student population.

Voluntary Participation

Participation in this study is completely voluntary. You are free to refuse to answer any question without giving reasons for your refusal. Your decision regarding participation in this study will not affect your grades or academic career. If you decide to participate, you are free to change your mind and discontinue participation at any time without any negative consequences.

Confidentiality

Information about you obtained for this study will be kept confidential. Your name and other identifying information will not be kept with the interview information. It and this consent form will be kept in separate, locked file cabinets, and there will be no link between the

consent form and the questionnaires and cognitive tests. The results of the cognitive tests will not be available to your university or any current or future employers, nor will it be made available to anyone else. Any reports or publications about the study will not identify you or any other study participant.

Questions

Any study-related questions, problems or emergencies should be directed to the following researchers:

Prof. Kevin Thomas	021-650-4608	kevinthesisdocs@gmail.com
Robyn Human	021-788-5536	hmnrob001@gmail.com
Victoria Parry	082-657-4174	prrvic002@myuct.ac.za

Questions about your rights as a study participant, comments or complaints about the study may be presented to the Research Ethics Committee, Human Sciences Research Council, Cape Town, or by telephone to 0800 212 123 (this is a toll-free call if made from a landline telephone; otherwise cell phone rates apply).

I have read the above and am satisfied with my understanding of the study and its possible benefits and risks. My questions about the study have been answered. I hereby voluntarily consent to participation in the research study as described.

_____ _____

Signature of participant Date

Appendix D
State Self-Control Manipulation

Text for the Manipulation

From the moment Alexander Graham Bell yelled those famous words, "Come here Mr. Watson, I want to see you!" the business of providing telephone service was off and running. Soon after that fateful day of March 10, 1876, Bell and Watson were demonstrating the instrument.

In July of 1877, the Bell Telephone Company was formed by Gardiner Hubbard. The Charles Williams shop made the first telephones under the direction of Watson, who in effect was the Research and Development Department of the company. Alexander Graham Bell opted out of the day-to-day managing of the company and traveled to England, staying for over a year. By the end of 1877 there were three thousand telephones in service.

In mid-1878, Hubbard named Theodore Vail, the Superintendent of the Railway Mail Services as the new general manager of the Bell Company. This one decision alone would become lead to the basic foundation of what would become the giant monopoly, the "Bell System." The Bell Company had 10,000 phones in service at this time.

Vail fought any and all the competition with vigour. Indeed, over the course of twenty years, the Bell Company would fight over 600 lawsuits… and win all of them.

Vail also expanded the business from the New England area west to the towns and cities of the United States. Coupled with these new exchanges, he developed long distance service to connect them. Vail left the company in the late 1880s, but returned in the early 1900s to guide the Bell System to even greater successes as a company that provided, "Universal Service" to anyone wanting a telephone.

Although Western Union refused the offer of Hubbard to buy all the rights to the patents in 1876, they now realized their tremendous mistake and in December of 1877, using Elisha Gray's patents set up the American Speaking Telephone Company. This was clearly an infringement on the Bell patents. Western Union had actually commissioned Thomas Edison to help in the venture and he developed a carbon-button transmitter that was superior to the Bell transmitter.

In 1878 a manual switching board was introduced that allowed many phones to be connected through a single exchange. The first switchboard was located in New Haven Connecticut. Interestingly enough, the first switching board operators were teenage boys. With the invention of the switchboard, exchanges opened rapidly across the country. Because of the fierce competition, some cities actually had two telephone exchanges.

Knowing Western Union had a better transmitter, Bell introduced a newer, better transmitter than Edison's, with the help of two inventors: Emile Berliner and Francis Blake. In September 1878, the Bell Company filed suit against Western Union. To put this suit in perspective consider that Western Union was a giant. The Bell Company was still a small fledgling company. Against the odds, the Bell Telephone Company won the suit.

An agreement was reached in November of 1879 the Western Union Company gave up all its patents, claims, network and inventory of 56,000 phones (a Western Union phone at right). In return, they would receive 20% of the rentals over the next seventeen years--the life of the Bell patents. With this victory, a new company was chartered; the American Bell Telephone Company.

The company flourished in the 1880s. In 1881, American Bell purchased controlling interest in the Western Electric Company. This is interesting for two reasons. First, Western Electric Company was Elisha Gray's Electrical Supply Company. In fact, it was originally

"Gray and Barton." Second, this is the company that supplied phones to Western Union. In 1882, Western Electric became the sole supplier to the Bell Companies.

Also in the 1880s the first "metallic" circuits were installed. Simply put, this was an upgrade from one-wire to two-wire circuits. The change was due to the tremendous "noise" and interference over the one-wire grounded lines.

An interesting turn of events happened in 1891. A Kansas City Undertaker by the name of Almon Strowger tired of waiting for operators to answer the phone to make connections. So, he invented an "automatic" telephone that "dialled" a number with the push of buttons – early push button phones. He formed the Automatic Electric Company. This was a major development and it happened outside the Bell Companies.

With the Bell patents running out in 1893 and 1894, and the public tiring of Bell's monopolistic behaviour, the era of "Independent Telephony" was born. Almost overnight, hundreds of smaller companies built phones and installed systems all over the country. And most all of those systems were in smaller towns and rural communities--areas in which the Bell Company had no interest.

As the new century dawned, the Bell Company had 800,000 phones in service compared to 600,000 in independent territories. The figures tell a story. With public distrust of the Bell Company and the independents aggressively expanding--even into Bell operating territories, the Bell companies were starting to feel the heat. By 1903 and for a time, these independents had more subscribers than Bell.

Another third and separate advancement was the availability to farmers to build their own telephone plants with their own phones, wires and switchboard. Many of these systems, "cooperatives" were put into service and served these rural customers for years.

Indeed, the new century was going to put a real strain on the Bell companies. But the telephone industry was exploding.

Source: http://www.telephonymuseum.com/telephone%20history.htm

Manipulation Check Questions

	Very much so	Moderately so	Somewhat	Not at all
1. How difficult did you find this task?				
2. How effortful did you find this task?				
3. How tired are you after completing this task?				
4. How well do you think you did on the task?				

Note. The text used by Bertrams et al. (2013) was written in German, because the participants were a group of German students. In addition, the content of the paragraph was the history of a German monument. Because the participants in the present study were English speaking and from a South African context, the language and text used for this manipulation was adjusted.

Appendix E

List of Trigrams and Arithmetic Problems

Trigrams

VAW

EDN

ZER

MAS

FRT

YOP

DRA

NUS

OCH

IDL

GHA

QOS

SNB

RAV

URR

Arithmetic

4x(3-1)

1+7x2

5+9+24

13-74

5x5x4

15-9+3x0

(12+4)x2

1+9-16

12+13x2

(44+9)x0

15-24+10

3x2x9

99-12x2

25+25-19

(13-9)x7

Note. All trigrams were presented in capital letters. For both trigrams and arithmetic, the font used was Calibri and the font size was 44.

Appendix F

Marking Guidelines for Anxiety-Present Conditions

Marking Guidelines:

Words Remembered/Problems Solved

0-4/15 Very Poor (IQ=40)

5-7/15 Poor (IQ=60)

8-10/15 Fair (IQ=80)

11-13/15 Average (IQ=100)

14-15/15 Good (IQ=120)

Appendix G
Debriefing Forms

Debriefing: Anxiety-Present Groups

In order to manipulate your anxiety levels in the study, you were not explicitly told that anxiety is an important part of this study. The title of this study is State and Trait Self-Control Mediate the Relationship between Anxiety and Performance. This means that I am looking at whether state and trait self-control affect the relationship between anxiety and cognitive performance. The results of the tests you have just done do not reflect intelligence, but were constructed to test working memory in an anxiety provoking situation. Therefore, you were told that this was an intelligence test in order to induce anxiety. Furthermore, there will not be personal feedback or score comparisons amongst the class. Again, this was used as a method of inducing anxiety.

Self-control is also an important part of my study. At the start of the experiment, you were told that you would be provided with possible methods of improving levels of self-control. Before a test you might like to try setting aside time for a period of relaxation, positively affirming yourself by focusing on tasks that you perform well in, creating a simple exercise regime, or eating a snack that is high in glucose.

Even though you have completed the entire study, you may ask to have your results withdrawn. If you still feel anxious following the completion of this study, you can contact the South African Depression and Anxiety Group on 0800 21 22 23 or 011 234 4837 in order to deal with possible issues that may have arisen during the study. You may also like to visit their website (www.sadag.org) for more information. Your SRPP points will be awarded to you as soon as possible. Thank you for participating.

Debriefing: Anxiety-Absent Groups

In order to manipulate your anxiety levels in the study, you were not explicitly told that anxiety is an important part of this study. The title of this study is State and Trait Self-Control Mediate the Relationship between Anxiety and Performance. This means that I am looking at whether state and trait self-control affect the relationship between anxiety and cognitive performance.

Self-control is also an important part of my study. At the start of the experiment, you were told that you would be provided with possible methods of improving levels of self-control. Before a test you might like to try setting aside time for a period of relaxation, positively affirming yourself by focusing on tasks that you perform well in, creating a simple exercise regime, or eating a snack that is high in glucose.

Even though you have completed the entire study, you may ask to have your results withdrawn. If you feel anxious following the completion of this study, you can contact the South African Depression and Anxiety Group on 0800 21 22 23 or 011 234 4837 in order to deal with possible issues that may have arisen during the study. You may also like to visit their website (www.sadag.org) for more information. Your SRPP points will be awarded to you as soon as possible. Thank you for participating.