Exercise for stress management: the role of outcome expectancy

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Table of Contents

List of Tables

List of Figures

Abstract

Extensive evidence linking exercise with stress reduction has prompted many organisations to implement exercise stress management interventions in order to combat employee stress. These interventions however, have generally yielded low levels of effectiveness. Determining factors that can enhance the effectiveness of exercise stress management interventions is important for organisations implementing such interventions. The main purpose of the present study was to investigate the role that outcome expectancy has in the relationship between exercise and stress. Stress perceptions and exercise behaviours were assessed in 54 university students over the 4 weeks leading up to final examinations. Outcome expectancy was assessed once during this period. Heart rate was also assessed in 20 students on two occasions, including the exam. In contrast to the majority of research linking exercise with lower stress, individuals who exercised more than their own average during the study period had higher levels of exam stress over time, whilst variance in exercise levels from the group average was not significantly related to exam stress over time. Conversely, there was a significant difference in physiological exam stress (heart rate) between high and low exercise groups overtime for the overall heart rate average, but not the sleep or exam period heart rate averages. More specifically, it was found that the low exercise group had a stronger negative physiological reaction to the exam overall. No significant moderation effects of outcome expectancy on the relationship between exercise and stress were found. The results indicate that exercise is related to both self-reported and physiological indicators of stress, and that exercise at different levels (within-person and between-person) have differing effects on exam stress.

Introduction

Overview

The current study investigated whether exercise was related to self-report and physiological exam stress, and whether outcome expectancy beliefs related to the benefits of exercise for stress management had a direct moderating impact on this relationship. In order to examine these relationships, exercise behaviours and self-reported exam stress were measured several times over a four week period leading up to University end of year final examinations. The introduction reviews the literature on stress, and research on the relationships between exercise and stress, exercise and expectancy beliefs, and outcome expectancy and stress. A rationale is developed for three research hypotheses. The overall aim of the research is to contribute to knowledge on factors that can enhance the effectiveness of exercise interventions for managing employee stress.

Stress Management

The detrimental effects of stress are well established, particularly in relation to job-related stressors which have been considered to be among the most common sources of stress in our society today (Ganster & Schaubroeck, 1991). Moreover, many researchers have demonstrated that stress can have a negative impact on both individual employees and organisations (Ganster & Schaubroeck, 1991; Ivancevich, Matteson, Freedman & Phillips, 1990; Edwards & Burnard, 2003). From an employee's perspective, the individual consequences of stress perceptions can include a myriad of psychological and physiological strains that can lead to health implications and illnesses such as cardiovascular disease, increased cholesterol, weight gain, and hypertension (Colligan & Higgins, 2005; Ganster & Schaubroeck, 1991; Jacobs, 2001; Kelloway, Hurrell Jr & Day, 2008), and affective and cognitive disturbances such as memory and concentration issues, depression and anxiety (Colligan & Higgins, 2005; Fleming & Baum, 1987; Gerber, Kellmann, Hartmann & Puhse, 2010). Furthermore, organisational issues can also emanate from stress including decreased worker productivity, absenteeism (Colligan & Higgins, 2005; Cooper & Cartwright, 1994;Danna & Griffin, 1999), low morale (Edwards & Burnard, 2003), labour turnover (Van der Hek & Plomp, 1997) and increase in accidents (Cartwright, Cooper & Murphy, 1995; Ivancevich et al., 1990; Kelloway et al., 2008; Kerr, McHugh & McCrory, 2009; Occupational Health and Safety Service, 2003). Poorer job performance, decreased job satisfaction, and burnout are also consequences of stress that impact both employees and organisations (Colligan & Higgins, 2005; Ivancevich et al., 1990).

While the detrimental impacts of stress have been well identified, consensus on the definition of stress is less well established (Beehr & Newman, 1978). The notion of imbalance between environmental demands and adequate resources for coping however has commonly emerged across a variety of models describing stress (Ivancevich et al., 1990; Lazarus, 1993; Williamson, 1994). Cited as the most influential conceptualisation of stress to date, and considered to be most essential for understanding stress (Contrada, 2011; Lazarus, 1993; Smith & Kirby, 2011), Lazarus and Folkman's (1984) transactional theory of stress classifies stress as a process that is characterised by individual subjective perceptions. More specifically, this theory states that stressors induced by a situation are cognitively appraised in terms of harm, threat, or challenge (primary appraisal) and one's resources to cope (secondary appraisal; Lazarus & Folkman, 1987). If demands exceed one's resources for effective coping then stress perceptions are considered *distressful*, which results in strain (physiological or psychological), also deemed the stress response or stress outcome (Lazarus, 1993; Lazarus & Folkman, 1987). Furthermore, the term distress is what is commonly referred to when stress is mentioned (Berger, 1996), and distress will also be referred to in the current research where stress is discussed.

Whilst the transactional theory focuses on stress as a psychological process, it is also important to acknowledge the physiological characterisations of stress. Physiological aspects of stress have been the focus of early stress research such as the theory of ‘fight or flight’ (cf. Cannon, 1935), General Adaptation Syndrome (cf. Seyle, 1936), and more recently ‘allostatic load’ theory (cf. McEwen & Stellar, 1993). In general these theories highlight that stressful demands disrupt ‘homeostasis’ or system balance (McEwen, 1998). This imbalance thus stimulates activation and mobilisation of physiological systems in order to prepare the body for ‘fight or flight’ (Gray, 2007), and to protect from, and adapt to stressful situations to restore balance (McEwen, 1998). As such, stressors generate arousal of the sympathetic nervous system, activating the hypothalamus-pituitary-adrenal (HPA) axis, and thus stimulating excretion of stress hormones such as adrenaline and cortisol (Fleming & Baum, 1987; Gray, 2007; McEwen, 1998). Stress hormones cause physiological changes such as increased heart rate, blood pressure, and energy, and suppression of immune and digestive systems which are effective for addressing acute stressors, but can in fact cause harm to an individual after prolonged exposure (Gaab, Rohleder, Nater & Ehlert, 2005; Gray, 2007; McEwen, 1998). Jacobs (2001) highlights that this biological stress response is not suited to dealing with modern day stressors, which are becoming more psychological in nature. As such, the activation of physiological stress systems in response to psychological stressors causes over reactivity, which often continues after one is no longer exposed to psychological stress, therefore leaving little room for recovery (Burg & Pickering, 2011). Additionally, it is this lack of recovery as the result of excessive activation of physiological stress responses that results in chronic stress, and which can exert detrimental impacts on individual health (Burg & Pickering, 2011; Jacobs, 2001).

In acknowledging the potentially negative consequences of stress and in order to ensure employee health and organisational well-being, organisations have taken responsibility for addressing stress in the workplace (Gerber, et al., 2010). Furthermore, health and safety legislation has been altered such that employers are obligated to acknowledge stress as harmful (Whatmore, Cooper & Cartwright, 1999), as is evident here in New Zealand with the amendment in 2002 to the *Health and Safety in Employment Act* 1992 to include stress as a source of harm. In conjunction, the number of job stress interventions that have been adopted by organisations has increased substantially (LaMontagne, Keegel, Louie, Ostry & Landsbergis, 2007), which is highlighted by the adoption of some form of stress intervention within around 90% of medium sized U.S. companies (Kelloway et al., 2008). Job stress interventions can be considered as individually targeting a stage of the stress process (Landsbergis, 2009) and can be characterised as primary (stressor prevention), secondary (stress management), or tertiary (treating outcomes of stressor exposure) level preventative interventions (Cooper & Cartwright, 1994; Ivancevich et al., 1990; LaMontagne et al., 2007; Landsbergis, 2009). Secondary level preventions, or "stress management" however, tends to be the most popular approach to addressing stress in organisations (Weinberg & Cooper, 2011). Stress management aims to improve the adaptability and coping abilities of the individual in order to reduce stress, and has been noted to be particularly useful where stressors cannot be modified or where the organisation will continue to be stressful (Cooper & Cartwright, 1994; LaMontagne et al., 2007; Murphy, 2002). Popular stress management interventions include relaxation/meditation techniques, cognitive behavioural approaches, and exercise (Ivancevich et al., 1990; Kelloway et al., 2008; LaMontagne et al., 2007; Landsbergis, 2009; Weinberg & Cooper, 2011). Furthermore, exercise as a stress management technique has received much attention, particularly in the literature, as being an effective means of reducing or controlling stress levels as commonly utilised by both individuals and organisations (Proper et al., 2002).

Exercise and stress

Defined as physical activity (bodily movements that result in energy expenditure) "…that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (Caspersen, Powell, Christenson, 1985, p. 128), exercise has been considered to be one of the most effective techniques for reducing negative stress outcomes, when compared to other techniques (Bruning & Frew, 1987; Whatmore, et al., 1999; Williamson, 1994). Thus, exercise is a commonly implemented method of stress management. While exercise is a subcomponent of physical activity, it is important to note that not all physical activity is classified as exercise, despite the use of these terms interchangeably throughout the literature (Caspersen et al., 1985).

The causal relationship between physical activity or exercise, and stress reduction has been investigated and established over a variety of disciplines (Gerber et al., 2010). For instance, epidemiology studies demonstrate that exercise has an impact on the physiological manifestations of stress (Edenfield & Blumenthal, 2011; Salmon, 2001). Furthermore, exercise has been found to be an effective stress-buffer with evidence to support effects of reduced stress reactivity as a result of exercise (e.g. Carmack de Moor, Boudreaux, Amaral-Melendez, & Brantley, 1999; Hamer, Taylor & Steptoe, 2005; Rimmele, Zellweger, Marti, Seiler, Mohiyeddini, Ehlert, & Heinrichs, 2007; Scully Kremer, Meade, Graham, & Dudgeon, 1998). It has been suggested that exercise is an effective means of stress reduction through physiological adaption (Salmon, 2001). In particular, it is believed that due to the physical stress that exercise induces (stimulating a physiological response), habitual exercise levels reduce the amount of activation of the HPA axis and the sympathetic nervous system, thereby limiting stress reactivity when exposed to stressors (Carmack et al.., 1999; Edenfield & Blumenthal, 2011; Hamer, et al., 2005; Rimmele et al., 2007; Salmon, 2001). In support of this belief, Rimmele et al. (2007) found that exercise training had a significant impact on lower cortisol and heart rate responses to a laboratory induced stressor, when comparing trained (elite sportsmen) and untrained men (men who exercised less than 2 hours per week). Additionally, Bruning and Frew (1987) demonstrated that assigning participants to an exercise intervention of 30 minutes of free choice aerobic exercise every day, resulted in decreased physiological stress responses of heart rate, blood pressure, and galvanic skin responses after 6 weeks. Conversely, de Geus, Van Doornen, and Orlebeke (1993) found that exercise training over a 4 month and 8 month period did not have a significant impact on physiological stress reactivity, as indexed by heart rate and blood pressure.

In conjunction, fitness (a set of health-related or skill-related attributes achieved by an individual which facilitate abilities to perform physical activity; Caspersen et al., 1985) is thought to have an impact on stress responsivity and recovery through greater efficiency in processing oxygen (McGilley & Holmes, 1988). The more efficient use of oxygen results in smaller cardiovascular responses to stress, and therefore provides fewer indications to stimulate subjective arousal (McGilley & Holmes, 1988). This premise is supported by research which has found that aerobic fitness was effective for reducing stress reactivity and facilitating quicker autonomic recovery from stress (Gerber et al., 2010; Holmes & Roth, 1985; Keller & Seragania, 1984; McGilley & Holmes, 1988). Although, a study by Plante and Karpowitz (1987) found that when baseline measures were controlled for, there were no differences in stress reactivity between high and low fit individuals. There are also studies which find results completely contrary to these expectations, for example de Geus et al. (1993) found that stress reactivity was greater for participants who were aerobically fitter, with higher fit participants experiencing higher rather than lower cardiovascular reactivity in response to both cognitive and physiological stress tests.

The fields of sport, exercise, and health psychology also add to our understanding of the exercise-stress relationship by documenting the psychological benefits of exercise (Edenfield & Blumenthal, 2011). From a psychological perspective, exercise has been linked to positive effects on affect including improvements in mood and its subcomponents of tension, depression, fatigue, and anxiety (Long & van Stavel, 1995; Rimmele et al., 2007; Roth, 1989; Scully et al., 1998; Taylor, 2000; Wienberg & Gould, 2007), and cognitive aspects of enhanced mental alertness, concentration, and memory (Berger, 1996). For example, Moses Steptoe, Mathews, and Edwards (1989) found psychological benefits (reduced anxiety/tension) in participants who engaged in moderate intensity exercise training over 10 weeks, and a review by Taylor (2000) revealed that exercise had a low to moderate effect on reducing anxiety over a variety of populations. Similarly, Kobasa, Maddi, and Puccetti (1982) observed that fewer psychological stress symptoms were reported in response to high stress when the male managerial participants regularly engaged in exercise. Norris, Carroll, and Cochrane (1992) also found that exercise had psychological benefits, whereby exercise of a high intensity was related to lower levels of self-reported stress and depression.

Exercise has also been highlighted as “an emotion-oriented coping strategy” (Gerber et al., 2010, p.287) that provides a stress-buffering effect through increasing mastery experiences (Long & van Stavel, 1995; Salmon, 2001), enhanced feelings of control, increased competence, self-efficacy, self-esteem, and intrinsic motivation, which foster more positive perceptions of coping abilities (Brown & Siegel, 1988; Carmack et al., 1999; Edenfield & Blumenthal, 2011; Salmon, 2001; Weinberg & Gould, 2007; Wijndaele, Matton, Duvigneaud, Lefevre, De Bourdeaudhuij, Duquet, Thomis & Philippaerts, 2007). In line with this, empirical support exists for the distraction effects (Brown & Siegel, 1988; Carmack et al., 1999; Long & van Stavel, 1995) and stress recovery effects that exercise produces (Berger, 1996; Hahn, Binnewies, Sonnentag & Mojza, 2011; Haskell & Blair, 1980; Salmon, 2001; Sonnentag & Jelden, 2009). It is proposed that the distraction and recovery effects that exercise facilitates act to reduce stress by allowing temporary reprieve from stressors and the context in which they are induced (Brown & Siegel, 1988; Carmack et al, 1999; Haskell & Blair, 1980; Sonnentag & Jelden, 2009). Thus, distraction and recovery allows time for individuals to restore levels of psychological functioning to levels that were evident prior to experiencing stressors (Sonnentag & Jelden, 2009). It has also been noted that the mere engagement in exercise can facilitate distraction effects (Carmack et al., 1999; Scully et al., 1998; Weinberg & Gould, 2007), regardless of intensity and fitness levels which have been highlighted as important for stress reduction in much exercise-stress research (e.g. Edenfield & Blumenthal, 2011; Norris et al., 1992). For example, Roth (1989) found that a single bout of exercise had positive effects on mood, specifically demonstrating a significant reduction in tension and anxiety.

Despite predominantly consistent evidence that exists for the stress-buffering and coping facilitation effects of exercise, meta-analyses and reviews of the exercise intervention literature have revealed mixed and inconclusive findings of effectiveness for stress management (Proper, Staal, Hildebrandt, Van Der Beek & Van Mechelen, 2002; von Thiele Schwartz, Lindfors & Lundberg, 2008). In support of the benefits of exercise, in their meta-analysis reviewing exercise effectiveness for stress management, Long and van Stavel (1995) found a significant low to moderate effect on reducing anxiety (d = 0.36 for contrast group studies, and d = 0.45 for within group (pre-post) studies). In contrast, Dishman, Oldenburg, O'Neal, and Shephard (1998) conducted a meta-analysis of worksite physical activity interventions and found the mean effect was small (r = 0.11) and not significantly different from zero. Similarly, in a review conducted by Proper et al. (2002) inconclusive results were found for the effects of worksite physical activity programmes on job stress. More recently however, Conn, Cooper, Brown, and Lusk (2009) assessed the impact of physical activity interventions on improving health, well-being and job stress in their meta-analysis and found that physical activity appeared to have a greater effect on treatment compared to control groups, with an effect size of d = 0.33 for the effect of physical activity interventions on job stress. These authors however issue caution in the interpretation of these findings due to the small number of studies including physical activity and job stress, and the significant heterogeneity of studies reviewed (Conn et al., 2009). In conjunction, explanations for mixed findings have been attributed to limitations such as poor quality research designs, inconsistent definitions of stress (Ivancevich et al., 1990) and exercise, use of poorly validated measures (Gerber et al., 2010), small sample sizes (Dishman et al., 1998;

von Thiele Schwartz et al., 2008), lack of evaluation of programmes (Ivancevich et al., 1990; Parks & Steelman, 2008; Whatmore et al., 1999), heterogeneity of interventions reviewed (Conn et al, 2009; Cooper & Cartwright, 1994), inconsistent results of the studies reviewed (Long & van Stavel, 1995; Proper et al., 2002) and programme compliance issues (Dishman et al., 1998; Proper et al., 2002; von Thiele Schwartz et al., 2008).

Exercise and Outcome Expectancy

Motivation and compliance to exercise interventions have been highlighted as major components contributing to mixed levels of effectiveness on stress reduction (Proper et al., 2002). In conjunction, a great deal of research has been dedicated to predicting exercise intentions and behaviours, so as to inform effective ways to enhance adherence (Conn, 1998; Kobasa et al., 1982; Sniehotta, Scholz & Schwarzer, 2005; Williams, Anderson & Winett, 2005). The health belief model (cf. Becker, 1974), the theory of planned behaviour (cf. Ajzen, 1985), and social cognitive theory (cf. Bandura, 1987) have commonly been utilised to understand health behaviours such as exercise, and within these models outcome expectancies surface as one of the main psychosocial determinants of behaviours (Bandura, 1998). For example, the health belief model uses constructs of perceived susceptibility to disease and perceived benefits of adopting preventative behaviour, which correspond to both negative and positive outcome expectations, respectively (Bandura, 1998). Additionally, the theory of planned behaviour posits that attitudes about the behaviour and subjective norms determine intention for engagement in the behaviour, whereby attitudes correspond to perceived outcomes (positive or negative expectancy) and norms correspond to perceived social outcome expectations (Bandura, 1998). Furthermore, social cognitive theory states that outcome expectations, or more specifically physical, social, and self-evaluative expectations of behavioural outcomes, facilitate motivation for, and performance of that behaviour (Bandura, 1998, 2004).

Outcome expectancies constitute individual expectations or beliefs about the outcomes or consequences that will follow a given behaviour (Conn, 1998; Williams et al., 2005), and as such people engage in behaviours they believe will have positive outcomes (Bandura, 1998; Jensen, Turner & Romano, 1991). This has been demonstrated by several researchers such as Sniehotta et al., (2005) who found that outcome expectancy of exercise predicted exercise motivations and intentions, which in turn predicted exercise behaviour. More specifically, positive expectancies were associated with greater intentions for behaviour change in previously sedentary participants (Sniehotta et al., 2005). Similarly, Dishman, Sallis, and Orenstein (1985), who examined determinants of engagement and adherence to exercise programmes, found that outcome expectancy of the health benefits of exercise predicted exercise behaviour. Additionally, Jones, Harris, Waller, and Coggins (2005) found that those participants who were successful in adhering to a prescribed 12-week exercise course had higher expectations of change on personal development variables such as happiness and confidence, prior to engagement in the scheme, than those who dropped out of the programme. Furthermore, a review of outcome expectancy in physical activity research conducted by Williams et al. (2005) revealed that, although preliminary empirical investigations yielded mixed results, outcome expectancy of physical activity's benefits appeared to predict physical activity; however it was found that this was more evident for older rather than young and middle aged adults. Additionally, this finding was whilst controlling for self-efficacy (Williams et al., 2005) which is considered another significant determinant of exercise behaviours (Bandura, 1998).

Outcome Expectancy and Stress

Outcome expectancy has also been found to be directly related to stress. More specifically, generalised positive outcome expectancies have been linked to decreased perceptions of stress and related physiological symptoms (Lai, Evans, Ng, Chong, Siu, Chan, Ho, Ho, Chan, & Chan, 2005; Scheier & Carver, 1985). This relationship can be understood both within positive psychology with the notion of optimism (Seligman & Csikszentmihalyi, 2000) and through the understanding of placebo effects (Desharnias, Jobin, Côté, Levesque & Godin, 1993). Optimism, also referred to as generalised positive outcome expectancy, has been found to predict both decreased stress perceptions and reduced physical symptoms of stress (Scheier & Carver, 1985). Scheier and Carver (1985) suggest that outcome expectancy assessments can be likened to the secondary cognitive appraisal stage in the stress process whereby positive emotions associated with optimism can act to facilitate perseverance in coping. This notion was highlighted by the finding that optimism was linked with fewer reports of stress symptoms (Scheier & Carver, 1985). Optimism has also been found to be a buffer in the relationship between perceived stress and psychological outcomes, as was illustrated by Chang (1998, 2002), who observed that stress perceptions resulted in greater life satisfaction and fewer depressive symptoms when participant optimism was higher. Chang (2002) notes however that it may be that optimism results in reporting of fewer stress symptom in the act to remain optimistic rather than actually reducing symptoms resulting from stress.

The role of expectations has also been understood from the perspective of placebo effects (Jensen & Karoly, 1991) which demonstrate the power that belief has in influencing particular experienced outcomes (Seligman & Csikszentmihalyi, 2000). The placebo effect, or consequences of administering a placebo ("non-specific treatment procedure" Jensen & Karoly, 1991, p. 144) can be understood from a cognitive perspective based on evidence that placebos alter expectations of benefits and has been likened to outcome expectations defined by Bandura (Desharnais et al., 1993; Jensen & Karoly, 1991). Desharnais et al., (1993) demonstrate placebo effects in relation to exercise and well-being. In their 10 week study participants were prescribed an exercise programme, with half of the participants receiving information that the programme had been designed to enhance psychological well-being and the other half receiving no such information (Desharnais et al., 1993). It was found that those who received the expectancy modification intervention experienced greater increase in psychological well-being than the control group, illustrating an outcome expectancy placebo effect on the relationship between exercise and psychological well-being enhancement (Desharnais et al., 1993). Moses et al. (1989) however, found that psychological benefits resulting from exercise training were not the product of outcome expectations of the programme to improve fitness, health, and sense of well-being. This result was found by comparison of groups prescribed to a 10-week programme of high exercise, moderate exercise, or attention-placebo (which consisted of flexibility exercises), in which all groups had high outcome expectations of the prescribed programme at the outset, but whereby only the moderate exercise group experienced increased positive psychological responses, including tension/anxiety reduction (Moses et al., 1989).

As has been illustrated, there are some discrepancies in the literature and empirical research that investigate the role that exercise has as a stress management intervention. Many health promotion models (e.g. the theory of planned behaviour, and social cognitive theory) have been adopted to increase understanding of exercise behaviours and outcomes as a means to inform ways in which effectiveness of exercise interventions can be enhanced (Williams et al., 2005). Outcome expectancies are a central focus of these health models (Bandura, 1998), and have been found to have a significant impact on participation in exercise (e.g. Sniehotta et al., 2005) as well as the magnitude of stress that is experienced (e.g. Scheier & Carver, 1985).

The present research

With evidence for mixed levels of stress management intervention effectiveness, it is important to determine what factors contribute to those interventions that have been found to be effective. Identification of effective components will be able to inform ways in which current stress management programmes can be improved and how new programmes can be designed to enhance the likelihood of a successful intervention. As such, the improvement of intervention effectiveness will enhance the cost effectiveness for organisations implementing exercise interventions for stress management (Bruning & Frew, 1987).

Due to the nature of the stress process characterised as a subjective and individual phenomenon (Lazarus & Folkman, 1987), it is essential to analyse individual difference factors that may impact the stress process and act to enhance the effectiveness of exercise interventions for stress management. Outcome expectancy may provide an important contribution to enhancement of exercise stress management intervention effectiveness. Whilst it has been established that outcome expectancy predicts exercise intentions and behaviours (e.g. Sniehotta et al., 2005), and stress perceptions and outcomes (e.g. Scheier & Carver, 1985), outcome expectancy has also been suggested to have a moderating role in the relationship between behaviours and outcomes (Bandura, 1998). More specifically, it has been suggested that outcome expectancies can influence the outcomes experienced from exercise (Salmon, 2001).

However, whilst studies have investigated the effects of outcome expectancy on the relationship between physical activity and psychological wellbeing (e.g. Desharnais et al., 1993; Moses et al., 1989), empirical evidence for the moderating effects that outcome expectancy has on the relationship between exercise and stress has received less research attention (Berger, 1996; Gerber et al., 2010). Gerber et al. (2010) suggest that outcome expectancy may have an important impact on the potential of exercise to relieve stress, and highlight that this moderating relationship needs to be investigated further to better understand the potential stress reducing effects of exercise. Based on this proposition and in line with Bandura's (1998) social cognitive theory outlining that outcome expectancy has an effect on the relation between behaviour and outcomes, the current research aims to investigate the relationship between exercise, stress, and outcome expectancy. More specifically, the current investigation aims to evaluate the impact that expectations regarding the ability of exercise to alleviate stress has upon the strength of this relationship. The current study investigates these relationships by adopting a longitudinal design whereby stress and exercise behaviours are measured over the 4 weeks leading up to university end of year final examinations. A longitudinal field-study design was adopted for the current study in order to assess stress responses leading up to and including a stressful event and in response to calls for exercise and stress to be analysed longitudinally (e.g., Gerber & Puhse, 2009).

An academic examination was used to allow the stress response to be evaluated in relation to a naturally occurring stressor, which in previous research has been found to elicit both psychological and physiological stress responses (Folkman & Lazarus, 1985; Gaab et al., 2006). Therefore, university students with an end of year academic exam were identified as the participant pool for the current research.

Self-report measures of anxiety over four time points leading up to and immediately prior to the exams were used to measure stress perceptions. Given the limitations of primarily relying on self-reported data (de Geus et al., 1993, Zeidner, 1998) an objective measure of heart rate was also used as an indication of the stress response/stress-related arousal. As such, preliminary analyses were conducted to assess the associations between self-reported exam stress and heart rate, as well as the relationship between exercise and heart rate. These analyses were conducted using a physiological measure in a smaller sample as replication of the self-report measures obtained in the current study. The assessment of heart rate allowed continuous evaluation of the stress response over the entire exam period, thus accounting for natural fluctuations in the stress response before, during, and after the event, and therefore acknowledging stress as a process rather than a static state (Fleming & Baum, 1987). Exercise behaviours in the current study were also measured via self-report. Self-reports of exercise behaviours have been found to be more reliable estimates of exercise when participants are required to specify frequency, duration, type, and intensity of the exercise (Gerber et al., 2010). Therefore the Exercise Behaviours

Questionnaire used in the current study required participants to report all of these aspects of their exercise behaviours over each week in the study.

Participants who were already engaged in exercise to some degree were used for the current study in order to control for exercise motivation issues which have been identified as a contributor to low levels of exercise intervention effectiveness (Dishman et al., 1998; Proper et al., 2002; von Thiele Schwartz et al., 2008). Additionally, given the difficulty of ensuring motivation and adherence to exercise interventions, exercise in the current study was not primed by prescription of any type of exercise intervention, thus allowing exercise intensity, frequency, duration, and activity to be determined by the individuals within the study. This field study therefore, does not induce or motivate exercise engagement, but rather records the self-determined exercise behaviours of participants.

Most of the research analysing health behaviours has assessed the differences between people, whilst overlooking analysis of variables at the within-person/ intra-individual level (Scholz, Keller & Perren, 2009). It has been noted that it is important to analyse effects at both levels as associations that exist at the between-person level, may differ to associations at the within-person level (Scholz et al., 2009). Therefore, the current study investigates the associations between exercise and self-reported exam stress both at the intra-individual and inter-individual levels.

Based on information presented in the literature reviewed, several research hypotheses were formulated:

1. Exercise scores will be negatively related to exam stress.
    a. Exercise scores higher than average individual scores (intra-individual difference) will be related to lower levels of exam stress.

b. Exercise scores higher than average group scores (inter-individual difference) will be related to lower levels of exam stress

c. Exercise scores will be negatively related to heart rate stress reactivity over time.

2. The relationship between exercise and exam stress will be moderated by outcome expectancy: there will be a stronger negative relationship between exercise and exam stress when outcome expectancy levels are higher.

3. Self-reported exam stress will be positively related to physiological exam stress (heart rate).

Method

Participants

The participants were 54 university students from various disciplines at the University of Canterbury, Christchurch. The participants, including 19 males and 35 females, had a mean age of 22.39 years (*SD* = 5.4) and a mean of 2.74 years (*SD* = 1.4) in university study. Participants were recruited via email and poster advertisements. The recruitment poster (see Appendix A) was posted around the University of Canterbury on notice boards in lecture blocks, department blocks, the central library, and at the University Recreation Centre. The recruitment email (see Appendix B) was sent out to email addresses of students within the Psychology Department at the University. Additionally, the recruitment email was sent to all of the Academic Departments and Schools listed on the University of Canterbury website (www.canterbury.ac.nz/deptcentres.shtml) requesting that the email advertisement be forwarded to the students within those departments. Participants were also recruited via word of mouth to friends and class mates. It was a requirement that participants be currently engaged in any type of exercise at least once per week and that they have an end of year exam that occurred in the morning (to ensure consistency for heart rate participant selection). However, criteria for participation were then modified such that participants who only had an afternoon exam were able to participate (so as to increase the participant pool), but were omitted from heart rate selection. Recruiting participants who were already engaged in exercise ensured existing exercise engagement and thus reduced the likelihood of motivation issues. Participants were tracked throughout the study with a unique code made up of the first two letters of their mother's first name and the last three digits of their cellphone number. This code was used for the purpose of concealing the identity of participants and ensured their data could not be readily identified as theirs. Participants were rewarded for their participation with a $5 Café voucher and were entered into the draw to win a $100 Westfield Mall shopping voucher. All participants provided written consent to conditions of the study before participation in the study commenced (see Appendix C for consent form). Of the 60 participants who completed the Time 1 Questionnaire, 54 participants completed the Time 2 Questionnaire (90%), and 57 participants completed questionnaires 3, 4 and 5 (95%). Only data from participants who completed all questionnaires were utilised in the analysis.

Heart rate selection participants

A subsample of 20 participants was randomly selected from the total participant pool to additionally complete the heart rate component of the study. The subsample of participants was selected on the basis that they had a morning end of year exam, and thus those with an afternoon exam were excluded. The 8 males and 12 females in the heart rate component subsample had a mean age of 21.8 years (SD = 6.8) and a mean of 2.5 years (SD = 1.5) in university study.

Materials

Four confidential online questionnaires (Time 1, Time 2, Time 3, and Time 4) and one text message question (Time 5) were designed for the purpose of this study. The online questionnaires were developed using Qualtrics Survey Software (2011). The Time 1, Time 2 and Time 4 questionnaires' were designed to measure stress state related to an end of the year exam, and exercise behaviours for the week prior to the day of the questionnaire's distribution. The Time 3 Questionnaire was designed to measure outcome expectancy beliefs of exercise, and the Time 5 Question was selected to measure stress state immediately prior to the stressor (end of year exam). All questionnaires (Time 1 through 5) requested that participants enter their unique study code before completing the questionnaire.

Questionnaires:

Personal details/demographics: Participant contact details were collected by the researcher during initial meetings with participants for completion of the Time 1 Questionnaire. The researcher asked the participant to provide a cellphone number to send text reminders and the Time 5 Question, a postal address to send participant rewards at the end of the study, their email address to send the questionnaire links, their unique code to track their data over the study, and the code of their first end of year morning (or afternoon) exam. Participants were assured all personal details would not be stored alongside any of the data they provided in the study and would be treated confidentially by the researcher. Additionally, the Time 1 Questionnaire asked participants to indicate their gender, age, whether they study part-time or full-time, the title of their degree and major, and the level of tertiary study they are at (first year, second year, third year, fourth year, fifth year, or sixth year or more), see Table 1.

The Revised Competitive State Anxiety Inventory- 2 (adapted version): The Revised Competitive State Anxiety Inventory- 2 (CSAI-2R; Cox, Martens, & Russell, 2003) is a 17-item scale designed to measure state anxiety. The CSAI-2R comprises three subscales of cognitive state anxiety (5 items), somatic state anxiety (7 items), and self-confidence (5 items), which has been found to have good internal consistency with reported Cronbach's alpha values of .75, .85, and .83 respectively (Terry, Lane & Shepherdson, 2005). The scale asked participants to rate each item on a 4-point Likert scale from *not at all* (1) to *very much so* (4) of how they feel *right now* in relation to their first end of year exam. The CSAI-2R was modified for the purpose of this study such that the word 'competition' in item 2 (I am concerned that I may not do as well in this competition as I could) was replaced with 'exam', and the word 'losing' was replaced with 'failing' in item 5 (I am concerned about losing) to apply the scale to the exam context. The scale includes items such as, "my body feels tense" (somatic anxiety), "I'm concerned about performing poorly" (cognitive anxiety), and "I feel self-confident" (self-confidence). Subscale scores were obtained by calculating the average score for each subscale within each time point. For purposes of analysis the scores for the items on the self-confidence subscale were reversed coded so that a high score (4) on each subscale was consistently indicative of high stress. For the current study Cronbach's alpha values for the CSAI-2R (adapted version) ranged from .84 to .90 for somatic anxiety, .82 to .90 for cognitive anxiety, and .80 to .86 for the self-confidence subscale over Time 1, 2 and 4.

One item from the adapted version of the CSAI-2R was used for the Time 5 Question. Ethical approval of the current study was contingent on not overtaxing the participants prior to their exam, and this included the sending of the item to participants no sooner than 90 minutes prior to their exam. Therefore, the item 'I am confident about performing well' was selected as the Time 5 Question due to the positive wording, so as to reduce the likelihood of elevating participant stress levels immediately prior to their exam. This item also was reverse scored, such that a high score was indicative of higher exam stress and thus less confidence in performing well on the exam. As this item is derived from the self-confidence subscale of the CSAI-2R, where the Time 5 Question item was used as a dependent variable in analyses, the self-confidence subscale was exclude as a covariate.

Exercise Behaviours Questionnaire: An Exercise Behaviours Questionnaire was developed for the purpose of the current study. The self-report Exercise Behaviours Questionnaire asked participants to indicate all of the exercise behaviours they had been engaged in over the last week (Monday – Sunday), where exercise was defined as "…physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective" (Caspersen, et al., 1985, p. 128). For scoring purposes, when reporting exercise, participants were asked to state the activity, the description/intensity of the exercise performed, and the duration of each specific activity in the table provided (see Appendix D). Participants were asked to exclude any incidental physical activity or physical leisure such as household chores that were not performed with the purpose of improving some form of fitness. If no exercise was completed on a particular day participants were asked to leave the table for that day blank. For Time 1, Time 2, and Time 4 Exercise Behaviours Questionnaires, the type of activity and description were coded as a single metabolic equivalent of task (MET) score using the Compendium of Physical Activities (Ainsworth, Haskell, Herrmann, Meckes, Bassett, Tudor-Locke, Greer, Vezina, Whitt-Glover, & Leon, 2011). The single MET score was then multiplied by the duration of the activity to produce a single exercise score for that activity. A single exercise score was calculated for each activity stated by each participant across the week. All of the single activity exercise scores across the week were then summed for each participant to give a total exercise score for the week (resulting in a total exercise score for each of Time 1, Time 2, and Time 4). Total exercise scores were also averaged to produce an average exercise score across the study for each participant.

Coding using The Compendium of Physical Activities was modified in some instances where activities stated by participants did not feature in the Compendium. Where activities stated were not listed, the nearest match to the activity was used (e.g. Basketball was used where Netball was stated). Additionally, where participants had stated more than one activity within one session, for example "Gym: run and row, moderate intensity, 60 minutes," the MET scores for running and rowing at moderate intensity were averaged and then multiplied by the duration stated, to give the exercise score representing one activity.

In order to analyse the differences in exercise between groups, participants were split into groups of high and low exercise based on their calculated overall average exercise scores. Participants were categorised in the high or low exercise group based on exercise scores that were equal and above, or below the national recommended standards of exercise for adults as stated by Sport and Recreation New Zealand (2008). The national recommended standards state that adults should exercise at a moderate intensity for at least 30 minutes on five or more days per week, thus totalling 150 minutes per week. According to the Compendium of Physical Activities (Ainsworth et al., 2011), moderately intense activity ranges between 3 and 5.9 METs. Therefore, participants were grouped as high exercisers if they had an average exercise score of 885 or above (150 minutes x 5.9 METs), and thus those participants who had an average exercise score below 885 were classified as low exercisers. Of the 54 participants in the study 39 were classified as higher exercisers (15 = low exercisers). Furthermore, of the 20 participants included in the heart rate component of the study, 13 were classified as high exercisers and 7 were classified as low exercisers. In order to analyse within-person variation in exercise grouping over time, high and low exercise grouping was also applied to individual time point (Time 1, Time 2, & Time 4) exercise scores.

Outcome Expectations of Exercise (adapted version): One item from the Multidimensional Outcome Expectations of Exercise was used to measure outcome expectancy. The Multidimensional Outcome Expectations of Exercise Scale (MOEES; Wȯjcicki, White, & McAuley, 2009) is a 15-item scale designed to measure three domains of outcome expectations for exercise. The items of the MOEES were originally developed to assess outcome expectations for exercise before participants were engaged in exercise. As the current sample is already engaged in exercise the item used was adapted to read past tense for the purpose of this study. As such, outcome expectancy related to the relationship between exercise and stress was represented by the single adapted item, “Exercise helps to manage stress.” Participants were required to respond to the item by stating to what extent they agree or disagree with the statement. Ratings were made on a 5-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (5), and thus a higher score on this item was indicative of a more positive outcome expectancy belief.

Table 1.
Means and standard deviations for participant demographics and questionnaire subscale averages

		Time 1		Time 2		Time 3		Time 4	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Demographics	Age	22.35	5.38						
	Level of study	2.70	1.44						
	Full Time Study	94.40%							
	Sex	Men: 35.2%							
CSAI-2R	Somatic Anxiety	2.04	0.37	1.37	0.48			1.40	0.49
	Cognitive Anxiety	1.57	0.36	2.16	0.80			2.10	0.80
	Self-Confidence	2.10	0.70	2.52	0.67			2.53	0.67
Exercise Behaviours	Exercise	1918.64	1302.17	1347.45	1086.87			1316.99	1188.04
MOEES	Outcome Expectancy					4.48	0.78		

Note: Participant demographics were consistent over time points

Text Messaging

One Telecom NZ SIM Card loaded with a cellphone number, one Telecom NZ mobile broadband MF636 T-Stick, and Telecom NZ Connection Manager Software was used to send to, and receive text messages from participants.

Heart Rate Monitoring

Heart rate was recorded at 5 second intervals continuously for two 24-hour periods as a physiological account of stress. Heart rate was recorded using 16 Polar S610i running computer wrist watches and Polar Electro OY wireless transmitter chest belts, and 4 Polar RS400 running computer wrist watches and Polar Wearlink 31 transmitter chest belts (Polar Electro, Kempele, Finland). Heart rate monitors were set to key lock after one minute to prevent accidental alteration to readings. Additionally, the sound volume on the heart rate monitors was turned off to ensure no sound was made whilst in the exams. Heart rate data was downloaded using Polar Precision Performance and PolarPro Trainer 5 Software. Data was extracted into Microsoft Excel for the purpose of data treatment.

Heart rate data was aggregated for both baseline and exam measures to attain variables representing sleep period, exam period, and overall heart rate at the two time points. The baseline and exam sleep periods were attained by calculating average heart rate over the time participants specified they went to sleep and woke up. The exam period variable was derived from taking the average of the period that participants specified entering and then exiting their exam. This time period was also used to calculate the exam time period during the baseline measure. Additionally, the overall average of heart rate was taken for each 24-hour period (at baseline and at exam).

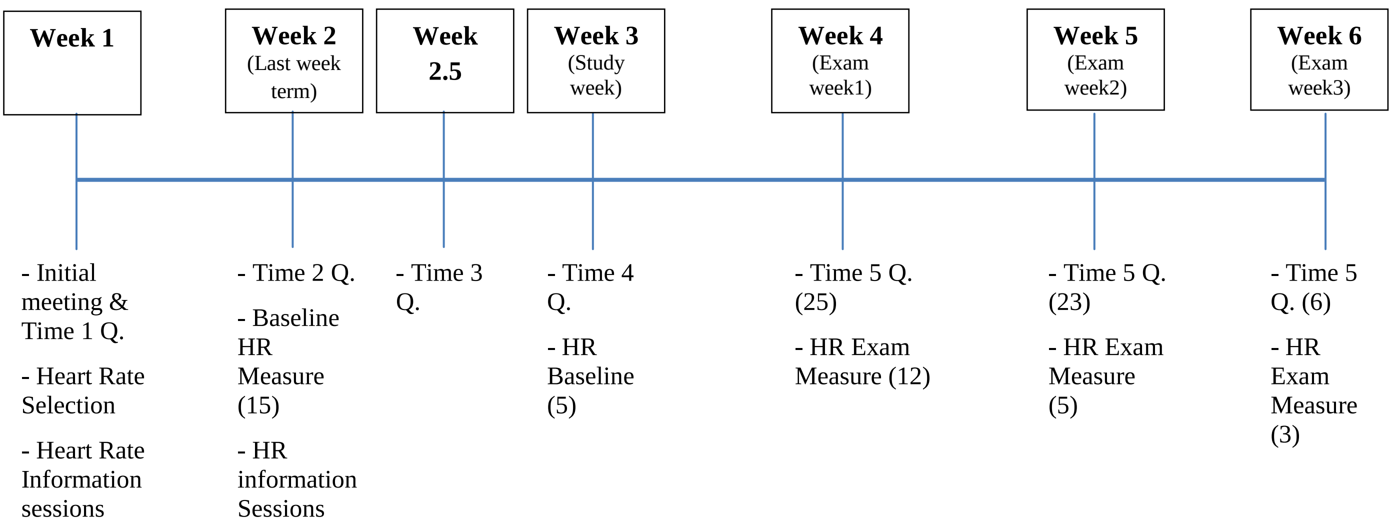
Technical issues with the Polar S610i heart rate monitors caused disruption to the recording of heart rate in some instances. In particular, data was not collected to enable adequate data analysis for one participant, and therefore heart rate data was only utilised for 19 participants. Electrical interference was common with the Polar S610i heart rate monitors, particularly during participant computer use. Additionally, due to the design of the Polar Electro OY transmitter belts, heart rate readings were often lost during the sleep period. The average of the sleep period was therefore calculated using only the data that was recorded during the stated sleep period.

Procedure

Study Timeline

The study was conducted over a period of six weeks over October/November leading up to, and including, the University of Canterbury 2011 end of year exam period. Figure 1 illustrates a week by week timeline of the current study whereby all participants completed a series of five questionnaires, and 20 participants additionally completed two heart rate measures. As illustrated by the timeline, there was a lag in time between the Time 3 Questionnaire and the Time 2 and 4 Questionnaires so as to reduce order effects that were likely to occur. The numbers indicated in brackets are the number of participants who completed that measure in each particular week.

Figure 1.
Six week timeline of the current study



Week One

Participants met with the researcher in small groups (2-4 people) 4 weeks prior to their first end of year exam. In meeting with the researcher, the participants were briefed on the nature of the study and the conditions of participation, as stated on the information sheet provided (see Appendix E). Those participants who agreed to partake in the study completed a signed consent form and were then instructed that they had 30 minutes to complete the Time 1 online Questionnaire on the computers provided in the meeting room. On completion of the questionnaire, and thus the end of the meeting, contact and course details were collected from participants. On leaving the meeting, participants were also reminded of the next stage of participation and they were thanked for their involvement.

After all participants had completed the Time 1 Questionnaire, 20 participants were randomly selected to complete the heart rate component of the study, on the basis of having a morning end of year exam. Two days after completion of the Time 1 Questionnaire, these 20 participants were notified of their selection via email. In the email notification participants were asked to confirm their selection as a heart rate measures participant by contacting the researcher. One participant declined participation in the heart rate component of the study, and therefore an additional participant was randomly selected. Participants were also asked to select a heart rate information session time to attend from a list provided by the researcher.

Heart rate participants met with the researcher in week one or week two of the study to be briefed on the conditions of the heart rate component of the study, and to be instructed on how to fit and use the heart rate monitors. The participants (1-3 people per information session) were taken through the details and instructions stated on the information sheet provided (see Appendix F, and Appendix G; information sheets were distributed in conjunction with heart rate monitor models). Instruction also included demonstration by the researcher, over clothing, where the heart rate transmitter belt should be worn. Heart rate participants were given one Polar heart rate monitor wrist watch and one transmitter chest belt. The participants entered personal details into the Polar wrist watches, including height, weight, age, and birthday, guided by the researcher. Participants were then required to go to the bathroom to fit the transmitter belt against the skin according to instructions, and return to ensure they were able to establish and record a heart rate reading. Participants were also provided with a diary sheet which they were asked to use to record their general activities on during the baseline measure period, including sleep, exercise, computer use or anything that may have an impact on heart rate, such as earthquake aftershocks. Opportunity was given to participants to ask any questions, and the meeting ended when both the researcher and participants were confident that participants understood what was required, and were able to appropriately fit and use the monitors.

Week Two

One week after completion of the Time 1 Questionnaire, in week two of the study, all participants were sent an email with a link to the Time 2 Questionnaire using Qualtrics Online Software. The Time 2 Questionnaire took approximately 10 minutes to complete.

Over week two and three of the study heart rate participants completed baseline heart rate measures. The majority of baseline heart rate measures were completed by participants in week two, with five participants completing baseline measurements in week three. Completion of the heart rate baseline measurement required participants to fit the heart rate monitor, at 6pm the evening before the day of the week that their exam was to occur. Participants were required then to wear the heart rate monitor for 24-hours from fitting, and record their general activities throughout this period on the diary sheet provided. Participants were sent a text message on the day of the baseline measurement fitting, to remind them to fit their heart rate monitor at 6pm that evening. After completion of the baseline measure, the participants were required to take the heart rate monitor to the researcher to have the data downloaded, return their baseline diary sheet, and receive a diary sheet for the exam measure.

Three days after the distribution of the Time 2 Questionnaire, the Time 3 Questionnaire link was sent to participants via email, and took approximately 5-10 minutes to complete.

Week Three

The Time 4 Questionnaire link was emailed to participants one week after the Time 2 Questionnaire, and three days after the Time 3 Questionnaire’s distribution. The Time 4 Questionnaire took participants approximately 10 minutes to complete.

Exam weeks

On the day of their exam, all participants were sent the Time 5 Question via text message. The Time 5 Question was sent 90 minutes before the exam, and required participants to text their individual study code and their answer to the item back to the researcher as soon as possible. Two days prior to the participant's exam, they were sent a text message to notify them that they will be receiving the Time 5 Question text 90 minutes before their exam, and prompted them to reply as soon as possible.

On receiving the Time 5 Question responses, participants not involved in the heart rate component of the study were posted out a debrief sheet (see Appendix H) along with a $5 Café Voucher. Participants were also notified that they had been entered into the draw to win a $100 Westfield Mall Shopping Voucher.

Heart rate participants completed an exam day heart rate measure in week four, five, or six depending on when their exam occurred. Participants were sent a text message the day before their exam to remind them to fit the heart rate monitor at 6pm that evening. Thus, participants were required to fit the heart rate monitor according to instructions on their information sheet at 6pm the evening before their exam. The participants were required to wear the heart rate monitor for 24-hours from fitting. During the exam day measurement, participants were required to record their general activities, including the time they entered and exited their exam. Additionally, participants were required to press the red/OK button on the heart rate watch when they entered their exam and then again on leaving the exam, to set a marker of the exam period.

After completion of the 24-hour exam day measure, heart rate participants were required to return their heart rate monitor watch and transmitter belt, and diary sheet from exam day to the researcher. On return of the heart rate monitor and diary sheet, participants received a $10 Café Voucher and a study debrief sheet (see Appendix H). Heart rate participants were also added to the draw to win a $100 Westfield Shopping Voucher, which was then drawn and the winner was notified.

Ethics

Subject to the conditions outlined in the procedure, the current research was reviewed and approved by the University of Canterbury Human Ethics Committee, reference HEC 2011/85.

Analyses

Statistical analyses: self-reported data

Since the current data set includes data at both the person level (Level 2: age, gender, level of study, average exercise grouping, outcome expectancy) and time-level (Level 1: cognitive anxiety, somatic anxiety, self-confidence, exercise), multilevel modelling (MLM) was used. Time-level data were nested within person-level data, and therefore due to the dependent and longitudinal nature of the data, MLM was deemed appropriate. MLM allows for the analysis of dependent data by predicting not only the contribution of between person variance in explaining the outcome variable, but also the variance attributed to within-person or intra-individual changes (Hayes, 2006; Hoffman & Stawski, 2009). Additionally, MLM is useful for assessing longitudinal data as the effect of change over time on the outcome variable can be examined, whilst taking into account individual differences in intercepts (mean levels) and rates of change (slopes) (Hayes, 2006; Hoffman & Stawski, 2009). To examine the hypotheses related to the relationship between exercise and stress, and the moderating effects of outcome expectancy multilevel models were estimated using the mixed procedure (MIXED) in SPSS.

In order to account for the effects of the different types of stress on the outcome variable, the time-varying covariates of cognitive anxiety and somatic anxiety were represented by two variables each, one of which represented within-person variation (Level 1, individual deviation from the person mean at each time point) and one representing between-person variation (Level 2, individual deviation from the group mean for each person). Thus, cognitive anxiety and somatic anxiety were centred using both the person mean (Level 1) and the group mean (Level 2) for each covariate, allowing both within- and between-person differences to be modelled and controlled for. Exercise was coded so that 0 represented low exercise (1 = high exercise) on average (between-person) and at each time point (within-person level).

The time invariant covariate of gender was coded such that 0 pertained to males (1 = female); age and level of study were analysed as continuous variables, and outcome expectancy was centred about the group mean. Participants' responses to the exam stress item over the last three waves of the study were used to represent the exam stress outcome variable. Furthermore, the outcome variable of exam stress was derived from the self-confidence subscale, and self-confidence was therefore excluded as a covariate in the multilevel analyses. Cognitive and somatic anxieties however were included as covariates in order to take into account the effects of the different types of stress over the course of the study, on the outcome variable.

Maximum likelihood was used to estimate multilevel models of increasing complexity in the current analyses. Models with greater complexity are considered more suitable if they provide a significantly better fit of the data than less complex models (Totterdell, Wood, & Wall, 2006). Due to nesting in the current data set, improvement of model fit was compared using the difference in model -2 Log Likelihood (LL) values. Lower -2LL values indicate better model fit; however a chi-square distribution was used to assess the significance of the changes between -2LL model values, using the number of difference in model parameters to represent the degrees of freedom (Hoffman, 2007).

Analytical model

The basic model that includes exercise as a predictor, and which was used as a basis for all multilevel model predictions, is shown in equation 1 (Model 1):

Level 1: $Y = \beta_{0i} + \beta_{1i}(\mathrm{Ex}_{ti}) + r_{ti}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(\mathrm{ExM_i}) + \mathrm{U_{0i}}$

$\beta_{1i} = \gamma_{10}$

In the Level 1 model, exam stress (Y) is a function of an individual intercept (β_{0i}), the within-person fixed effects of exercise (β_{1i}; exercise at time *t* for individual *i*) and the residual variance in the stress outcome (r_{ti}) at time *t* for individual *i*. In the Level 2 model, the individual intercept (β_{0i}) is a function of a fixed intercept (γ_{00}), the fixed effect of between person exercise (γ_{01}; average level of exercise for each individual) and individual specific deviation in the intercept (random intercept; $\mathrm{U_{0i}}$). The individual effect of within-person exercise (β_{1i}) is a function of the fixed effect of exercise (γ_{10}).

Statistical analyses: heart rate data

In order to assess hypotheses related to the association between self-reported and physiological exam stress, and the relationship between exercise and heart rate, correlational analysis and repeated measures, general linear modelling were utilised. Due to missing data between baseline and exam measures, there was variation in the heart rate data included in analyses for the sleep period (*n* = 11), exam period (*n* = 13), and overall 24-hour period (*n* = 18).

Results

Self-reported data

Person means, standard deviations, and correlations between the variables included in the prospective models are displayed in Table 2. Exercise, cognitive anxiety, somatic anxiety, and exam stress variables in Table 2 are aggregated across the three measures closest in time to the exam (Time 2 to 5 for exam stress). Therefore, the variables in Table 2 represent the means and standard deviations for variables over time, and correlations assessing relationships between variables across all time points.

Table 2.
Person means, standard deviations, and zero order correlations among multilevel modelling variables

	Variable	*M*	*SD*	1	2	3	4	5	6	7
1	Age	22.35	5.35	-						
2	Gender	0.65[a]	0.48	-.05	-					
3	Level of Study	2.70	1.43	.05	-.07	-				
4	Exercise	0.64[b]	0.48	.01	.03	.27*	-			
5	Cognitive Anxiety	1.95	0.73	-.13	.03	-.14	-.15	-		
6	Somatic Anxiety	1.60	0.54	-.01	.03	.05	-.06	.17*	-	
7	Outcome Expectancy	4.48	0.63	.10	.18*	-.07	.03	.06	.04	-
8	Exam Stress	2.44	0.78	.01	.20*	.19*	.10	.21*	.04	-.04

Note: Data for variables 5 and 6 was averaged across Time 1, 2, and 4; variable 8 was averaged over Time 2, 4, and 5; * $p < .05$; [a] 0 = males, 1 = females; [b] 0 = low, 1 = high.

Preliminary Analyses

Before testing the research hypotheses, a Null model including only an intercept and the residual variance as the predictor was calculated to estimate whether individuals differ on the stress outcome variable, and to estimate the intraclass correlation (ICC), the proportion of total variance in exam stress levels attributable to between-person variance. The ICC was calculated by dividing the random intercept variance by the total variance (intercept variance + residual variances). The Null model revealed that participants differed significantly on how stressed they were in relation to the exam, i.e., the estimated variance of the random components of .20 was significantly different from zero (t = 3.03, p < .05). The ICC for exam stress was .34 (34% between-person variance, 66% within-person variance). Therefore, a third of the total variance in exam stress was at the within-person level, indicating that individuals differed from their own average exam stress level more so than they differed from other individuals.

Testing the research hypotheses

A series of multilevel models were estimated and compared in order to test the current research hypotheses. To test the relationship between within-person exercise and exam stress over time, within-person variation in exercise over time (Level 1) was entered in Model 1. Between-person exercise (Level 2) was then added as a predictor in Model 2. Cognitive anxiety at the within- and between-person level was then entered in Model 3. In order to analyse the effect of somatic anxiety on exam stress independent of cognitive anxiety, within-person and between-person level somatic anxiety was entered as predictors in Model 4, whilst excluding cognitive anxiety variables. In Model 5, cognitive anxiety was re-entered and outcome expectancy was added as a predictor. Finally, in Model 6, the interactive effects of between-person and within-person exercise and outcome expectancy were added to test the moderation effects of outcome expectancy on the relationship between exercise and exam stress. The slopes were fixed and the intercepts in the models were allowed to vary randomly as estimating random slopes did not add to better model fit of the data. To examine the improvement of each model as new predictors were added, maximum likelihood statistics (-2LL) were compared to the preceding model using a χ^2 test, with the degrees of freedom equivalent to the number of new parameters added to the previous model.

Table 3 shows the series of multilevel models estimated predicting exam stress. The estimated fit of the models 1 to 6 are outlined below.

Model 1: Within-person exercise

Within-person variation in exercise was significantly related to exam stress over time and therefore, adding within-person exercise as a predictor improved the fit of the Null model, χ^2 (1) = 4.90, $p < .05$.

Model 2: Between-person exercise

When between-person exercise was added, Model 2 did not show significant fit improvement, χ^2 (1) = 1.19, *ns*, indicating that between-person exercise did not significantly contribute to the prediction of exam stress over time in Model 2.

Model 3: Cognitive anxiety

Model 3 fit the data significantly better than Model 2 when within- and between-person cognitive anxiety were included as predictors, χ^2 (2) = 29.07, $p < .001$. Thus, within- and between-person cognitive anxiety both had a significant effect on exam stress (-.20, $t = -2.11$, $p < .05$, and .68, $t = 5.56$, $p < .001$ respectively).

Model 4: Somatic anxiety

When somatic anxiety was tested independent of cognitive anxiety in Model 4, model fit decreased dramatically from Model 3 (poorer fit) and did not significantly improve fit from Model 2, $\chi 2$ (2) = 2.55, ns. The effects of both within-person and between-person somatic anxiety did not have a significant relationship with exam stress, -0.08, $t = -0.76$, ns, and 0.36, $t = 1.42$, ns respectively.

Table 3.
Multilevel parameter estimates and standard errors for models predicting exam stress

	Null Model			Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
	Est.	*SE*	*t*	Est.	*SE*	*t*	Est.	*SE*	*t*	Est.	*SE*	*t*	Est.	*SE*	*t*	Est.	*SE*	*t*	Est.	*SE*	*t*
Fixed Effects																					
Intercept	2.44	0.08	**30.97**	2.26	0.12	**19.49**	2.37	0.15	**15.41**	2.39	0.12	**19.64**	2.35	0.15	**15.49**	2.39	0.12	**19.71**	2.37	0.12	**19.75**
WP Exercise				0.30	0.13	**2.28**	0.39	0.16	**2.52**	0.32	0.15	**2.07**	0.40	0.16	**2.70**	0.31	0.15	**2.04**	0.32	0.15	**2.07**
BP Exercise							-0.24	0.22	-1.09	-0.21	0.18	-1.14	-0.23	0.21	-1.10	-0.20	0.18	-1.07	-0.19	0.18	-1.05
WP Cognitive Anxiety										-0.20	0.10	**2.11**				-0.20	0.10	**2.12**	-0.21	0.10	**2.14**
BP Cognitive Anxiety										0.68	0.12	**5.56**				0.69	0.12	**5.67**	0.71	0.12	**5.84**
WP Somatic Anxiety													-0.08	0.108	-0.76						
BP Somatic Anxiety													0.36	0.253	1.42						
Outcome Expectancy																-0.10	0.10	-0.94	-0.21	0.15	-1.40
Interaction Effects																					
WP Ex X OE																			-0.20	0.29	-0.68
BP Ex X OE																			0.39	0.32	1.21
Variance of random components																					
Random intercept variance	0.20	0.07	**3.03**	0.23	0.07	**3.19**	0.23	0.07	**3.24**	0.10	0.05	**2.23**	0.22	0.07	**3.20**	0.10	0.05	**2.18**	0.09	0.04	**2.12**
Residual variance	0.40	0.05	**7.35**	0.37	0.05	**7.29**	0.37	0.05	**7.32**	0.36	0.05	**7.34**	0.37	0.05	**7.33**	0.36	0.05	**7.33**	0.35	0.05	**7.33**
Fit Statistics																					
- 2LL			360.77			355.87			354.68			325.61			352.13			324.73			323.10
Deviance (- 2LL)						**4.90**			1.19			**29.07**			2.55			0.88			1.62
df [a]						1			1			2			0			1			2

Est. refers to estimate value. [a]*df* refers to the number of parameters added to the model. **Bold values =** *p* <.05. *Note:* The random effect of the slopes (T_{11}) term was tested but did not add to model improvement

Model 5: Outcome expectancy

The effect of outcome expectancy on exam stress was non-significant (-0.10, t = -.94, *ns*), and thus Model 5, which added outcome expectancy to Model 3, did not improve model fit, χ^2 (1) = 0.88, *ns*.

Model 6: Exercise and outcome expectancy interactions

In Model 6, both exercise and outcome expectancy interaction terms were non-significant (-.20, t = -0.68, *ns* for within-person exercise, and 0.39, t = 1.21, *ns* for the between-person exercise term). Furthermore, the addition of the interactive effects did not significantly improve model fit of the data, χ^2 (2) = 1.62, *ns*. Thus, the relationship between exercise and exam stress was not moderated by outcome expectancy.

Final Model

Model 3 in Table 3 was accepted as the Final model. The Final model included variables of within- and between-person exercise and within- and between-person cognitive anxiety. This model was the most parsimonious model with the best data fit in explaining exam stress. The Final model showed that higher cognitive anxiety over time was related to lower exam stress over time (-.20, t = -2.11, $p < .05$). In contrast, exam stress was higher among participants whose cognitive anxiety was higher than the group mean on average, 0.68, t = 5.56, $p < .001$. These results suggest that when participants pre-exam cognitive stress levels are significantly higher than the group average their exam stress levels appear to be higher. However, when participants' cognitive anxiety levels were higher than their own average level of cognitive anxiety over the weeks prior to the exam, their exam stress levels appear to be lower over time. Additionally, within-person exercise was significantly related to exam stress, whilst controlling for the effects of cognitive anxiety. As this model illustrates, when exercise levels in participants were higher than their personal average (taken over the four weeks prior to the exam), exam stress levels were also higher over time.

Heart rate data

The means, standard deviations, and correlations for exercise, self-reported stress, outcome expectancy, and heart rate accounts of stress, are presented in Table 4. There was a positive relation found between physiological and self-reported exam stress. As illustrated in Table 4, overall heart rate average on exam day was related to self-reported accounts of stress. More specifically, there were medium to large positive correlations (Cohen, 1988) between overall exam heart rate and the cognitive (Time 2 and Time 4), somatic (Time 1), and self-confidence (Time 1 and Time 2) subscales, as well as a positive relation with exam stress at Time 5. These correlations indicate that when overall heart rate average scores are higher, so too were self-reported accounts of exam stress.

High versus low exercise and stress

To assess the differences between high and low exercisers on physiological indicators of exam stress at baseline and exam, repeated measures general linear models were calculated using heart rate measures at both baseline and exam day as the dependent variables.

For the sleep periods, the main effects of time was not significant, $F(1, 9)$ 2.43, *ns*. Therefore, the mean heart rate sleep scores were not significantly different over baseline and exam day measures. Additionally, there was no interaction effect evident between time and exercise grouping ($F(1, 9)$ 0.07, *ns*), meaning that mean levels of sleep period heart rate were not found to be significantly different between exercise groups over time.

Table 4.
Means, standard deviations, and correlations for demographics, exercise and self-reported stress at each time point, outcome expectancy, and physiological stress at baseline and exam day

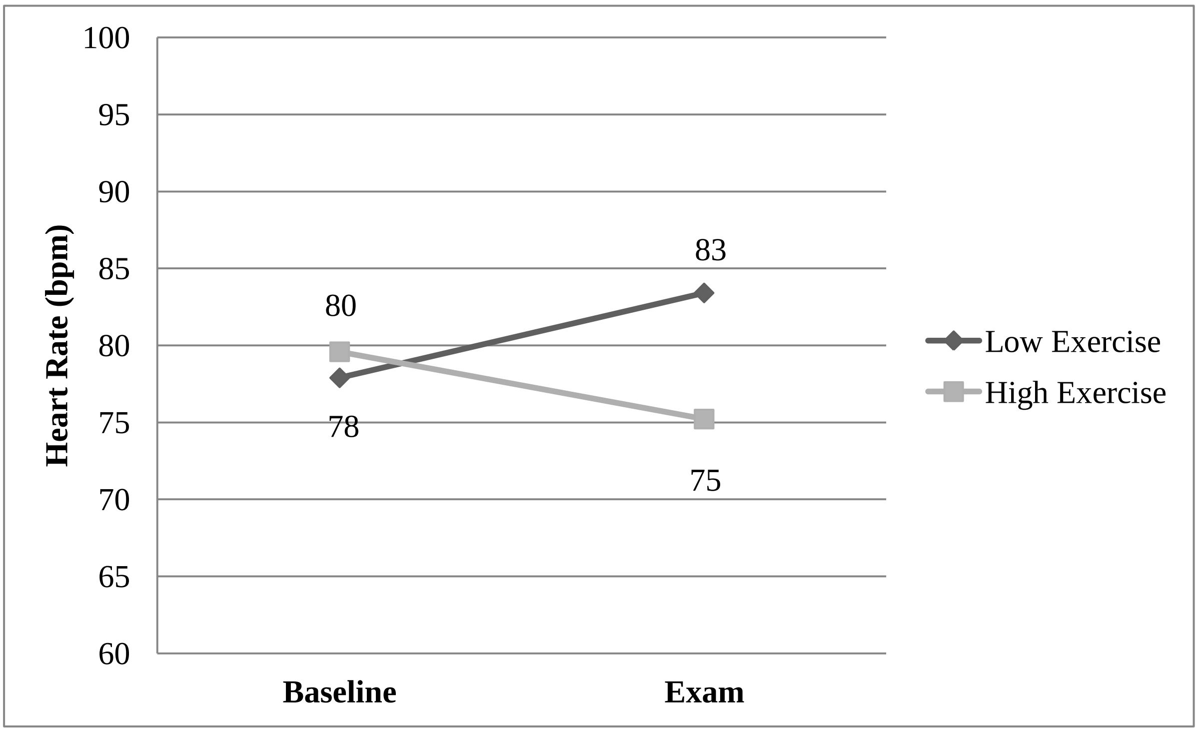
	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Age	21.80	6.80	-																					
2	Gender	0.60[a]	0.50	.18	-																				
3	Level of Study	2.50	1.47	-.06	.00	-																			
4	T1Exercise	1708.8	1130.2	.09	-.15	-.25	-																		
5	T2Exercise	1209.5	953.0	.17	.14	**.48**	**.58**	-																	
6	T4Exercise	1298.8	1129.5	.15	-.04	**.48**	**.63**	**.66**	-																
7	T1Cog Anxiety	1.60	0.35	-.02	-.21	.05	.27	.03	.24	-															
8	T2Cog Anxiety	2.18	0.74	-.21	.32	**.48**	.12	.35	.30	-.28	-														
9	T4Cog Anxiety	2.17	0.84	-.38	.32	-.30	.00	.18	.12	.00	**.87**	-													
10	T1Som Anxiety	2.03	0.40	.09	-.36	.37	.04	-.05	-.11	**.55**	**.55**	-.41	-												
11	T2Som Anxiety	1.31	0.34	-.15	.01	-.20	-.20	.08	.27	.22	.40	.38	.01	-											
12	T4Som Anxiety	1.36	0.50	-.22	.28	-.30	-.21	.21	.21	.19	.41	**.46**	-.24	**.51**	-										
13	T1Self-confidence	2.13	0.74	-.39	.23	-.26	.20	.27	.28	.06	**.82**	**.92**	**.47**	.33	**.47**	-									
14	T2Self-confidence	2.54	0.71	-.02	**.72**	.41	.22	-.17	-.04	**.49**	**.72**	**.62**	**.78**	-.19	-.32	**.53**	-								
15	T4Self-confidence	2.54	0.71	.20	**.69**	.17	.20	-.12	.11	.26	-.44	**.51**	**.66**	.05	-.35	**.50**	**.62**	-							
16	Outcome Ex.	4.50	0.61	.23	-.17	.12	.22	-.16	-.09	.13	-.02	-.14	.22	.13	-.28	-.11	.20	.34	-						
17	Exam Stress	2.50	0.67	.17	.24	-.11	-.23	-.06	-.01	-.28	**.60**	**.58**	-.36	.15	.07	**.49**	**.54**	-.32	.19	-					
18	Base Sleep HR	62.94	7.67	-.45	.43	.07	-.22	-.34	-.18	.00	.21	.32	-.13	.38	.39	.27	-.32	-.25	.30	-.08	-				
19	Exam Sleep HR	62.90	9.30	-.43	.37	.08	-.40	-.42	-.13	-.28	.39	.15	.02	.38	.29	.04	-.29	-.02	.18	.10	**.90**	-			
20	Base Exam HR	76.61	11.09	-.35	.04	.14	-.45	-.33	-.20	-.31	.02	-.04	-.08	-.09	-.07	-.11	-.13	.08	-.17	-.06	.31	.54	-		
21	Exam Exam HR	81.50	11.34	-.28	-.21	-.27	-.22	-.48	-.11	.45	.33	.43	.23	.41	.27	.29	.11	.14	.31	-.23	.45	.47	.12	-	
22	Base OA HR	78.63	8.02	**.56**	.26	-.07	-.13	-.11	.02	-.26	.09	.06	-.19	-.04	.14	.01	-.21	-.15	-.14	.11	**.70**	**.79**	**.66**	.14	-
23	Exam OA HR	78.40	10.42	-.28	.23	-.16	-.28	-.33	-.09	-.28	**.71**	**.60**	**.50**	.44	.35	**.51**	**.55**	-.25	.24	**.50**	.55	**.80**	.21	**.78**	.31

[a] 0 = males, 1 = females **Bold values** = $p < .05$
Cog = Cognitive; Som = Somatic; Outcome Ex. = Outcome Expectancy; Base = Baseline; OA = Overall

Likewise, the main effect of time for the exam period was not significant, $F(1, 11)$ 0.71, *ns*. Furthermore, the interaction between time and exercise grouping was also non-significant ($F(1, 11)$ 0.06, *ns*). Thus, mean levels of exam period heart rate was not significantly different over time, and mean heart rate did not differ significantly between high and low exercise groups over baseline and exam measures of the exam period.

The main effect of time between exercise groups for the overall heart rate averages was also not significant, $F(1, 16)$ 0.05, *ns*. However, the interaction effect between time and exercise grouping was significant on the slightly liberal 10% level ($F(1, 16)$ 4.05, $p = .06$), see Figure 2.

Figure 2.
Interaction effect between exercise grouping and time for overall heart rate average



As is illustrated in Figure 2, the interaction indicates a trend towards a significant difference in overall average heart rate between high and low exercise groups over the baseline and exam time points. As such, it appears that while the low exercise group had lower overall heart rate averages at baseline than high exercisers, their overall heart rate average on exam day was higher than at baseline. In contrast the high exercise group decreased in overall heart rate average from baseline to exam day, with a heart rate average difference of 8.19 beats per minute (bpm) between the high and low exercise groups on exam day. Therefore, it appears that the low exercise group had a stronger reaction to the exam than the high exercise group.

Discussion

The current study investigated whether exercise was related to self-report and physiological exam stress, and whether outcome expectancy beliefs related to the benefits of exercise for stress management had a direct moderating impact on this relationship. In order to examine these relationships, exercise behaviours and self-reported exam stress were measured over a four week period leading up to university end of year final examinations. Exercise and stress were measured in a sample of University of Canterbury students who exercised on a minimum of one day per week, in the week prior to recruitment. Thus, this field-study did not induce or encourage exercise in participants, which eliminated the issues that motivation and intervention compliance can pose for assessing the relationship between exercise and stress (Proper et al., 2002). Heart rate was also examined in a subsample of 20 participants at baseline and exam day as a physiological indicator of exam stress responses. Outcome expectancy beliefs were also recorded in all participants on a single occasion during the four weeks leading up to exams.

While there has been an extensive body of literature investigating exercise and stress (e.g. Brown & Siegel, 1988; Carmack et al., 1999; Gerber et al., 2010; Kobasa et al., 1982; Rimmele et al., 2007), and exercise stress management interventions (e.g. Conn et al., 2009; Long & van Stavel, 1995; von Thiele Schwartz et al., 2008), there is little, if any, known investigation into the effects of outcome expectancy as a moderator in the relationship between exercise and stress reduction. This relationship is particularly important as outcome expectancy has been found to be a significant determinant in the engagement in, and outcomes experienced from health behaviours (e.g. Dishman et al., 1985; Jones et al., 2005; Sniehotta et al., 2005; Williams et al., 2005). Thus, outcome expectancy may have significant potential in enhancing the effectiveness of stress management benefits derived from exercise stress management interventions. Therefore the current study set out to examine research hypotheses related to 1) the effects of exercise on exam stress, 2) the moderation effects of outcome expectancy on the exercise-stress relationship, and 3) the relation between self-reported and physiological exam stress. Investigation into these research hypotheses yielded differing results, and these will be discussed in correspondence to each research hypothesis below. The implications of the findings and the limitations of the current research will be discussed, followed by final conclusions and directions for future research.

Summary of results

The results corresponding to the first set of research hypotheses predicting a negative relationship between exercise and exam stress were found to be inconsistent across self-reported and physiological exam stress analyses, and were contradictory to the findings of the majority of previous research. This set of research hypotheses were investigated with multilevel modelling and repeated measures, general linear modelling analyses; a discussion of these findings follows.

1a. Exercise scores higher than average individual scores (intra-individual difference) will be related to lower levels of exam stress.

In the multilevel analyses the exercise and stress variables for which data was collected over several time points (time-level data) were split into two parts to reflect the individual deviations from the group mean levels (between-person/inter-individual level) and individual deviations from own mean levels (within-person/intra-individual level). In terms of research hypothesis 1a, the main effect of intra-individual variation in exercise behaviours over time was found to be significantly related to exam stress over time. More specifically, it was found that when an individual's exercise levels were high relative to their own average exercise levels over the study, exam stress levels over time were also high. This finding of a positive relationship between intra-individual exam stress and exercise is thus contradictory to hypothesis 1a which predicted a negative association between these variables.

This finding was also not consistent with the results of previous studies that have focused on the between-person associations between exercise and stress, and of which predominantly demonstrate that higher levels of exercise were related to lower levels of self-reported stress (e.g. Carmack et al., 1999; Kobasa et al., 1982; Norris et al., 1992) and anxiety (e.g. McGilley & Holmes, 1988; Taylor, 2000). Scholz et al. (2009) outline that the relationships found between variables at the between-person level may not hold at the within-person level, and this was the case for the current relationship found.

The direction in the relationship found between higher within-person exercise and higher exam stress over time nonetheless, cannot be established. Therefore, within-person exercise and exam stress over time may have a reciprocal relationship whereby it may also be the case that individuals who felt higher levels of exam stress, engaged in more exercise than they would on average. This relationship may be plausible due to the high levels of outcome expectancy across the participants in the current study, such that participants strongly agreed ($M = 4.48$, $SD = 0.63$; 1 to 5 scale) that exercise helps to manage stress. This notion has the support of previous research that finds that outcome expectancy is a significant determinant of engagement in exercise behaviours (e.g. Sniehotta et al., 2005; Williams et al., 2005). As such, in the current study, it may be that those who felt more stress may have exercised more as a means of reducing their stress levels, and therefore in the current sample higher levels of exam stress could have prompted higher levels of engagement in exercise behaviours.

Conversely, the current finding linking higher within-person exercise with higher exam stress levels aligns with the contention that it is *habitual* exercise levels that have a stress reducing effect (Berger, 1994; Edenfield & Blumenthal, 2011; Salmon, 2001). As stated earlier, habitual levels of exercise have an effect on stress through physiological adaption, whereby physiological systems (sympathetic nervous system and HPA axis) adapt to the level of physical stress induced by exercise (Edenfield & Blumenthal, 2011; Hamer et al., 2005; Salmon, 2001). This therefore, results in less physical stress reactivity which provides fewer cues to stimulate subjective stress perceptions, thus influencing lower levels of self-reported stress (McGilley & Holmes, 1988). As such, it has been suggested that exercise that is more intense than one is use to engaging in (i.e. high than one's average level of exercise) may have a stress inducing effect and thus may potentially worsen subjective stress perceptions (Edenfield & Blumenthal, 2011; Salmon, 2001). As such, it may be plausible that the levels of exercise higher than one's average may not be reflective of habitual levels of exercise. Therefore, exercise may have acted as an additional source of stress for physiological systems in the current study, thus stimulating greater report of stress perceptions.

1b. Exercise scores higher than average group scores (inter-individual difference) will be related to lower levels of exam stress.

In contrast to studies that find that exercise was significantly related to stress (e.g. Gerber et al., 2010; McGilley & Holmes, 1988; Rimmele et al., 2007), and contrary to research hypothesis 1b, between-person variation in exercise behaviours was not significantly related to self-reported exam stress over time. Hoffman and Stwaski (2009) note that effects found at the within-person and between-person levels may differ in magnitude and/or direction as within-person and between-person variance represent different theoretical constructs. As such, the reasons that individuals differ in exercise from one point in time to the next may not be for the same reasons that individuals differ from each other in exercise behaviours (Hoffman & Stwaski, 2009). Therefore, whilst there was a significant positive effect of within-person exercise on exam stress over time in the current study, variance from the group mean level of exercise was not significantly related to exam stress over time. This finding may suggest that within-person variations in behaviour are more important for understanding the relationship between behaviours and outcomes.

Hayes (2006) highlights that multilevel modelling is a statistical procedure that requires a large sample in order to ensure enough power for uncovering a meaningful effect. Although it is difficult to determine just how large of a sample is required (Hayes, 2006), the small sample in the current study (n = 54) may have contributed to the non-significant relationship found between exercise variation at the between-person level and exam stress over time.

1c. Exercise scores will be negatively related to heart rate stress reactivity over time.

There were no main effects of time in predicting average heart rate scores for the sleep period, exam period, and over the whole 24 hour period. Therefore, the heart rate average scores were not significantly different over baseline and exam day measures.

The lack of significant difference between baseline and exam measures may be related to the timing of the baseline measure, which occurred during the final week of the university fourth term. As such, many participants had final assignments that were due, and some even had tests, which may have resulted in elevated physiological arousal (higher heart rate) during the baseline measure. This baseline measure may therefore have not given a true depiction of participants' typical heart rate fluctuations over a 24 hour period, thus contributing to a lack of significant difference between baseline and exam measures.

However, consistent with hypothesis 1c, exercise was negatively related to heart rate stress reactivity, whereby the time by exercise grouping interaction predicting overall heart rate average was significant on the slightly liberal 10% level ($p = .06$). McClelland and Judd (1993) suggest that it is much more difficult to detect an interaction effect in field research and therefore this interaction was interpreted as significant on the $p < .10$ level as a means of enhancing power. Therefore, this result indicates a trend towards a significant difference in overall heart rate average between high and low exercise groups over time. More specifically, the interaction demonstrated that the low exercise group had a stronger reaction to the exam than the high exercise group. Furthermore, while the low exercise group had lower heart rate averages than the high exercise group at baseline, the high exercise group had lower overall heart rate averages than the low exercise group on exam day. The trend presented by this result was consistent with previous research, such as that found by Rimmele et al. (2007) who found that men trained in exercise responded to a laboratory stressor with fewer cortisol and heart rate responses than men who were not trained in exercise.

This finding, although rather preliminary given the small sample size ($n = 19$), illustrates a negative relationship between exercise and physiological exam stress. However, this preliminary finding requires more rigorous investigation in order to confirm the emergent trend exhibited by the current result.

2. The relationship between exercise and exam stress will be moderated by outcome expectancy: there will be a stronger negative relationship between exercise and exam stress when outcome expectancy levels are higher.

In testing research hypothesis 2, it was found that exercise and outcome expectancy interaction effects did not moderate the relationship between exercise and stress. This finding was evident for self-reported exam stress in relation to both within-person and between-person level effects of exercise. Furthermore, the within-person by outcome expectancy interaction term and the between-person by outcome expectancy interaction term, tested with multilevel modelling, were both non-significant and did not improve the fit of the model of exercise predicting exam stress. Thus, contrary to hypothesis 2, outcome expectancy did not have a moderating effect on the relationship between within- and between-person exercise and exam stress. The sizes of the interaction terms however, were low to moderate in effect (-0.20 for within-person and 0.39 for between-person interactions; Cohen, 1988) which could indicate that the current non-significant results may be attributable to a lack of statistical power.

Therefore, the results indicated that on this occasion outcome expectancy does not moderate the relationship between exercise and both self-reported exam stress. In other words, if a person had low exercise levels their exam stress levels were not altered by the level of outcome expectancy beliefs that they held. These results do not support the contention of Bandura (1998) who posits that outcome expectancy has a moderating effect on the relationship between behaviours and their outcomes, nor do these results align with the suggestion that outcome expectancy may be useful for understanding the stress alleviation effects of exercise (e.g. Gerber et al., 2010).

3. Self-reported exam stress will be positively related to physiological exam stress (heart rate).

In line with the prediction made in hypothesis 3, correlation analyses revealed significant positive associations between self-reported and physiological exam stress. As such medium to large positive correlations were found between overall exam heart rate and the cognitive (Time 2 and Time 4), somatic (Time 1), and self-confidence (Time 1 and Time 2) subscales, as well as the exam stress variable Time 5. These results therefore highlight that the self-report accounts of exam stress used in this study were assessing a construct related to physiological accounts of stress. Additionally, the relation between self-report and physiological exam stress offers support for the validity of the self-reported measures of exam stress utilised in the current research.

While the correlational nature of the positive relationships found between self-report and physiological exam stress do not infer causation, this finding could align with contention of several authors (e.g. Edenfield & Blumenthal, 2011; McGilley & Holmes, 1988; Salmon, 2001) that physiological stress reactivity provides cues for stimulating subjective stress perceptions, thus positing that the two are related.

Due to the inconsistency of the results established in the current study across hypotheses, and given the small sample in the study, future research is needed in order to determine the applicability of the current findings for understanding exercise stress management interventions. While future research is needed, these results may be informative to organisations who implement exercise interventions for stress management. The finding that high levels of intra-individual variation in exercise was related to higher levels of exam stress over time, highlights the notion that exercise at different levels (i.e. within-person and between-person) may have differing effects on stress. This finding also provides important direction for future research whereby the role of habitual versus non-habitual exercise levels on stress should be investigated further. If this result is replicated in future research, this may suggest that stress management interventions adopting exercise should focus on establishing habitual regimens of exercise in employees to reduce stress, or that maintaining a habitual exercise regimen should be the focus for employees during periods of stress. Furthermore, if replicated, this finding may also suggest that no matter what level of exercise an individual is at, maintenance of typical exercise levels may be most important for stress reduction. The finding that high levels of within-person variation in exercise was related to higher levels of exam stress over time therefore, provides a significant basis for future research analysing exercise and stress management. As such, future research is needed in order to confirm the current within-person finding and to further investigate the role of habitual versus non-habitual levels of exercise in stress management.

As for the role of outcome expectancy in the relationship between exercise and stress, future research is need in order to determine the nature of the effects of outcome expectancy, and its applicability in enhancing the effectiveness of exercise stress management interventions. Should future studies replicate this result with a greater level of statistical power, and thus reveal significant exercise by outcome expectancy interactions, this results would suggest that organisations implementing exercise interventions for stress management may want to investigate and implement strategies to enhance outcome expectancy beliefs.

Methodological considerations and suggestions for future research

There are several limitations of the current study which warrant attention. Firstly, as has been suggested throughout, the current study yielded a small sample size for both self-reported stress (n = 54), and physiological exam stress analyses (n = 19) which may have contributed to a low level of statistical power. The small sample in the current study is therefore a limitation which may have had a significant impact on the non-significance of the effects investigated in this study. McClelland and Judd (1993) argue that statistical power is much harder to achieve in field research, as compared with true experiments. Therefore, it may be that the field-type nature of the current study could have contributed to the non-significance of the results, and in particular the non-significant interaction effects (McClelland & Judd, 1993). McClelland and Judd (1993) illustrate that moderation effects have been found to be particularly difficult to detect in field research and that this difficulty can be attributed to issues such as measurement error in the independent variables, which field researchers have less control over (McClelland & Judd, 1993). Furthermore, this lack of precision in the measures is amplified when two variables are multiplied (McClelland & Judd, 1993). Therefore, significant results may have been achieved in the current study with a larger sample. As a result, a greater level of statistical power would have created a greater basis for establishing significant trends in the data, including the establishment of relationships between exercise groups over multiple measures of stress, and would also provide a more substantial basis for evaluating the moderator effects of outcome expectancy. Thus, future studies should act to replicate this study with a larger sample in order to enhance statistical power and enhance understanding of the emergent trends revealed in the current results.

Secondly, a severe range restriction in the outcome expectancy variable may have not only contributed to low levels of statistical power, but also may have had a direct bearing on the ability of the current study to uncover a statistically significant interaction effect in the moderation analyses. The variability in the residual component has a direct impact on the statistical power required for detecting a moderator effect, and is itself impacted by the range or variance in the independent variables included in the analysis (McClelland & Judd, 1993). More specifically, greater residual variance makes the moderator easier to detect (McClelland & Judd, 1993). According to McClelland and Judd (1993), the range restriction in the outcome expectancy variable would have been exacerbated when multiplied by exercise for the purposes of the moderation analyses. Outcome expectancy has been linked to engagement in exercise behaviours, and thus the recruitment of participants who are already engaged in exercise was likely the cause of the lack of variance in the outcome expectancy variable. Consequently, future research should act to increase outcome expectancy score range without compromising the strengths of the current study. Therefore, perhaps the recruitment of a control group who do not exercise, and do not have intentions to exercise for the duration of the study, would contribute to greater range in outcome expectancy. Furthermore, there were double the amount of high versus low exercisers in the current study (i.e. 39 High, 15 Low), and thus recruiting more participants who have lower levels of exercise may also expand the range in outcome expectancy.

Thirdly, the baseline period measurement may be a further limitation of the current research. It is quite possible, as indicated by the lack of significant difference between baseline and exam measures of heart rate, that the baseline measure was not representative of participants' typical heart rate fluctuations over a 24 hour period. More specifically the baseline measure of heart rate was conducted during the final week of the university final term, and thus many participants had final assignments and class tests during this week. Therefore, it is likely that participants were under greater pressure than they would generally be in a typical week, which may have had a significant impact on the stress levels experienced. As such, future research should attempt to measure baseline heart rate during a time in the academic year in which students are not placed under additional stress (e.g. during the holiday period or during the start of the academic year). Additionally, perhaps future studies should also record and account for participants resting heart rates, particularly as participants as at physical rest during the exams.

Fourthly, while the current study adopted multiple methods of assessing exam stress, the assessment of exam stress and exercise behaviours via self-report measures may have been a limitation of the current study. Self-report measures can be prone to a variety of biases such as over-reporting of attributes or behaviours that are considered socially desirable, and which have an impact on the accuracy of the data collected (Krosnick, 1999). As such the self-report measures of behaviour may have been impacted by socially desirable responding, particularly as overestimation of physical activity levels has been found to be common with self-report (van de Mortel, 2008). The methodology of the current study however, implemented several aspects which would have enhanced the reliability of the data collected via self-report. For example, multiple measures of exam stress were collected and were also lagged in time which contributed to greater ability to detect causal relationships (Razavi, 2001). Not only this, the high correlations found between the self-reported stress measures and heart rate index of physiological exam stress add to confidence in the current self-report measures as valid measures of exam stress. Furthermore, the Exercise Behaviours Questionnaire, designed for the purpose of this study, asked participants to report the activity, intensity, duration, and frequency of the exercise performed on each day over the week. The requirement of participants to report these specific details of exercise behaviours have been reported to enhance the reliability and accuracy of the exercise reported (Gerber et al., 2010). Therefore, while self-report measures were utilised in the current study, the reliability of the data obtained from these measures were enhanced by lagging the measures in time and asking participants to report specific details of exercise behaviours.

Furthermore, the use of university students and academic exams for investigation of the current research questions may be a limitation for the applicability of the trends established in this study. Despite the analysis of fluctuations in stress and exercise behaviours in response to a naturally occurring stressor, the patterns of exercise behaviours and the levels of stress experienced by the University of Canterbury students in this study may not be reflective of those experienced by the typical adult employed population. Therefore, this field study could be replicated in the workplace environment whereby exercise behaviours and stress are assessed in response to a naturally occurring stressor that is experienced by all employees, such as an annual performance appraisal.

In addition, as suggested in the discussion of the first set of research hypotheses, it is recommended that future research record and control for typical or habitual levels of exercise. In particular, it would be beneficial to enquire about participants' typical levels of exercise over at least one month prior to the studies commencement, and establish for how long those participants have been engaged in the typical levels of exercise stated (i.e. < 2 months, < 6 months, < 12 months, or > 12 months). This will help to establish a greater outlook on the role of habitual levels of exercise on the experiencing of stress and whether participants differ from habitual exercise during the period leading up to final academic exams. Furthermore, this will contribute to interpretation of within-person level analyses, particularly if the within-person results of this study are replicated in future studies.

Final conclusions

The present research investigated the relationship between exercise and exam stress, and the role of outcome expectancy as a moderator in the exercise-stress relationship. Significant effects between exercise and stress were limited to findings of a significant relationship between higher within-person exercise and higher self-reported exam stress over time. Furthermore, a marginally significant difference between high and low exercise groups in overall heart rate average over time (a trend highlighting high exercise was related to lower heart rate average on exam day) provides preliminary results for the relationship between exercise and physiological exam stress. These findings provide an important basis for further investigation into the role of habitual and non-habitual levels of exercise on perceived stress reduction and also support the notion that variance in exercise behaviours attributable to intra-individual and inter-individual differences have differing and independent effects on stress outcomes.

Furthermore, the present research found no significant moderation effect of outcome expectancy on the relationship between exercise and both physiological and self-reported exam stress. This finding however could be attributed to limited statistical power as the result of a small sample size and restriction of range in the outcome expectancy variable. Therefore, despite a lack of significant results, this study provides a noteworthy basis for investigating the role that outcome expectancy may have in enhancing the effectiveness of exercise for stress management. Furthermore, this study illustrates the potential that exercise has for managing stress.

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Appendix A

EXAM STRESS AND EXERCISE BEHAVIOURS STUDY

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

$5 Café 101 Voucher and a chance to win a $100 Westfield Shopping Voucher

⇒DO YOU TYPICALLY EXERCISE AT LEAST ONCE A WEEK?

⇒DO YOU HAVE A MORNING FINAL EXAM?

If so, we need you!

You will be required to complete four short online questionnaires and one text questionnaire over 4 weeks leading up to exams

20 people will also be randomly selected to wear a heart rate monitor for two 24 hour periods, one period including your first morning end of year exam

This study has been reviewed and approved by the UC Human Ethics Committee.

If you are interested or want to know more please email Charlotte at clb86@uclive.ac.nz

Exam stress & Exercise behaviours study
Email: Clb86@uclive.ac.nz
Or call into Room 435 Psychology Building

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Appendix B

Do you exercise at least once a week? If so, we need you!

Hello, my name is Charlotte Bowe and I am currently studying towards a Master's of Science in Applied Psychology at the University of Canterbury. As part of my studies I am required to complete a year-long dissertation.

I invite you to participate in my research project, which is investigating **exam stress and exercise behaviours**. To investigate this I am currently seeking **students who have a morning end of year exam and who typically exercise at least once per week** (where exercise is classified as planned and purposeful physical activity with the intention of improving or maintaining some form of fitness, e.g. health- or skill-related). If you fit these criteria and are 18 years or older, I would really appreciate your time to complete this study.

This study will require participants to complete **four short online questionnaires** and **one question via text messaging** across the four weeks leading up to the end of year exam period. The first questionnaire will take approximately 20 minutes and require you to meet with the researcher to complete. The Time 2 to Time 4 questionnaires will take approximately 10 minutes to complete and will require you to follow the link that you will be emailed to you. The text-message questionnaire will be sent to you via a text message 90 minutes before your first end of year morning exam, and will require you to text back your answer to the question on receiving this message. Additionally, after completion of the first questionnaire, 20 participants will be randomly selected to complete physiological stress measures by wearing a heart rate monitor for two 24-hour periods (in week 2 of the study and on the day that includes your first end of year morning exam in week 4 of the study). This study will take a total of approximately 1 hour of your time over 4 weeks, as well as 48 hours wearing a heart rate monitor for those 20 participants that are randomly selected to complete these measures. The study will run in the four weeks leading up to the end of year study period, and thus week 1 of the **study will commence on the 3rd of October 2011**.

At the end of the study, as a small token of appreciation for participation in and commitment to this study, you will receive a $5 **Cafe101 voucher** and will be entered into the **draw to win a $100 Westfield shopping voucher**. In addition, you will also receive feedback of the study's general results.

All of the data collected in this study will be kept confidential to the researchers (Charlotte Bowe and her supervisors Dr. Katharina Naswall, Dr. Christopher Burt, and Dr. Nick Draper).

You may withdraw from the study at any point, and this includes withdrawal of any data you have already provided prior to withdrawal.

This study has been review and approved by the Human Ethics Committee.

If you would like to participate in my research, please email me at: clb86@uclive.ac.nz with your name and email address. I will then organise a meeting with you to brief you on the study and for you to complete the first online questionnaire.

Thank you for your time, and I would really appreciate your participation. Please do not hesitate to contact me if you have any questions.

Kind regards, Charlotte Bowe

Appendix C

CONSENT FORM

College of Science
Department of Psychology
Email: charlotte.bowe@pg.canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Exam stress and exercise behaviours

I have read and understood the description of the above-named project. On this basis I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. As part of this consent I understand the following conditions (please initial next to each statement):

I understand that I may at any time withdraw from the project, including withdrawal of any information I have provided.

I understand that my involvement in this study will require completion of four short online (one each week leading up to exams) and response to one question via text messaging 90 minutes prior to my first morning final exam.

I understand that I could be randomly selected to wear a heart rate monitor for two 24 hour periods, once in week two of the study and once in week four of the study and on the day including my first morning final exam.

I understand that in participating in this study there are risks of increased feelings of stress as participation requires me to pay conscious attention to my current stress states when completing questionnaires.

I understand that complete confidentiality of the data gathered and personal details provided is assured and that the data will remain anonymous in publication of the results. Furthermore, I understand that any identifying data will not be stored alongside the data that I provide in this study.

I note that the project has been reviewed **and approved** by the University of Canterbury Human Ethics Committee.

NAME (please print): …………………………………………………………….

Signature:

Date:

Appendix D

Exercise Behaviours Questionnaire

Please indicate below, all of the exercise activities that you have been engaged in over the last week. Keeping in mind that exercise:

> *"…is physical activity that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective." (Caspersen, Powell & Christensen, 1985, p. 128)*

In the ***Activity*** column please state all of the physical exercise activities (e.g. running) that you have completed in that particular day. Please exclude any incidental physical activity or physical leisure that you engaged in on these days (e.g. any physical activity that is not conducted with the purpose of improving some form of fitness, be it health or skill related, such as gardening or household chores).

In the ***Description*** column please describe the intensity of the activity/activities completed on a given day (e.g. slow run/fast run).

In the ***Duration*** column please state the length of time (in minutes) that you engaged in each specific activity.

If no exercise was completed on a particular day then please leave the table for that day blank.

EXAMPLE:	**ACTIVITY**					
MONDAY	**1**	**2**	**3**	**4**	**5**	**Additional**
Activity	Run	Weights	Walk			
Description	Fast	Moderate effort	Slow			
Duration	30 minutes	20 minutes	15 minutes			

	Activity					
MONDAY	**1**	**2**	**3**	**4**	**5**	**Additional activities**
Activity						
Description						
Duration						

	Activity					
TUESDAY	**1**	**2**	**3**	**4**	**5**	**Additional activities**
Activity						
Description						
Duration						

	Activity					
WEDNESDAY	1	2	3	4	5	Additional activities
Activity						
Description						
Duration						

	Activity					
THURSDAY	1	2	3	4	5	Additional activities
Activity						
Description						
Duration						

	Activity					
FRIDAY	1	2	3	4	5	Additional activities
Activity						
Description						
Duration						

	Activity					
SATURDAY	1	2	3	4	5	Additional activities
Activity						
Description						
Duration						

	Activity					
SUNDAY	1	2	3	4	5	Additional activities
Activity						
Description						
Duration						

Appendix E

INFORMATION SHEET

You are invited to take part in this research project which is being conducted by Charlotte Bowe as part of the requirements for her M.Sc. in Applied Psychology at the University of Canterbury. Charlotte is being supervised by Dr. Katharina Naswall, Dr. Christopher Burt and Dr. Nick Draper.

The aim of this study is to investigate the effect of exercise behaviours on exam stress.

Your involvement in this project will be the completion of four short online questionnaires (one per week, leading up to your first morning end of year exam) and one questionnaire via text messaging. You will be required to meet with the researcher to complete the first online questionnaire, which will take approximately 20-30minutes. The remaining three online questionnaires will take approximately 5 -10 minutes to complete and a link to the questionnaire will be emailed to you each week. The last questionnaire will be sent to you via text message 90 minutes before your first end of year morning exam, and will require you to text your answer back to the question as soon as possible.

Throughout this study your data will be tracked using a code (that you will be required to create) so that your data cannot readily be identified as yours. You will be required to enter this code on each of the questionnaires that you complete. The code will be made up of the first two letters of your mothers first name and the last 3 digits of your cellphone number (e.g. Mary, 027 1122334, code = MA334).

Additionally, 20 participants will be randomly selected to complete physiological stress measures by wearing a heart rate monitor for two 24-hour periods. The first period will be in week two of the study (10^{th} – 16^{th} October on the same day that your first morning exam is on), and the other period will be the 24hours that include your first morning end of year exam. On both occasions, this will require meeting with the researcher to receive the heart rate monitors and return them also. The participants will meet with the researcher at the University of Canterbury, at times most suitable to the participant and researcher. There will however be a group session scheduled to receive the heart rate monitors and instructions on their use on the first occasion, which participants will be required to attend. The 20 participants who are randomly selected to wear the heart rate monitors will be notified by Wednesday 5^{th} October and the information session will be scheduled for Friday 7^{th} October, with the time to be confirmed. You must be a minimum of 18 years old to participate in this study.

As a small token of appreciation for your participation, when you have completed the final phase of the study (text answer is received) you will be sent a $5 Café101 voucher and be entered into the draw to win a $100 Westfield Shopping Voucher. The winner of the $100 Westfield Shopping voucher will receive this in the mail along with their Cafe101 voucher. In addition, within the two weeks after completion of the study you will be sent a general summary of the results of the study via email. For these reasons, you will be asked to provide personal details of your postal and email addresses, and cell phone number. These details however will not be stored alongside your questionnaire data, and will remain confidential to the researchers.

You have the right to withdraw your participation at any time, including any data that you have already provided in the study.

In the performance of the tasks and application of the procedures, there are risks of increased feelings of stress as participation requires you to pay conscious attention to your current stress states, which may be distressing for some people. If at any point throughout this study you have concerns about stress or any stress related problem a GP or counsellor can be contacted at the Student Health Centre at the University of Canterbury on 03 36402402 or LifeLine New Zealand can be contacted for free on 0800 534 354.

The results of the project may be published, but you can be assured of the complete confidentiality of data gathered in this study. Additionally, your data will remain anonymous in publication of the results. Although the study requires you to provide a postal address, please note that this is only to post the Cafe101 voucher and Westfield Shopping voucher (should you win the draw) and the address list will be stored separately from the data files. Additionally, contact details such as email and cell phone numbers will not be stored alongside the data gathered and will be kept strictly confidential. To ensure confidentiality, the researchers will be the only people who will have access to the information collected.

Charlotte Bowe can be contacted at clb86@uclive.ac.nz and is happy to discuss any concerns you may have about participation in this study. Additionally, you may contact Charlotte's primary supervisor, Dr. Katharina Naswall on katharina.naswall@canterbury.ac.nz. Your participation and commitment to this study is very much appreciated, and the researchers thank you.

This study has been reviewed and approved by the University of Canterbury Human Ethics Committee.

Appendix F

INFORMATION SHEET (Heart Rate Sample)

You have been randomly selected to complete the physiological stress measurement component in the study e*xam stress and exercise behaviours*. This study is being conducted by Charlotte Bowe as a part of the requirements for her M. Sc. in Applied Psychology at the University of Canterbury, and under the supervision of Dr. Katharina Naswall, Dr. Christopher Burt and Dr. Nick Draper.

Your involvement in the physiological stress measurement component will require you to wear a heart rate monitor on two occasions: once in week two of the study (10^{th}-16^{th} October 2011 on the same day that your first morning end of year exam will occur), and again on the day of your first end of year morning exam. You will be required to wear the heart rate monitor for 24 hours on these two occasions which will require you to **fit the heart rate monitor at 6 pm the night before** the day you exam will occur (e.g. if your exam is on Monday morning the heart rate monitor will be fitted at 6 pm on Sunday evening). You will receive a text to remind you to fit the heart rate monitor. You will also be required to record your general activities (e.g. exercise, sleep) throughout the 24 hour period of wearing the monitor on a diary sheet given to you by the researcher. Before you are able to complete the second heart rate measure, you will be required to bring the heart rate monitor in after the baseline measure to have the data downloaded.

In addition to receiving a Café 101 voucher, you will receive entry into the draw to win a $100 Westfield Shopping voucher and an email reporting the general results of the study.

You have the right to withdraw from the heart rate measure component of the study at any time. You also have the right to withdraw from the entire study, including withdrawal of any of the data you have already provided.

In performance of the tasks and application of the procedures there is risk of heart rate monitor equipment interference with pacemakers, defibrillators or other implanted electronic devices, and therefore completion of this component of the study is not recommended in these instances.

The results of this project may be published, but you may be assured of complete confidentiality of all data gathered in this study and anonymity of the data presented in any publication. To ensure confidentiality, identifying information will be stored securely by the researchers, and the researchers will be the only people who will have access to the information collected.

Charlotte Bowe can be contacted on clb86@uclive.nz or found in Psychology room 435 and is happy to discuss any concerns you may have about participation in this study. Additionally, you may contact Charlotte's primary supervisor, Dr. Katharina Naswall on katharina.naswall@canterbury.ac.nz. Your participation and commitment to this study is very much appreciated, and the researchers thank you.

This study has been reviewed and approved by the University of Canterbury Human Ethics Committee.

INSTRUCTIONS FOR USE OF HEART RATE MONITORS (Polar Heart Rate Monitor Guide)

You will receive one Polar RS400™ Running computer watch and one Polar WearLink® 31 Transmitter and belt that you will be required to wear for the two 24-hour periods.

Fitting the Transmitter belt

1. You will need to dampen the electrode areas of the strap under water and make sure they are well moistened.
2. Attach the connector to the strap. Adjust the strap length to fit snugly and comfortably against the skin. Secure the strap around the chest muscles, and for females make sure the belt is fitted so that it sits just below your bra.
3. Check that the wet electrode areas are firmly against your skin and the Polar logo of the transmitter is in a central, upright position.

Recording Heart Rate

1. Once the Polar WearLink® 31 transmitter belt and Polar watch have been fitted appropriately, press the red OK button on the watch.
2. Within 15 seconds, your heart rate should appear on the display. Stand still and wait until the watch finds the belt transmitter sensor signal (runner symbol stops flashing).
3. To start recording heart rate, press the red OK button. Different displays and data appear on the display. Scroll through the displays by pressing UP or DOWN on the right hand side of the watch until you get to 'stopwatch'. Place the tape provided over the display without covering the OK button.
4. To set a marker (lap time) of when you enter your exam, press the red OK button once. Please press the OK button again when you exit your exam to mark the end of your exam. (You will need to hold down the LIGHT button to unlock the watch first)
5. To stop heart rate recording after 24 hours has passed, press the STOP button **twice**.
6. Remove the transmitter belt and watch, and disconnect the connector from the strap. Store in a cool dry place.
7. To unlock the watch display hold down the LIGHT button.

Precautions

1. *Electromagnetic interference and exercise equipment:* please note that disturbance may occur near high-voltage power lines, traffic lights, televisions, car motors, bike computers, some motor-driven exercise equipment, cellular phones, or when you walk through electric security gates. Microwave ovens, computers and WLAN base stations may also cause interference when wearing the RS400. To avoid erratic readings, move away from possible sources of disturbance.
2. *Water resistance*: The heart rate devices are 30m water resistance and can be worn when bathing/showering. The heart rate devices may also be worn when swimming. It is not however, a diving instrument. To maintain water resistance, do not press the buttons of the running computer watch under water. When measuring heart rate in water, you may experience interference.
3. *If you lose your heart rate reading*, remove the transmitter belt and refit according to the *fitting the Transmitter belt* instructions above.
4. *Storing the heart rate equipment whilst not in use:* do not store the transmitter belt wet, and make sure that the connector/transmitter is removed from the belt so as to preserve battery power.

If you have any questions about the heart rate monitors or any component of the heart rate measure, feel free to contact Charlotte Bowe at clb86@uclive.nz or in Room 435.

(Polar Electro OY, 2006)

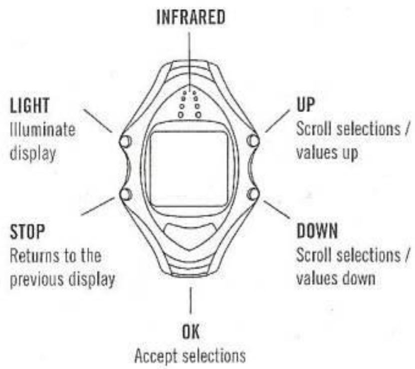
2. GETTING STARTED

Basic Settings

Before exercising with your running computer, customize the basic settings. Enter as accurate data as possible to ensure correct performance feedback based on your personal metrics.

To adjust the data, use UP, DOWN and accept with OK. The values scroll faster if you press and hold UP or DOWN.

1. To activate your running computer, press OK twice.
2. **Welcome to Polar Running World!** is displayed. Press OK.
3. **Language**: Select **English**, **Deutsch**, **Español** or **Français**.



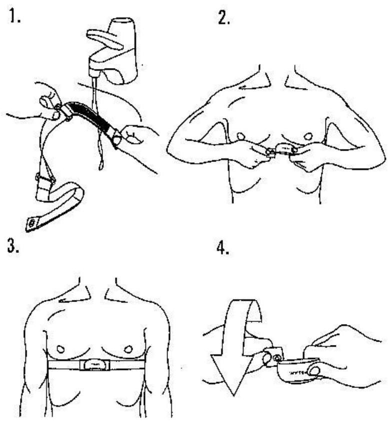
4. **Start with basic settings** is displayed. Press OK.
5. **Time**: Select either **12h** or **24h**. With **12h**, select **AM** or **PM**. Set the local time.
6. **Date**: Set today's date, dd=day, mm=month, yy=year.
7. **Units**: Select metric (kg/cm/km) or imperial (lb/ft/mi) units.
8. **Weight**: Enter your weight. To change units, press and hold LIGHT.
9. **Height**: Enter your height. If you use imperial units, first set feet (ft) then inches (in).
10. **Birthday**: Enter your date of birth, dd=day, mm=month, yy=year.
11. **Sex**: Select **Male** or **Female**.
12. **Settings OK?** is displayed. Select **Yes**: Settings are accepted and saved. The running computer displays time of day. Select **No** if settings are incorrect and need to be changed. Press STOP to return to the data you want to change.

3. PREPARE FOR TRAINING

Wear the Transmitter

Wear the transmitter to measure heart rate.

1. Moisten the electrode areas of the strap under running water and make sure that they are well moistened.
2. Attach the connector to the strap. Position the connector's letter L to the word LEFT on the strap and snap the fastener. Adjust the strap length to fit snugly and comfortably. Secure the strap around your chest, just below the chest muscles, and snap the second fastener.
3. Check that the wet electrode areas are firmly against your skin and that the Polar logo of the connector is in a central, upright position.
4. To detach the connector from the strap, apply pressure with your thumb and forefinger and turn your hand as indicated in the picture.



4. RECORD TRAINING

Wear the transmitter and foot pod/stride sensor* as instructed. Make sure the S1 foot pod is on (RS400) and that the foot pod or stride sensor in your running computer (**Settings > Features > Footpod / S sensor**) is activated.

1. Start by pressing OK on the running computer.
2. Within 15 seconds, your heart rate appears on the display. Stand still and wait until the running computer finds the foot pod/stride sensor signal (runner symbol stops flashing).
3. Start exercise recording by pressing OK. Different displays and data appear on the display. Scroll the displays by pressing UP or DOWN.
4. Stop exercise recording by pressing STOP twice. For further information on functions during exercise, see the User Manual.

*Optional S1 foot pod/s3 stride sensor W.I.N.D. required.

Appendix G

INFORMATION SHEET (Heart Rate Sample)

You have been randomly selected to complete the physiological stress measurement component in the study e*xam stress and exercise behaviours*. This study is being conducted by Charlotte Bowe as a part of the requirements for her M. Sc. in Applied Psychology at the University of Canterbury, and under the supervision of Dr. Katharina Naswall, Dr. Christopher Burt and Dr. Nick Draper.

Your involvement in the physiological stress measurement component will require you to wear a heart rate monitor on two occasions: once in week two of the study (10^{th}-16^{th} October 2011 on the same day that your first morning end of year exam will occur), and again on the day of your first end of year morning exam. You will be required to wear the heart rate monitor for 24 hours on these two occasions which will require you to **fit the heart rate monitor at 6 pm the night before** the day you exam will occur (e.g. if your exam is on Monday morning the heart rate monitor will be fitted at 6 pm on Sunday evening). You will receive a text to remind you to fit the heart rate monitor. You will also be required to record your general activities (e.g. exercise, sleep) throughout the 24 hour period of wearing the monitor on a diary sheet given to you by the researcher. Before you are able to complete the second heart rate measure, you will be required to bring the heart rate monitor in after the baseline measure to have the data downloaded.

In addition to receiving a Café 101 voucher, you will receive entry into the draw to win a $100 Westfield Shopping voucher and an email reporting the general results of the study.

You have the right to withdraw from the heart rate measure component of the study at any time. You also have the right to withdraw from the entire study, including withdrawal of any of the data you have already provided.

In performance of the tasks and application of the procedures there is risk of heart rate monitor equipment interference with pacemakers, defibrillators or other implanted electronic devices, and therefore completion of this component of the study is not recommended in these instances.

The results of this project may be published, but you may be assured of complete confidentiality of all data gathered in this study and anonymity of the data presented in any publication. To ensure confidentiality, identifying information will be stored securely by the researchers, and the researchers will be the only people who will have access to the information collected.

Charlotte Bowe can be contacted on clb86@uclive.nz or found in Psychology room 435 and is happy to discuss any concerns you may have about participation in this study. Additionally, you may contact Charlotte's primary supervisor, Dr. Katharina Naswall on katharina.naswall@canterbury.ac.nz. Your participation and commitment to this study is very much appreciated, and the researchers thank you.

This study has been reviewed and approved by the University of Canterbury Human Ethics Committee.

INSTRUCTIONS FOR USE OF HEART RATE MONITORS (Polar Heart Rate Monitor Guide)

You will receive one Polar S610™ Running computer watch and one Polar Electro OY Transmitter belt that you will be required to wear for the two 24-hour periods.

Fitting the Transmitter belt
1. Attach the transmitter to the elastic strap.
2. Adjust the strap length to fit snugly and comfortably. Secure the strap around your chest, just below the chest muscles, and buckle it.
3. Lift the transmitter off your chest and **moisten the grooved electrode areas** on the back.
4. Check that the wet electrode areas are firmly against your skin and the Polar logo is in a central, upright position.

Measuring Heart Rate
1. Once the Polar Electro OY transmitter belt and Polar watch have been fitted appropriately, press the red OK button on the watch to start measuring your heart rate.
2. A heart symbol will start flashing and your heart rate (beats per minute) will appear in a maximum of 15 seconds.
3. To start recording heart rate, press the red OK again. The stopwatch starts running and will start to record your heart rate data.

To set a lap time when you enter the exam
1. Press the red OK button **once** immediately before you enter the exam.
2. Press the red OK button **once** again when you have exited the exam.

How to Stop Measuring Your Heart Rate after 24 hours
1. Press the STOP (□) button **twice**. The heart rate measuring stops and the receiver shows the Time of Day display again.
2. Remove the transmitter and watch and store in a cool **dry** place.

Precautions

1. *Electromagnetic interference and exercise equipment:* please note that disturbance may occur near high-voltage power lines, traffic lights, televisions, car motors, bike computers, some motor-driven exercise equipment, cellular phones, or when you walk through electric security gates. Microwave ovens, computers and WLAN base stations may also cause interference when wearing the RS400. To avoid erratic readings, move away from possible sources of disturbance.
2. *Water resistance*: The heart rate devices are water resistant but **are not waterproof**. Therefore, the heart rate device **cannot be submerged in water**, and thus cannot be worn when swimming or showering. In these instances please remove the heart rate monitor immediately before you swim/bathe and refit the monitor according to the instructions as soon as possible afterwards. Additionally, please note down this removal on the diary sheet provided.
3. *If you lose your heart rate reading*, remove the transmitter belt and refit according to the *fitting the Transmitter belt* instructions above.
4. *Storing the heart rate equipment whilst not in use:* do not store the transmitter belt wet – store in a cool dry place.

If you have any questions about the heart rate monitors or any component of the heart rate measure, feel free to contact Charlotte Bowe at clb86@uclive.nz

Appendix H

Study Debriefing:

Exam stress and exercise behaviours

Thank you for taking part in this study.

The study aims to investigate the causal relationship between exercise and stress, and to better understand this relationship by taking into account expectations about the role of exercise to reduce stress. In particular we are interested in determining the role of outcome expectancy in relation to the exercise-stress relationship, so as to inform effectiveness of exercise interventions implemented in organisations for stress management. This aim of the study was not disclosed to participants before and throughout the study as we believe that this may have had an impact on the responses given on the other questionnaires (without realising it), and as a consequence, result in failure to give a true depiction of the outcomes.

Previous research has shown that individuals who exercise tend to be more resilient when facing stressors compared to those who exercise less frequently or not at all (Salmon, 2001). Additionally, outcome expectancy beliefs have been found to have a significant moderating impact on the relationship between behaviours and their outcomes (Bandura, 1998). However, no research to date has investigated whether outcome expectancy about the exercise-stress relationship has an impact on the stress reducing benefits exercise has been found to produce. For the current study, it is predicted that exercise will have a negative relationship with stress (stress levels will decrease as exercise frequency increases) and that those who hold more positive outcome expectancies of the exercise-stress relationship, will exhibit an even stronger negative relationship between exercise behaviour and stress state levels (experience a greater stress reducing effect from exercise than those with less positive outcome expectations).

This study required each participant to reflect on and report their perceived stress states, and therefore it is possible that such self-reflection may lead to distress for some individuals. If you have any concerns that you may be experiencing stress or want to discuss a stress related problem then a GP or counsellor at the Student Health Centre at the University of Canterbury can be contacted on 03 364 2402 or LifeLine New Zealand can be contacted for free on 0800 534 354.

All information collected in this study will remain confidential, and the data will be stored securely at all times. You can also be assured of complete confidentiality and anonymity in publication of the data collected in this study. For further questions or for a PDF copy of the dissertation when it is complete please contact Charlotte Bowe on charlotte.bowe@pg.canterbury.ac.nz.

Please find enclosed with this debrief sheet, your Cafe101 Voucher. You have also been entered into the draw to win a $100 Westfield Mall Voucher which will be drawn at the end of the study. You will be notified and posted the voucher if you are the lucky winner of the Westfield Voucher.