AN EXAMINATION OF THE PSYCHOLOGICAL INFLUENCES ON CHANGES IN CARDIO-RESPIRATORY FITNESS

by

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Abstract

Low levels of cardio-respiratory fitness represent a major health risk. Few studies have investigated the possible contribution of psychological determinants to cardio-respiratory fitness, with none longitudinally. The purpose of the present thesis was to explore the cognitive and behavioural correlates of adults' cardio-respiratory fitness using theoretical constructs forwarded in Self-Determination Theory (SDT; Deci & Ryan, 2000) and the Theory of Planned Behaviour (TPB; Azjen, 1991).

Studies 1 and 3 tested potential contributions of the Self Determination Theory cognitions of autonomous (intrinsic and identified) and controlled (introjected and external) motivations, including amotivation, to cardio-respiratory fitness over 9 weeks and 3 years. Studies 2 and 4 tested potential contributions from the Theory of Planned Behaviour constructs of intention, attitude, subjective norm and perceived behavioural control to cardio-respiratory fitness over the same time period. Analysis from structural equation modelling revealed only intrinsic motivation and affective attitude, constructs from the SDT and TPB respectively, contributed to changes in fitness.

Collectively, the four studies suggest that intrinsic motivation and affective attitude are of major importance to cardio-respiratory fitness, even when individuals may have prominent controlled reasons for participating in exercise. The findings provide a foundation for theoretically aligned future research investigating the psychosocial antecedents of exercise with a view to developing more effective theory driven lifestyle interventions directed at enhancing this important health outcome.

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Finally I would like to dedicate my thesis to the ‘beautiful bump’ which gave me the inspiration to complete!

Contents Listing

Table of contents Page

Table of contents continued Page

Table of contents continued Page

List of figures Page

List of tables Page

List of appendices Page

List of papers

The following four empirical papers form the basis of this thesis:

Reay, A. S., Eves, F. F., Ntoumanis, N., Treweek, A. J., & White M. Contributions of Self-Determination Theory Variables to Cardio-respiratory Fitness Before and After a 9-Week Fitness Course. *Submitted*.

Reay, A. S., Eves, F. F., Ntoumanis, N., Treweek, A. J., & White M. Contributions of the Theory of Planned Behavior Variables to Cardio-respiratory Fitness Before and After a 9-Week Fitness Course. *Submitted*.

Reay, A. S., Eves, F. F., Ntoumanis, N., Treweek, A. J., & White M. Prediction of Cardio-respiratory Fitness with Self-Determination Theory Variables over a 3-Year Period.

Reay, A. S., Eves, F. F., Ntoumanis, N., Treweek, A. J., & White M. Prediction of Cardio-respiratory Fitness with Theory of Planned Behavior Variables over a 3-Year Period.

CHAPTER 1

Introduction

Background

Four empirical chapters (i.e., Chapters 2, 3, 4 and 5) are presented as individual empirical papers within this thesis. As such, the introduction sections of these chapters present a review of evidence pertinent to the specific research question of the investigation. Chapter 1 provides an overview of the conceptual and theoretical underpinnings that inform the research objectives of the four empirical studies. In summary, the research objective is overarching within all four empirical chapters, and is based on four assertions.

Firstly, low levels of physical activity, at levels sufficient to be health enhancing, are common place in UK and other western populations (Hallal et al., 2012). As such, this chapter will begin by analysing current trends in physical activity participation and the benefits of a physically active lifestyle.

Secondly, physical activity (the behaviour) is the only way of positively changing cardio-respiratory fitness (the outcome) which is known to be a major determinant of health. Perseverance with exercise therefore represents the only way of maintaining fitness levels, and changes to this physiological attribute over time are of major importance to public health. As such, this chapter will review current evidence linking physical activity and fitness to good health, and conversely, low physical activity and fitness to premature morbidity and mortality.

Thirdly, cardio-respiratory fitness is highly dependent upon a number of factors, with only one such factor being the maintenance of physical activity. One particular limitation of extant literature is the failure of investigations to test for *changes* in fitness. The physiological and environmental contributors to changing

fitness levels therefore need to be delineated. An overview of the role of physical fitness within the population under investigation, serving members of the Royal Air Force, will also be provided. Personnel serving in today's armed forces neatly echo both the public health drive (the importance of fitness to this organisation is absolute) and the activity and fitness conundrum (fitness testing is mandatory once per year providing standardised indicators of activity). In summary, cardio-respiratory fitness is an important component of general service life, and the only way to meet the fitness standard it to exercise regularly.

Finally, information about potential psychological determinants can only be explored fully through theoretical models that will enable a complete examination of the cognitive and behavioural determinants of exercise and cardio-respiratory fitness. As the cornerstone of the present thesis, a comprehensive overview of the theoretical framework and constructs forwarded from The Theory of Planned Behaviour (TPB; Azjen, 1991) and the Self Determination Theory (SDT; Deci & Ryan, 2000) will be presented, as it is through these psychological constructs that the present thesis is guided.

A Case for Studying Physical Activity in Adults

The World Health Organisation's (WHO) 'Global Strategy on Diet, Physical Activity and Health' emphasises the importance ascribed to active lifestyles in combating the growing global burden of chronic disease (WHO, 2004). Given the important connection between health and physical activity, it is important to begin by defining this concept and other interrelated terms. Health is defined by the World Health Organisation as a state of complete physical, mental and social well-being and not

merely the absence of disease or infirmity (WHO, 2002). This definition was originally developed in 1946 and has subsequently been expanded. The definition provided by Bouchard, Shephard, & Stephens (1994) provides additional clarification when they state that health is a *'human condition with physical, social and psychological dimensions, each characterised on a continuum with positive and negative poles. Positive health is associated with a capacity to enjoy life and to withstand challenges; it is not merely the absence of disease. Negative health is associated with morbidity and, in the extreme, mortality' (p.84).*

In addition to health, physical activity is defined by Caspersen, Powell, & Christenson as encompassing all movement produced by skeletal muscles that confers energy expenditure above rest (1985, p.129). Current physical activity guidelines state that individuals between the ages of 18 and 65 should engage in at least 30 minutes of moderate physical activity on a minimum of five days per week (Department of Health, 2004). The definitions of physical activity and exercise are not synonymous terms, and so to ensure parity, it is important that they are distinguished. Caspersen et al's. (1985) definition appropriately delineates exercise from physical activities of daily living as a '…*sub-component of physical activity that is more planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective*' (p.128).

For the purpose of the present thesis therefore, planned physical activity (exercise) is seen as the behavioural enactment that is sufficiently purposeful to require cognitive processes to deliver changes in behavioural outcomes

Hallal et al. (2012) obtained comparable estimates for physical inactivity in adults (aged 15 years or older) from 122 countries through the WHO global health observatory data repository. Worldwide, 31% of adults were reported to be physically inactive, a figure which increased with age, higher socio-economic status and was found more commonly in women than in men. Consequently, physical inactivity is estimated to cause 6% of global mortality (6% for men and 6.7% for women) and 3% of global morbidity. The scientific consensus suggest these trends bear much and possibly most of the responsibility concerning the pandemic of obesity (Katzmarzyk & Janssen, 2004; Lee, Blair, & Jackson, 1999) with physical inactivity currently representing the fourth leading risk factor for global mortality, ahead of obesity (WHO, 2009). For example, Lee and co-workers (2012) on the basis of a meta-analysis of published studies, derived an estimate of 5.3 million deaths worldwide attributable to physical inactivity, which contrasts with the 4.8 million deaths attributable to smoking in 2000. The authors argue that if patterns of inactivity were decreased by 25%, more than 1.3 million deaths could be averted every year.

Continued updates and renewals to global and national position statements on health related behaviours, is indicative of the '*…increasing concern regarding the adverse changes in morbidity and premature mortality that face many contemporary societies due to inactivity and unhealthy living'* (Biddle & Mutrie, 2001, p.9). As a method of encouraging greater uptake of activity, global campaigns have also promoted more intermittent, moderate intensity physical activity. For example, the Chief Medical Officer published *'At least five a week: evidence on the impact of*

physical activity and its relationship to health' (Department for Health, 2004) which recommended that the volume of activity described earlier could be performed as either a single bout or as a daily accumulation through shorter 10-minute bouts of activity (Department for Health, 2004).

Physical activity levels in the UK also remain exceptionally low, with an estimated cost to the British economy of £8.2 billion per annum and a direct financial cost to the NHS estimated at £900 million (Scarborough et al., 2011). This is not a new phenomenon however, with large scale population surveys from as early as 1986 (General Household Survey) indicating that as few as 33% of men and 20% of women participated in any form of sporting or recreational activity (Office of Population Census & Surveys, 1989). A later study which analysed both activity and fitness trends, the Allied Dunbar National Fitness Survey (ADNFS), also reported similar trends in the proportion of adults (<30% of men and <20% of women) achieving the health benefits associated with physical activity (ADNFS; Sports Council, 1992).

As a result, the British Government introduced its 'Game Plan' strategy (Department of Culture, Media & Sport [DCMS], 2002) to develop a sport and physical activity culture to produce a fitter, more active population and realise the significant health benefits and savings available, and the potential wider social benefits. The national strategy set an objective for 70% of the UK population to meet the recommended activity guidelines by 2020 (DCMS, 2002), including an interim target of 50% by 2011. When the Health Survey for England (2008) assessed activity levels on a large scale more recently, public health statistics are discouraging with only 39% of men and 29% of women (≥16 years) self-reporting levels of physical

activity in accordance with current health guidelines (HSE, 2008). These figures are particularly pertinent given contemporary rises in overweight and obesity (Department for Health, 2004) and the larger volumes of activity required to prevent weight-gain in the absence of reduced energy intake (45-60 minutes of moderate activity at least five times per week), and for those who have lost weight and want to maintain a healthy weight (60-90 minutes of moderate activity at least five times per week).

Paradoxically, the health benefits associated with a physically activity lifestyle are undeniable (ACSM, 2006) and benefit not just at the individual level (e.g., reduced likelihood of coronary heart disease, type 2 diabetes, obesity, and certain cancers) but also at the organisational and societal level (e.g., increased work productivity; decreased absenteeism; reduced health care costs). In the case of the air force, not only will personnel who remain physically fit reap the reported health protective benefits associated with regular exercise, yet aerobically trained individuals, compared with untrained individuals, are significantly more likely to navigate basic training successfully and without injury (Nicholls, 1998).

Extensive epidemiological evidence consistently demonstrates a steep, inverse and curvilinear relationship between physical activity and important health outcomes (Morris et al. 1953; Paffenbarger & Hale, 1975; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Paffenbarger et al., 1993). This relationship can be summarised in the form of dose-response curve - the greatest health benefits are associated with a given increase in physical activity as one moves from low through to higher levels of activity.

Whilst exercise participation is predicted to yield many benefits for both physical and psychological health, the literature presented thus far has only dealt with the issue of 'quantity', rather than the 'quality' of behavioural engagement. Increasing participation rates (i.e., increasing the quantity of exercise behaviour) is not the only factor which requires addressing by national health campaigns. Physical activity is also known to be an important determinant of physical fitness (Blair, Cheng, & Holder, 2001). This key physiological health attribute, must also be appropriately maintained for the population under study as the absolute physical demands of a particular role are dictated by extrinsic factors that cannot be altered to account for a reduction in physical performance capability over time. A review of fitness, its components and a review of extant literature now follows.

A Case for Studying Physical Fitness in Adults

When defining fitness, there is no universal definition for both the concept and its subsequent components. The WHO (1968) defines fitness as *'…the ability to perform muscular work satisfactorily'.* However, physical fitness (or performance related fitness) however, is referred to by Caspersen et al. (1985) as *'….a person's ability to perform physical activity'.* The present thesis is solely interested in one component of physical fitness, health-related fitness, i.e. in the physical and physiological components that impact more directly on health status.

Health-related fitness is referred to by Pate (1995) as *'…those components of fitness that are affected favorably or unfavorably by habitual physical activity and relate to health status. It is characterised by (a) an ability to perform daily activities*

with vigor and (b) demonstration of traits and capacities that are associated with a low risk of premature development of hypokinetic diseases and conditions'. Within the context of each empirical chapter, potential psychological determinants of cardio-respiratory fitness are investigated.

Cardio-respiratory fitness, a health related component of physical fitness, is the ability of the circulatory, respiratory and muscular systems to supply oxygen during sustained physical activity. As an objective marker of physical activity, its recognised measure is maximal aerobic power (referred to as $\dot{V}O_{2\,max}$ [ml.Kg^{-1}.min^{-1}]) which is reached when the body can no longer increase the amount of oxygen it uses despite the intensity of exercise increasing. Within each of the empirical chapters presented in this thesis, the population under study, active serving members of the Royal Air Force, must undertake purposeful exercise to maintain a state of physical readiness at all times. The definition of exercise referred to earlier by Caspersen et al. (1985), therefore seems indicative of the importance currently placed on this purposeful behaviour in today's expeditionary air force given that *'…improvement or maintenance of one or more components of physical fitness is an objective'.*

The Physical Activity and Fitness Connection

Physical activity represents the only way to change fitness (Blair et al., 2001). Whilst more vigorous forms of exercise confer the greater fitness benefits than those conducted at moderate intensities (Blair et al., 2001), moderate intensity exercise is known to improve cardio-respiratory fitness at intensities of 40-55% peak VO_2 (Church, Earnest, Skinner, & Blair, 2007). Further, a systematic review confirmed no

differences in cardio-respiratory fitness between accumulated bouts (i.e. 10 minute sessions) or continuous bouts of exercise (>10 minutes; Murphy, Blair, & Murtagh, 2009). These are important findings as physical activity is more likely to be maintained when it is undertaken in smaller bouts (Murphy et al., 2009).

A steep, inverse and curvilinear relationship exists between cardio-respiratory fitness and a reduction in risk of early onset morbidity and all-cause mortality (Blair et al., 1989; 1995; Lee & Skerritt, 2001; Kodama et al., 2009). One of the first studies to demonstrate this association was the Aerobics Centre Longitudinal Study (Blair et al. 1989), which reported magnitudes of risk on mortality from low cardio-respiratory fitness (Relative Risk (RR) = 1.52) as being greater than the relative risks from high blood pressure (RR = 1.30), high cholesterol (RR = 1.34), high blood sugars (RR = 1.24) and being overweight (RR = 1.02; Blair et al., 1996). An adequate level of cardio-respiratory fitness is also known to be protective against conditions associated with above average body mass index. For example, lean but unfit men were reported to be at higher risk of cardiovascular disease and premature mortality than obese men who were fit (Blair & Church, 2004; Lee, Blair, & Jackson., 1999).

However, associations are even more striking when changes in fitness are monitored (Blair et al., 1995), with risk reductions from cardiovascular disease events (44%) and premature mortality (53%) reported in participants unfit at baseline yet at least moderately fit on follow up. A review of 33 studies reveal similar estimated effects by reporting that for every one metabolic equivalent (MET) increment in cardio-respiratory fitness, (i.e. each increase in oxygen consumption of 3.5 $ml.Kg^{-1}.min^{-1}$), resulted in a 13% and 15% risk reduction from all-cause mortality and cardiovascular disease events respectively (Kodama et al., 2009).

Collectively, these studies not only provide substantial evidence for a cause and effect relationship between physical activity, planned activity (exercise) and important health outcomes through positive changes in cardio-respiratory fitness, yet it suggests that measuring objective outcomes of behaviour (fitness), not the behaviour itself (physical activity) may be a more accurate determinant of health.

Although chapters 2 to 5 of the present thesis comprise a logical series of original research studies in the format of submitted manuscripts, including a review of the methodology undertaken, it is important to expand upon certain methodological considerations relating to the measurement of behaviour which transcend all empirical chapters. The Health Survey for England (2008) was the first large scale population survey to measure physical activity with both self-report (questionnaire) and objective (accelerometry) measures. Objectively derived physical activity levels fell sharply to 6% (from 39%) for men and to 4% (from 29%) for women when compared with self-reported estimates. This suggests that current health promotion campaigns are not only failing at a national scale based on activity patterns previously reported, yet the methods that are often utlised to elicit activity patterns (self-report measures) may also be over estimating true levels of activity (Troiano et al., 2008). Although being the most practical and cost-effective way of measuring physical activity, significant limitations of self-report estimates relate to issues of recall (participants may experience difficulty in recalling all activities which could lead to either under or over reporting), social desirability bias (participants may overestimate their levels of activity to provide socially desirable answers), and lack of objectivity (individuals' assessment of the duration and intensity of physical activity may be inaccurate).

There are also indications that measures of cardio-respiratory fitness may show more discrimination than measures of physical activity on health outcomes. Studies that have measured physical fitness have found a larger reduction in cardiovascular and all-cause mortality as fitness levels increased, compared with studies using self-reported activity levels. For example, in a study by Lee, Artero, Sui, & Blair (2010), men and women self-reporting recommended levels of activity, were found to have a 13% and 17% lower risk of premature mortality respectively, compared to inactive individuals. However, when measured objectively through estimates of cardio-respiratory fitness, risk reductions increased significantly to 36% and 39% respectively. A systematic review of 187 articles which ascribed comparable data for objective versus self-report measures used within studies found that correlations between self-report and direct measures of physical activity were generally low-to-moderate (Prince et al., 2008). For public health therefore, objective data appears to be important as it will account for physiological (age, gender) and environmental (genetics) contributions, excluded through physical activity data alone.

Contributors to Cardio-Respiratory Fitness

Blair et al. (1989) was the first study to identify the protective, asymptotic level of cardio-respiratory fitness in adults equivalent to an age-adjusted peak score of approximately 10 METs in men ($\dot{V}O_{2\,max}$ of 35 ml.Kg^{-1}.min^{-1}) and 9 METs in women (31.5 ml.Kg^{-1}.min^{-1}). More recently, Kodama et al. (2009) estimated a minimum 'protective' cardio-respiratory fitness level for men and women aged 40 years as 9 METs and 7 METs respectively. Given that cardio-respiratory fitness is highly

dependent upon a number of factors, changes in fitness over time are of particular importance to public health. To put the 'protective' cardio-respiratory fitness levels into perspective, male personnel in the Royal Air Force aged 16-29 must meet a minimum fitness standard of 13.3 METS (46.6 $ml.Kg^{-1}.min^{1}$). Further, male personnel aged 55 years and over are set a minimum standard of 10 METs (35 $ml.Kg^{-1}.min^{-1}$), which is directly related to the protective, asymptotic level of cardio-respiratory fitness in adults reported earlier (Blair et al., 1989). In order to appreciate the rationale for the differences in fitness standards between these age groups, a review of non-modifiable (gender, age and genotype) and modifiable (physical activity) factors now follows.

Firstly, specific morphological and physiological differences between the sexes in terms of size of the cardiac muscle, and subsequent impact on stroke volume, places females at a distinct disadvantage in terms of peak cardio-respiratory fitness. A significantly greater ventricular mass from age 8, greater muscle mass from age 12 and significantly higher hemoglobin content in red blood cells from age 16, result in increased blood flow, increased oxygen extraction capacity, and greater oxygen carrying capacity of the blood in men (Armstrong, 2001). Expressed in absolute terms (litres of oxygen per min [l/min], the difference between males and females is on average 60%. However, this difference is not translated into a 60% performance difference as peak cardio-respiratory fitness is normalized to account for differences in body weight and fat free mass, the generators of locomotive performance (Toth, Goran, Ades, Howard, & Poehlman, 1993). Now expressed relatively in $ml.Kg^{-1}.min^{-1}$, differences between male and female adults are on average 20%, in favor of males.

Secondly, increasing age leads to inadvertent changes in maximal aerobic capacity. A decline in peak physiologic function through reduced oxygen extraction capability of the working muscles is predominantly as a result of the lowering of maximal heart rate and muscle atrophy. Both longitudinal and cross sectional studies verify loss rates in cardio-respiratory fitness of approximately 10% per decade beginning from the age of 25 (Hawkins & Wiswell, 2003; Jackson, Sui, Herbert, Church, & Blair, 2009) although some studies report no losses until age 30 (Plowman, Drinkwater, & Horvath, 1979). Differences in the reduced rate of oxygen extraction capability, as well as in timing, is highly related to differences in occupational or leisure time physical activity, lifestyle and genetic profile, with accelerated decline associated with lower levels of physical activity. In general the rate of decline is greatest in sedentary individuals, with participation in regular vigorous exercise significantly reducing average losses. For example, sedentary individuals have reported losses over twice that of active exercisers, whilst active exercisers have reported losses per decade from as low as 3% to 6% from age 25 years (Bruce, 1984).

Thirdly, as documented in the HERITAGE intervention study, a large proportion of inter-individual differences in health related fitness remains unexplained (Bouchard & Rankinen, 2001). Genetic heritability (Bouchard et al., 1998) is estimated to be in the range of 25% to 40% (Bouchard & Perusse, 1994) with heart size and other cardiac functions influenced heavily by such factors. Not only is there large inter-individual responses to regular exercise but there is also considerable heterogeneity in responsiveness to exercise training, including low to high responders and even non-responders to an exercise programme of the same

frequency, intensity, duration and type of training. Heredity may account for fitness differences as large as 3 to 10 fold when comparing low and high responders who have performed the same physical activity program (Bouchard & Rankinen, 2001).

In the context of non-modifiable determinants of cardio-respiratory fitness, the protective levels of fitness identified by Blair et al. (1995) and Kodama et al. (2009) appear relatively modest and should theoretically be easily accessible to the majority of the population. To determine levels of cardio-respiratory fitness within the UK population, only two studies to date have measured this outcome on a nationally-representative scale. Firstly, the Health Survey for England (2008) tested participants (N=1693) through an indirect estimate of cardio-respiratory fitness (step test), whilst the Allied Dunbar National Fitness Survey (ADNFS; Sports Council 1992) tested participants' (N=1,741) directly using a graded treadmill test. Whilst a direct comparison between the data is therefore not possible, results echo the public health concern over falling physical activity patterns. For example, cardio-respiratory levels in men aged 16-24 reduced significantly over the space of 18 years (55.5 ml ml.Kg^{-1}.min^{-1} in 1990 to 40.9 ml.Kg^{-1}.min^{1} in 2008). When these figures are placed in the context of the asymptotic level of cardio-respiratory fitness (40.9 ml.Kg^{1}.min^{1}) identified by Blair et al. (1989), UK men (<24 years) are, on average, just 6 ml.Kg^{-1}.min^{1} above the recognised marker of increased risk of premature morbidity and mortality. Further, when the declines in cardio-respiratory fitness through increasing age are taken into account (10% per decade for an inactive population), this is a worrying statistic for the UK. Increased levels of fitness are clearly a national priority.

Regarding the modifiable aspects in cardio-respiratory fitness, positive adaptations are highly dependent upon the prescription of exercise (frequency,

intensity, duration and mode of activity), and initial level of fitness. Improvements in cardio-respiratory fitness are mostly attributable to increases in cardiac output and stroke volume and greater arterio-venous oxygen difference during exercise, reflecting the ability of trained skeletal muscles to extract and use more oxygen (Blomqvist & Saltin, 1983). Whilst factors related to heterogeneity in responsiveness to exercise training (Bouchard & Rankinen, 2001) are important, in general, a dose response relationship between physical activity (through moderate to vigorous modes) and cardio-respiratory fitness exists (Blair et al., 1995; Church et al., 2007). An average gain in cardio-respiratory fitness of 10-20% is supported in programmes that meet the recommended ACSM (2006) guidelines related to frequency, intensity, type and duration, stressing primarily the aerobic processes (Bouchard et al., 1994).

However, lack of time is often cited as a barrier to being regularly physically active (Health Survey for England, 2008), which suggests that current guidelines (minimum of 150 minutes per week) may not be the ideal approach to increase physical activity levels in line with public health goals. Several studies have suggested that High- Intensity Interval Training (HIT), a training model involving a series of 30 second maximal cycling sprints (i.e. Windgate sprints), with 4 minutes for rest/recovery between each bout, may provide a time-efficient strategy for inducing adaptations that are similar, if not superior, to traditional cardio-respiratory training (Kemi et al., 2005; Wisløff et al., 2007). For example, recent epidemiological evidence from the Norwegian HUNT study (Wisløff et al., 2006) indicated that just a single weekly bout of high-intensity exercise was found to reduce the risk of cardiovascular disease in both men and women (relative risk: 0.61 and 0.49, respectively). Further, Bartlett et al. (2011) has reported that ratings of perceived

"enjoyment" were higher for HIIT than for steady-state continuous exercise, despite Rate of Perceived Exertion being higher for HIIT. Similarly, patients with heart failure found HIIT more motivating than traditional steady-state exercise, which was perceived as "quite boring" (Wisløff et al., 2007). These findings are of particular interest when studying one's autonomous motives for exercise participation.

A Case for Studying the Determinants of Fitness within a Military Population

When investigating the public health concerns of exercise related behaviour, it remains unclear whether the differences reported are between objective and subjective measurements or between activity and fitness per se. Personnel serving in today's armed forces neatly echo both the public health drive (the importance of fitness to this organisation is absolute) and the activity and fitness conundrum (fitness testing is mandatory once per year providing standardised indicators of activity). In summary, cardio-respiratory fitness is an important component of general service life, and the only way to meet the fitness standard it to exercise regularly.

An unfit serviceman within a military unit may not only compromise the effectiveness of operations but could ultimately jeopardize the safety of themselves and others around them. Equally, the absolute physical demands of a particular role in the military are dictated by extrinsic factors that cannot be altered to account for a reduction in physical performance capability over time. Therefore, a minimum level of physical performance both on entry into service and throughout a service career is a requirement for all military personnel, regardless of age or gender. Indeed, it is for this reason that the Royal Air Force Queen's Regulations, QR (RAF) 430(1) state

'…All personnel are required to be fit to undertake their peacetime and wartime tasks effectively, with the added ability to recover rapidly'.

As reported, planned physical activity (i.e., exercise) is the only way to achieve this outcome. Not only will personnel who remain physically fit reap the reported health protective benefits associated with regular exercise, yet aerobically trained individuals, compared with untrained individuals, are significantly more likely to navigate basic training successfully and without injury (Nicholls, 1998).

The RAF's Fitness & Health Strategy states: '…*because of what the RAF does, our standards must in some ways be higher than those of society at large'*. The importance of cardio-respiratory fitness is reflected in the structure of the RAF Fitness Test. All servicemen and women are required to meet a minimum level of fitness every year. However, measuring fitness each year at the population level (>40,000 staff) is not straightforward. Whilst direct measurements of cardio-respiratory fitness are considered the most accurate method of assessing an individual's maximal aerobic power, they are time consuming, require high subject motivation, and cannot simultaneously test large numbers of subjects. Although the term cardio-respiratory fitness may imply that a maximal exercise test has been performed, within the purposes of the present investigation, an individual's 'estimated' level of cardio-respiratory fitness is measured, albeit directly.

The Multi-Stage Fitness Test (MSFT; Leger & Lambert, 1982), also known as the 'bleep test', involves a 20 meter shuttle run between two points. Each shuttle must be completed before a bleep is played over a loudspeaker. The time between each bleep progressively decreases, requiring participants to increase their pace to reach the point before the next bleep. Eventually, the performer is unable to

complete a shuttle run before a bleep and the test ends. The final level and bleep reached can be used to estimate $\dot{V}O_{2\,max}$ (Ramsbottom, Brewer, & Williams, 1988) by extrapolating derived estimates of $\dot{V}O_{2\,max}$ for each level and shuttle, from 26.8 to 84.8 $ml.kg^{-1}.min^{-1}$ in the form of a table. Validity of the MSFT has been assessed on its correlation with the *'gold standard'* laboratory test and the standard error of the estimates, reporting a high correlation (Leger & Gadoury, 1989; Ramsbottom et al., 1988), a high level of reproducibility (Armstrong & Duggan, 1990; McNaughton, Hall, & Cooley, 1998), independent of sex and age (Armstrong & Duggan, 1990) and running surface (Leger & Lambert, 1982).

RAF Fitness Test standards are also age and gender equitable, by firstly taking into account the physiological differences between the sexes (a difference of 20% in cardio-respiratory fitness level is maintained across all age categories) and secondly, the expected deterioration through increasing age from 30 years onwards, with a reduction in standards of 8% per decade indicative of an active population (Kasch, Boyer & Schmidt, 1999). These standards of fitness also reflect the 'expeditionary status' which the service has adopted since 2001. This in turn has required improvements in training at all levels of the organization and as such, the Royal Air Force operates a 4 tiered programme for its uniformed personnel.

Firstly, as the RAF seeks to recruit healthy individuals capable of undertaking the physical demands of training and general Service life, potential recruits are screened (interview and body composition measure) at their local careers office before enrolment. All personnel successful at this stage must then undertake a pre-joining fitness test, and meet a cardio-respiratory fitness standard 10% lower than the RAF standard for their respective age and gender.

Secondly, on entry, airmen undertake 9 weeks of initial training at RAF Halton, Buckinghamshire which covers basic military skills such as marching, skill at arms, teamwork, leadership training and fitness. Trainees follow structured and progressive syllabuses of physical education that aim to inculcate a lifetime habit of health and physical activity. It is during this time that Physical Training Instructors (PTIs) educate trainees on the health benefits of exercise. The fitness output standard for personnel leaving RAF Halton onto Phase 2 training is the RAF Fitness Test, with standards again specific to age and gender.

Thirdly, on completion of Phase 1 training, airmen then complete professional training at their respective specialist units. Although time for physical training is included within a weekly programme, personnel have autonomy over the intensity, frequency and mode of activity. The annual standard of cardio-respiratory fitness required for all personnel during Phase 2 training remains their age/gender specific standard on the RAF Fitness Test.

Finally, on completion of Phase 2 training, airmen are then posted to their permanent unit, to undertake duties aligned to their professional training. Permanent staff can remain in the same role for several years before being posted to a new role at a different unit. During this time physical training is voluntary, however the standard of cardio-respiratory fitness acceptable for all personnel remains their age/gender specific standard on the RAF Fitness Test.

Whilst it is reasonable to assume that the RAF fitness test will make a significant contribution to operational effectiveness, an educational and training element led by professional health practitioners is delivered on every RAF unit, which is compulsory for those who fail to meet their fitness test standard. Failure to meet

fitness standards places personnel in a state of jeopardy at two levels: they are less likely to perform satisfactorily in demanding work situations, and are at higher risk of premature morbidity and mortality. On initial failure, a 12 week conditioning training programme is issued by a professional practitioner, following a period of counselling and lifestyle education. Participants are then expected to follow the programme for three days per week for approximately 60 minutes per session. Participants are expected to participate enthusiastically throughout the programme and at the end of the 12 week programme, re-take and pass the fitness test. Continued failure to meet the fitness test standards can be directly linked to conditions of pay and progression in service, leading to involuntary discharge from the service in extreme cases.

The Psychological Determinants of Physical Activity

Whilst motivation is evident in all human actions, the reasons and foci of why individuals partake in activities differ greatly. Engagement in regular physical activity is no exception, involving a complex interaction between biological, environmental, social, and psychological influences (Biddle & Mutrie, 2001). It is for these reasons that the examination of the psychological determinants of exercise is a prominent topic in exercise psychology (Biddle & Mutrie, 2001).

When referring to the determinants of exercise, Nahas, Goldfine, & Collins (2003) state the importance of addressing the motives that potentially influence behaviour in two ways. Firstly, consideration must be given to the determinants that promote exercise participation (the facilitators). According to Willis and Campbell (1992), people have multiple motives rather than single reasons when participating in physical activity, with the the most common facilitators including to:

- Improve or maintain health and fitness including the prevention of diseases;
- Improve physical appearance including, for example, losing weight;
- Experience a sense of enjoyment;
- Have a social experience; and
- Obtain the psychological benefits.

Secondly, consideration must be given to the determinants which discourage or restrain exercise participation (barriers). As for the common barriers individuals face, findings from the Health Survey for England (2008) report:

- Lack of leisure time
- Work commitments
- Lack of motivation
- Caring for other people
- Not the sporty type

In a study by Frederick & Ryan (1993), when exercisers cited more internal motives, initiated for reasons more related to the enjoyment of being involved in the activity itself, this was reported to be critical to sustained physical activity. However, whilst the listed motives provide a description of behaviours, they do not provide a conceptual basis to understand motivational processes. This is where studying the long term influences of exercise behaviour through psychological modelling is

particularly useful (i.e., from a conceptual basis). Furthermore, using more than one theory within this investigation could allow the identification of the origins of the antecedents of the behaviour (through the Self-Determination Theory), to then chart the exact process by which motivational orientations are converted into intentions and onto behaviour itself (through the Theory of Planned Behaviour).

In reviewing the determinants of exercise, Sallis & Hovell (1990) identified four important transition phases (sedentary behaviour - adoption/maintenance behaviour - drop out behaviour –resumption behaviour) which have considerable utility when trying to understand the cyclical process of exercise behaviour: The authors state that *'…those who study determinants of exercise behaviour must carefully define which transition they are studying, because the determinants are likely to be different at each transition point'* (1990, p.310).

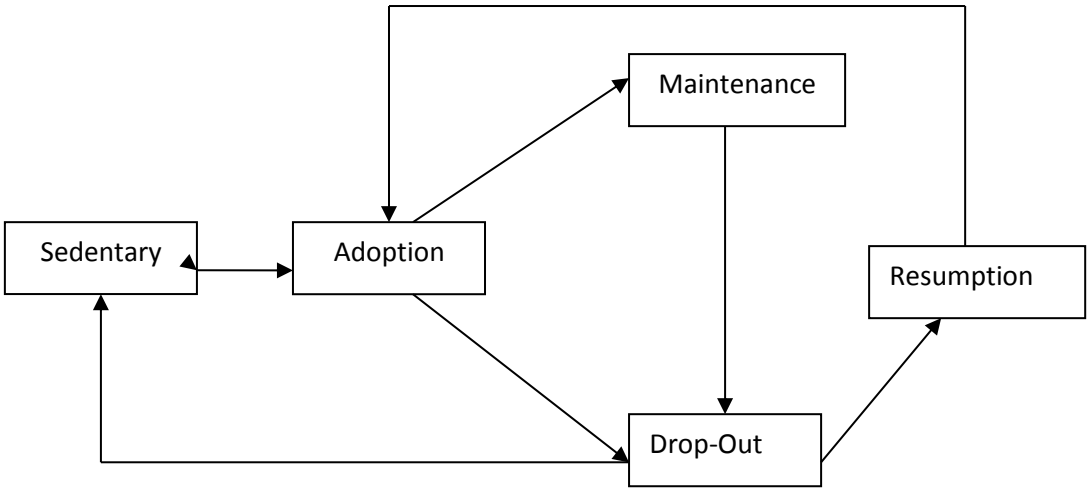

Figure 1.1: A Natural History Model of Exercise. (Adapted from Sallis and Hovell, 1990).

One critical factor in this model represents the unsolved public health issue of the maintenance of exercise. Adherence based studies typically report drop-out rates of 45% (range 9-87%) with the majority of exercise initiates ceasing planned activity within 6 months of starting an exercise regime (Marcus et al., 2006). Further, the greatest attrition rates in exercise programmes typically occur early (2 to 4 months) and then begin to level off to approximately 50% after 6 months. Given that the physical and psychological benefits of planned physical activity will only be achieved through maintenance of behavior, this demonstrates the complexity of studying associated determinants.

Furthermore, the motives commonly cited for participating in exercise are often more externally based, which can have lower associations with adherence to exercise (Frederick & Ryan, 1993). In the ADNFS (Sports Council, 1992) for example, over 85% of men and women reported that they exercised to 'feel in good shape physically' and to 'improve or maintain my health'. A large (n=15,239) European survey completed by Zunft et al. (1999), concluded that the most important motives for physical activity were to 'maintain good health' (42%), 'release tension' (30%) and to 'get fit' (30%). The prominence of these external motives corroborates with the findings by Willis & Campbell (1992).

Dishman (1990) supports this internal/external dichotomy by stating that 'knowledge and belief in the health benefits of physical activity may motivate initial involvement….but feelings of enjoyment and well-being seem to be stronger motives for continued participation' (p.83). Managing feelings and sensations therefore seem to be an important strategy if exercise behaviour is to be maintained. An important factor also relates to the intensity of the exercise bout. Two key issues, feasibility and

efficacy, led to the update of recommendations by the ACSM (1990; 2000; 2006). What this underscores is the importance of ensuring that an individual's exercise experience is more positive, an outcome more likely at lower levels of intensity (Ekkekakis, Parfitt, & Petruzzello, 2011; Parfitt & Hughes, 2009; Parfitt, Markland, & Holmes, 1994), and undertaken in more manageable bouts (Murphy et al., 2009). As a result, latest recommendations now promote the same benefits through 10 minute accumulated bouts of moderate intensity activity, three time per day or three weekly 20-minute bouts of vigorous intensity physical activity or a combination of the two (Haskell et al., 2007).

A Case for Studying the Psychological Determinants of Cardio-Respiratory Fitness

The body of evidence presented so far supports the health benefits of active lifestyles. However, given the discrepancy between current and target levels of physical activity, more information about potential psychological determinants of this behavior provide clear justification for conducting research pertaining to the motivation of exercise behaviours in adults. Given the strength of associations between cardio-respiratory fitness and public health, and most importantly, the loss of cardio-respiratory fitness over time, a longer term investigation into the role of motivation would represent a major unfilled gap in the literature. As detailed earlier, the absolute physical demands of a particular role in the military are dictated by extrinsic factors that cannot be altered to account for a reduction in physical performance capability over time. Perseverance with exercise is therefore the only

way to maintain fitness and changes to this physiological attribute over time can only be ascertained through a longitudinal investigation.

The Theory of Planned Behavior (TPB) and Self-Determination Theory (SDT) are popular frameworks that can investigate both the quantity and quality of behavioural engagement. The TPB focuses on the nature of people's beliefs and intentions to perform exercise (the 'what' of exercise determinants), whilst the SDT focuses on quality of motivational regulations that predict exercise behaviour (the 'why' of exercise determinants). The following section now introduces the central tenets of both models and the theoretical frameworks which will guide the four empirical papers within this thesis.

Theory of Planned Behavior: The 'What' of Behavioural Outcomes

The investigations reported in empirical Chapters 3 and 5 are based on the theory of Planned Behaviour (TPB). A review of its underlying constructs will now be given to lay the foundations of two of four empirical investigations.

The TPB is a popular psychological model for the prediction of exercise behavior (Ajzen, 1988). Based on the value expectancy theory (Peak, 1955) and subjective expected utility theory (Edwards, 1954) the historical antecedents of this model originate from the Theory of Reasoned Action (TRA; Fishbein & Ajzen,1975). Central to this theory (Ajzen, 1991) is the principle that behavior is determined by one's behavioral intention. Ajzen & Fishbein (1980) state that intentions through the TRA accurately predict behaviour only when the behaviour is under the individual's volitional control. Ajzen (1988, p.127) therefore conceded that: '…the TRA was developed explicitly to deal with purely volitional behaviours', and proposed the TPB

as: '…a conceptual framework that addresses the problem of incomplete volitional control' (p. 132). When control over the behavior is incomplete (Ajzen, 1991), perceived behavioral control (PBC) reflects an individual's perceived versus actual control over the behavior (Sheeran, Trafimow, & Armitage, 2003). PBC may influence both intention to perform the behaviour and actual behaviour (Ajzen & Madden, 1986). A review of each TPB construct now follows.

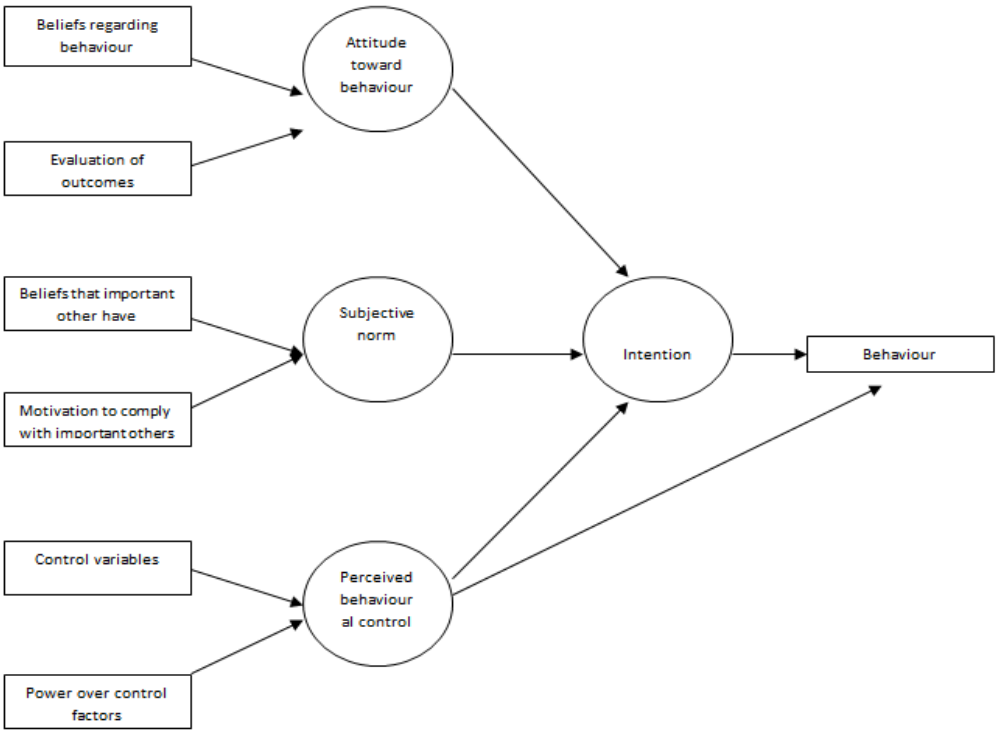

Figure 1.2: Theory of Planned Behavior (Adapted from Biddle and Mutrie, 2001).

The intention construct of the TPB is described by Davis et al. (1984) as: '…the most important and one of the most consistently relevant predictors of continued participation in health improvement programs'. Intention represents a person's immediate behavioral orientation towards performing a given target behaviour, having mediated completely the influence of the three belief based components of attitude, subjective norm and PBC on behavioural engagement

(Hagger, Chatzisarantis, & Biddle, 2002). Ajzen (1991, p. 181) states that '…intentions are assumed to capture the motivational factors that influence behaviour; they are indicators of how hard people are willing to try, of how much effort they plan to exert in order to perform the behaviour'.

The intention-behaviour relationship is supported reliably through several meta-analytic reviews covering a range of health behaviors (Armitage & Conner, 2001; McEachan, Conner, Taylor, & Lawton, 2011) including physical activity and exercise (Hagger et al., 2002; Hausenblas, Carron, & Mack, 1997; Symons Downs & Hausenblas, 2005). The Armitage and Connor (2001) review found that the TPB accounted for 39% and 31% of the variance in intentions and behavior respectively over a broad range of health behaviors. For physical activity, Hagger et al. (2002) concluded that the TPB explained 46% and 27% of the respective variances of intention and behavior, with McEachan et al. (2011) reporting similar effects when the data were confined to prospective designs (46% and 24%). The TPB further postulates that intention to engage in a given target behaviour (Hagger et al. 2002) is affected by three broad types of beliefs during deliberation. A review of the these components, which impact directly upon intention, will now be discussed.

Eagly and Chaiken (1993) define attitude as: '…a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour'. In general, the more favourable one's attitude is to a given behaviour, the stronger one's intention will be to perform it. The meta-analysis by Hausenblas et al. (1997) revealed that attitude was over twice as useful a predictor of intention to exercise than subjective norm (reviewed later), a view also shared through reviews by Blue (1995) and Godin (1993). A later meta-analysis by Hagger et al. (2002)

revealed that when intention predicted behaviour, attitudes were the strongest predictor of intention.

Assessing attitude as a solely one-dimensional construct would however be incomplete. Support for this assumption is based on previous research by Rosenberg (1956), who identified distinct concepts of 'hot' and 'cold' attitude. Attitudes towards physical activity comprise two separable aspects, namely, instrumental (distal consequences) and affective (immediate consequences) components (Ajzen & Driver, 1992; Ajzen & Timko, 1986; Courneya, Nigg, & Estabrooks, 1998; Eves, Hoppé, & McLaren, 2003; French et al., 2005; Godin, 1987; Lawton, Conner, & Parker, 2007; Lawton, Conner, & McEachan, 2009; Lowe, Eves, & Carroll, 2002; Scott, Eves, Hoppé, & French, 2010; Valois, Desharnais, & Godin, 1988). Instrumental components relate to the outcomes of the behavior (e.g. healthy or unhealthy), whereas affective components are emotion-laden judgments about the experience of the behavior (e.g. pleasant or unpleasant). Attitudes will be most favourable toward behaviors with outcomes that are believed to be both beneficial (instrumental) and experiences that are pleasant (affective).

Importantly for physical activity adoption and maintenance, affective components of the attitudinal construct may be more important determinants of intention than instrumental ones, both for voluntarily chosen physical activity (Eves et al., 2003; French et al., 2005; Lawton et al., 2007; 2009; Lowe et al., 2002) and when behavior is constrained but a modicum of choice remains (Scott et al., 2010). Affective attitude has also predicted behaviour independently of intention (Lowe et al., 2002). This distinction is important given that health consequences (instrumental) of exercise are not immediately apparent to the participant, whereas proximal

feelings (affective) of enjoyment are (Eves, 1995; Sallis & Hovell, 1990). More attention aligned to the affective nature of exercise appears sensible in the present thesis (Eves et al., 2003; French et al., 2005; Sutton, 2002) in order to avoid the predictive capacity of the TPB being underestimated and biased towards instrumental consequences of behavior.

A second determinant of intention, subjective norm, includes an injunctive element (social pressure from family members, friends, and co-workers to engage in or avoid particular behaviours), and a descriptive element (the individual's motivation to comply with these expectations). These 2 elements represent one's normative beliefs (Ajzen, 2000). Empirical support for this construct is less convincing than other TPB constructs, with typical effects on intention ranging from non to low (Hausenblas et al., 1997; Hagger et al., 2002). As a result, several authors have deliberately removed subjective norms from their analysis (McEachan et al., 2011; Plotnikoff et al., 2012). However, the relative importance of the normative component may be a function of its measurement, given that the majority of TPB studies have used single-item measures, especially in exercise contexts (Armitage & Connor, 2001). Connor & Armitage (1998) argue that an alternative operational definition for this construct, more closely related to support and praise received from others who are significant in one's life (such as moral or descriptive norms), may increase its predictive power.

Finally, perceived behavioral control (PBC) reflects both the internal aspects of control (perceived ease or difficulty of performing the behavior, including past behavior), and external constraints (resource impediments such as time and lack of energy; Hagger, Chatzisarantis, Biddle, & Orbell, 2001). Under conditions of very

high volitional control, behavioural intention should predict behaviour directly. Conversely, under conditions where there are problems of volitional control, PBC can bypass intention and predict behaviour directly, or as Ajzen (1991) states that '…the addition of perceived behavioural control should become increasingly useful as volitional control over behaviour decreases' (p. 185).

The inclusion of PBC has been found to significantly increase the explained variance in intention to exercise, supporting the notion that the TPB is superior to the TRA in predicting and explaining exercise behavior. For example, Blue (1995, p.115) suggests that '… the TPB has more predictive qualities for exercise intention and does not make the assumption that control for exercise behavior rests solely in the individual', indicating that people are more likely to exercise if they hold favourable beliefs about exercise and have the confidence to carry out the behavior.

Meta-analyses (Conner & Armitage, 1998; Hausenblas et al.,1997; Armitage & Conner, 2001; Hagger et al., 2002) report PBC to add on average 5% to the explained variance in intention, over and above attitude and subjective norm, and 1% to the variance in behaviour, over and above intention. Hagger et al. (2002) and Armitage & Connor (2001) also report a significant direct effect of PBC on behavior. The two empirical chapters presented in this thesis will consider this reasoning by examining the impact of PBC and related constructs on behaviour under both suboptimal (i.e. problems of volitional control) conditions. For example, during Phase 1 training (Study 1) recruits follow a mandatory exercise programme for 9 weeks, whereas during more optimal conditions (i.e. complete volitional control) during Phase 2 and 3 training (Study 2), personnel have autonomy over the frequency, intensity and duration of exercise, however still have to meet an annual fitness

standard. In conditions when behaviour is not under complete volitional control, we would expect PBC to moderate the relationship between intention and behaviour.

TPB Research

McEachan et al. (2011) completed a meta-analysis of all prospective studies (n=207) using the TPB and reported explained variance on intention and behavior as 46% and 24% respectively. However, the authors argue that cross-sectional studies only provide measures of past or current behavior rather than future behavior, a critical feature of the TPB framework (p.101). To address the maintenance of physical activity, this distinction is important for several reasons.

Firstly, meta-analytic reviews such as Godin & Kok (1996) have indicated that up to two thirds of the variance was not predicted by intentions and PBC. Although some of this is likely attributable to the operationalisation of the PBC construct, similar to that of subjective norm, a significant proportion of variance remains unaccounted for. Triandis (1977) has suggested that novel behaviours are as a result of formed intentions, whereas repeated behaviours are determined more by habit or past behaviour. Bagozzi (1981) also suggested that '…as habit increases, the performance of the behaviour becomes less of a rational evaluation of the consequences of the act and more one of a learned response'. In the meta-analysis by Hagger et al. (2002), the authors state that establishing a regular pattern of physical activity in the past, will act as an important determinant of physical activity in the future. Thus, the frequency of past behaviour could moderate the relationship between PBC and behaviour, as when the frequency of past behaviour increases it

will reduce the perceived versus actual control gap (Norman, Conner, & Bell, 2000). The inclusion of past behaviour in the meta-analysis by Hagger et al. (2002) for example, increased the explained variance of intention (by 9.9%) and future behaviour (by 17.6%), as well as attenuated the relationships of attitude and intention with behaviour (Hagger et al., 2002). The degree of motivational 'baggage' that any study participant would bring as a result of prior experience of physical activity behaviour clearly highlights a potential advantage of testing TPB constructs longitudinally, when construct measurements collected at baseline are controlled for.

Secondly, Sutton (1998) argues that longer time intervals would allow for greater opportunities for the behaviour to be performed, thus increasing the intention-behaviour correlation. Disappointingly to date however, only a small number of physical activity studies (n=103) have utilised longitudinal designs (McEachan et al., 2011) with 15% of variance in behavior explained over longer term follow ups (>5 weeks) compared to 32% variance over shorter term follow ups (<5 weeks). Fishbein & Ajzen (1975) suggest that the predictive power of intention should vary inversely with the time between its measurement and subsequent behaviour. Sheeran, Orbell & Trafimow (1999) suggest that when intentions are stable, past behaviour is less likely to predict future behaviour, however when intentions are temporarily unstable, past behaviour is reported to be a significant predictor of subsequent performance.

Thirdly, extant longitudinal research has typically focused on prescribed exercise within at-risk populations such as diabetics (Plotnikoff, Lippke, Courneya, Birkett, & Cigal, 2010), health promotion clinics (Norman et al., 2000) and cardiac rehabilitation clinics (Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002; Blanchard et al., 2003). Norman et al. (2000) reported PBC to be the sole

independent predictor of exercise intentions and future exercise behavior (n=87) over a 6 month period, with the TPB explaining 15% of the variance. In a more recent study of the same duration (Plotnikoff et al., 2010), intention was significantly associated with physical activity behavior at baseline and follow up (n=2311), explaining 13% of the variance among adults with type 2 diabetes after 6-months (23% at baseline). Results from these studies are however limited to their specific contexts and populations.

When longitudinal studies have employed the TPB in more general contexts, two have been within transcontextual models and so findings are not very informative (Courneya, Nigg, & Estabrooks, 1998; Courneya, Plotnikoff, Hotz, & Birkett, 2001). A recent study over a 15 year period has claimed that TPB constructs can predict 9% and 22% of the variance in physical activity at baseline and follow up (Plotnikoff, Lubans, Trinh, & Craig, 2012). However, closer inspection suggests some major limitations in methodology. Intention was operationalised as a predicted frequency of self-reported exercise sessions on a 6-point scale in the coming year, a measure demonstrating substantial correlation with frequency of behaviour reported for the preceding year. There was no differentiation between affective and instrumental attitudinal constructs that would allow assessment of their relative contributions to behavior, nor was a measure of subjective norm included in the follow up. More importantly, all models included a path from intention for the coming year to behaviour in the past year. In effect, Plotnikoff et al., (2012) used a theory of *planned* behaviour to predict the past not the future and is not interpretable.

Fourthly, in studies that have employed longitudinal designs in more free living contexts, there has been an over reliance on self-reported measures of behavior or

limited objective measures. Although greater variance of behavior (25.7% for self-report versus 12.1% objective measures) is reported in the meta-analysis of prospective TPB studies (McEachan et al., 2011), an over reliance of prospective studies using self-report (n=91) rather than objective measures (n=14) may be failing to address the 'quality' of exercise bouts (intensity and duration) on hard outcomes. Armitage (2005) for example tested the utility of the TPB to predict actual participation in physical activity in a 12-week longitudinal study of gym enrollers (n=94) and reported PBC to be the main predictor of intention and behavior. Although stable exercise habits were reported after 5 weeks, analysis focused only on frequency of attendance with no data relating to the duration and intensity of exercise. This is problematic given that current health recommendations rely on the 'quality' of each exercise bout (intensity and duration), in addition to the 'quantity'.

The distinction between cross-sectional and longitudinal data is particularly pertinent for cardio-respiratory fitness. As reported earlier, physical activity can influence fitness but there are major effects of genetics that are independent of any activity (Bouchard et al., 1998; Bouchard & Perusse, 1994). Only longitudinal data would test for effects of motivation on fitness if the results are not to be obscured by these contributions. Again however, there remains a dearth of research that measures the effects on outcomes related to cardio-respiratory fitness.

While the meta-analysis of McEachan et al. (2011) documents over 100 prospective studies of the TPB and physical activity, we can find only three cross-sectional studies of the relationship between TPB variables and cardio-respiratory fitness, with only one in adults. One study (Shen, McCaughtry, & Martin, 2007) tested a transcontextual model of the TPB in conjunction with the Self Determination Theory

(SDT) in a sample of urban adolescents (n=653). Intention accounted for variance in moderate-vigorous physical activity (MVPA) with self-reported MVPA accounting for 9% of the variance in cardio-respiratory fitness. In a later study (n=129), Martin, McCaughtry, & Shen (2009) reported TPB variables to predict 10% of the variance in MPVA, whilst the TPB and MPVA predicted 8% of the variance in cardio-respiratory fitness, with both intention and PBC being statistically significant. However, both studies employed a limited number of items per TPB construct and the use of a composite score for attitude makes it impossible to assess the independent effects of this construct.

Sassen and co-workers tested the cross-sectional relationship between the TPB and fitness in 1,298 police officers (Sassen, Kok, Schaalma, Kiers, & Vanhees, 2010). The association between attitudes (2 items), subjective norm (2 items) and PBC (5 items) for participating in 60 minutes of physical activity each day and maximal aerobic fitness was tested. Analyses of the data revealed that attitude and PBC accounted for 5.8% of the variance in cardio-respiratory fitness, with minimal contributions from subjective norm. Unfortunately, attitude was again not separated into affective and instrumental components that would allow assessment of their relative contributions to cardio-respiratory fitness. Further, the modelling of Sassen and co-workers did not include sex of the participant, a major biological constraint on levels of cardio-respiratory fitness, and did not test any longitudinal relationships (Sassen et al., 2010).

In summary, the available data linking potential TPB constructs to longitudinal data is limited and not very informative. Whilst intention and PBC are known to predict future physical activity behaviour over shorter time frames (Hagger et al.,

2002; McEachan et al., 2011), McEachan and co-workers emphasize that attenuation of the intention-behaviour relationship for physical activity occurs as the length of follow-up increases. For example, the TPB predicted 32% of variance of physical activity for studies over five weeks or less and 15.7% of the variance for longer follow-up periods (McEachan et al., 2011). While longer time frames are required to address public health questions, the weakening of the model with time (Ajzen, 1991; McEachan et al., 2011) has resulted in TPB studies covering a relatively brief time frame; five weeks was the median of over 100 prospective studies (McEachen et al., 2011). With regards to objective measures, the 12.1% average reported variance is considerably lower than the 25.7% from self-report estimates. The 5.8% reported in the only TPB study to measure cardio-respiratory fitness (Sassen et al., 2010) most probably reflects, in part, the failure to include participants' sex in the modelling, but in the main, the study's cross-sectional design. Whilst physical activity can influence fitness, there are major effects of genetics that are independent of any activity (Bouchard et al., 1998; Bouchard & Perusse, 1994). Only longitudinal data will test for the true effects of TPB variables on fitness; results not obscured by genetic contributions. There is a clear requirement therefore in the TPB literature for a study to test for *changes* in fitness, i.e. control for initial levels of fitness.

Self-Determination Theory: The 'Why' of Behavioural Outcomes

Whereas the TPB addresses 'what' cognitive factors underlie the decision to act in a specific context tracing how one's motivational orientations are converted into intentions and then onto behaviour itself, adopting a second motivational framework in conjunction with the TPB to identify 'why' an individual might be motivated to perform a given behaviour is warranted. The investigations reported in Chapters 2

and 4 are based on a sub-theory of the Self-Determination theory. A review of this theory, including an overview of its sub-theories, will now follow as they provide many of the foundations crucial to the present empirical investigation by identifiying the origins of the antecedents of the behaviour.

Motivation is a multi-faceted construct with people impelled to act for very different reasons. Ryan (1995) contends that "the lion's share of social development concerns the assimilation of culturally transmitted behavioural regulations and valuations that are neither spontaneous nor inherently satisfying" (p. 405). Stated differently, most people engage in behaviours because they are of value but are not inherently interesting or enjoyable. As detailed earlier, for the generality of the population exercise is commonly undertaken to attain an external outcome (such as to become fitter or obtain recognition from significant others), rather than for more internal reasons of enjoyment, interest and excitement (HSE, 2008; ADNFS, 1992; Willis & Campbell, 1992). Research which investigates the motivational determinants of exercise through a multi-dimensional framework could elicit the conditions that sustain and enhance the most productive forms of motivation.

Self-Determination Theory (SDT) is an influential model to study the effects of motivation on health behaviours (Deci & Ryan, 2000; Hagger & Chatzisarantis, 2007; Ng et al., 2012; Ryan & Deci, 2007). As a macro level framework of human motivation, SDT can explain the antecedents and processes that foster (or forestall) motivational development and exercise behaviour, whilst distinguishing between the reasons 'why' individuals are moved to act. A recent meta-analysis of 184 SDT studies by Ng et al. (2012) demonstrates the popularity of this theory within the health domain.

SDT's organismic component suggests that humans are growth oriented organisms, actively seeking optimal challenges and new experiences to master and integrate (Ryan & Deci, 2002). Secondly, its dialectic component addresses the interaction between the growth oriented individual and social factors that either facilitate or impede the satisfaction of three basic psychological needs - autonomy, competence, and relatedness. (Deci & Ryan, 1991; Ryan & Deci, 2002).

The origins of SDT placed intrinsic and extrinsic motivation as a motivational dichotomy within SDT's Cognitive Evaluation Theory (Deci & Ryan, 1990), based on the work of 2 early theorists, White and DeCharms. White's (1959) paper on 'effectance motivation', suggested that for certain behaviours there was no apparent external reward except for the activity itself and by successfully mastering tasks led to intrinsically motivated future behaviour. DeCharms (1968) however, stated that individuals will only be intrinsically motivated when they are the 'origin' (in control) of their behavior which was referred to as one's 'perceived locus of causality' (PLOC). Consequently, those with an internal PLOC were seen to be the initiators of their behavior and were more likely to be intrinsically motivated. This early research emphasised the independence of intrinsic and extrinsic motivation, however it assumed that if one was present, the other could not be. A model that could ascertain how people acquired or internalised other forms of self-regulation, and their associated outcomes, was required.

Deci & Ryan (1990) conceptualized intrinsic and extrinsic motivation as a graduated continuum of motivational styles (rather than a bipolar distinction of intrinsic versus extrinsic motivation offered by DeCharms) ranging from high to low self-determination respectively. Deci & Ryan (1985, 1991) established the

Organismic Integration Theory (OIT), commensurate with the organismic foundations of SDT, to address the quality of people's motivation through an intrinsic-extrinsic continuum. Intrinsic motivation refers to "the doing of an activity for its inherent satisfactions rather than for some separable consequences" (Ryan & Deci, 2000, p. 56). In contrast, extrinsic motives (called regulations in SDT parlance) require engagement for some separable consequence (Deci & Ryan, 2000), which is particularly relevant within the present context given that exercise appears to be performed for personally valued goals or imposed by an external agent.

Moreover, OIT highlights five types of motivational regulations which reside along the continuum as distinct forms of motivation, ranging from self-determined to non-self-determined, respectively (Deci & Ryan, 2002). Each regulation has unique psychological conditions (called nutriments in SDT parlance) responsible for motivational development (Deci & Ryan, 1985; Ryan & Deci, 2000) and will be discussed in turn.

An inherent propensity to actively engage in challenges and develop new skills and for no external contingency, is the prototype of self-determined motivation (e.g., ''I exercise because it's fun''). A direct consequence of intrinsic motivation is feelings of exercise enjoyment, which in turn leads to perseverance, less stress and positive psychological feelings (Wankel & Mummery, 1993; Ryan & Deci, 2000; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997).

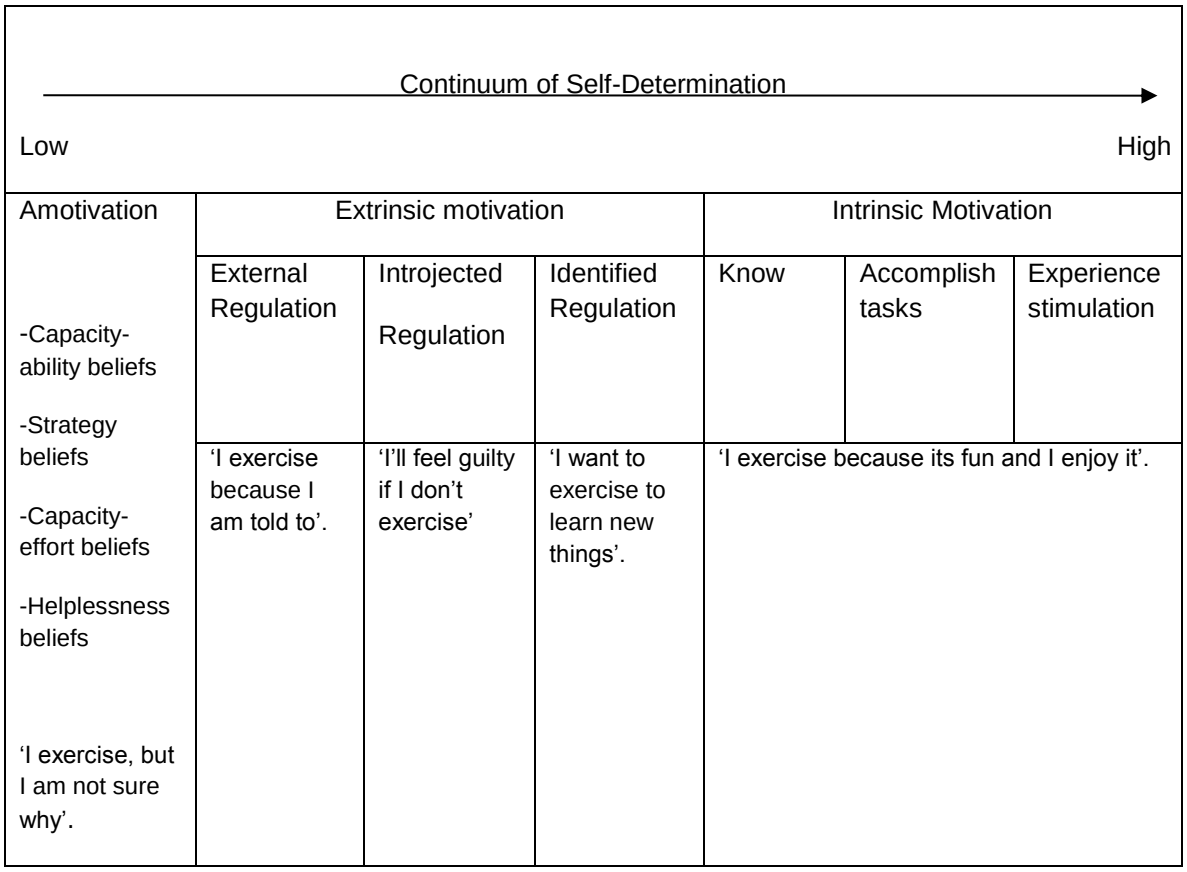

Figure 1.3: The OIT Continuum (Adapted from Carron, Hausenblas, & Estabrooks, 2003)

Similar to the multi-dimensional properties of the OIT, Vallerand (1997) proposed a tripartite taxonomy of intrinsic motivation. Firstly, intrinsic motivation towards 'knowledge' means to engage in an activity to learn something new i.e. athletes discovering and trying new training techniques. Secondly, intrinsic motivation toward 'accomplishment' means to interact with one's environment in order to feel competent and to create unique accomplishments i.e. mastering difficult training techniques. Thirdly, intrinsic motivation toward 'stimulation' means to experience the pleasant sensations derived from the activity itself. These three sub-dimensions are reported to be highly interrelated (Li, 1999; Pelletier, Fortier, Vallerand, Tuson, &

Briere, 1995). In contrast to intrinsic motivation, behavior can be controlling. Extrinsic motivation is subdivided into four types of regulation (integrated, identified, intojected, and external) that differ in their degree of self-determination.

Integrated regulation constitutes behaviour that is undertaken willingly and with no sense of coercion (Deci & Ryan, 1991). Although the most autonomous form of extrinsic motivation, it is still considered extrinsic because the instrumental action is performed through 'personally endorsed values, goals, and needs that are already part of the self' (Deci & Ryan, 2002, p. 18), rather than for its inherent enjoyment. Integrated regulation is illustrated by the phrase 'I exercise because it is important to me and symbolises who and what I am' (Whitehead, 1993). From a measurement perspective it is very hard to differentiate between integrated regulation and intrinsic motivation and for this reason, only intrinsic motivation was measured in the present investigation.

Identified regulation reflects more self-endorsed behaviour (Deci & Ryan, 2000) and is the conscious valuing of a particular goal, even if the behaviour is not particularly pleasant e.g., `I take part in exercise because I value the health benefits'. Whilst expressing choice, the underlying motive to engage is related to personally valued outcomes not to the behaviour itself and so is still externally driven. Whitehead (1993) coined this stage the 'threshold of autonomy', illustrated by feelings of 'I want to' rather than 'ought to or have to'.

In contrast, introjected regulation represents one's motivation that is yet to be internalized but also is not part of the integrated self (Ryan & Deci, 2000), e.g., 'I exercise to look good'. Vallerand (1997, p.13) describes introjected regulation as

‘…if individuals replace the external source of control by an internal one and start imposing pressure on themselves (through guilt or anxiety) to ensure that the behaviour will be emitted’, e.g., ‘I feel guilty if I don’t exercise’.

External regulation, the least self-determined form of extrinsic motivation, is performed to gain a desired consequence, such as approval from others e.g., `I must exercise because I am told to’. The behavior is therefore performed to obtain rewards i.e. praise, or to avoid negative consequences and satisfy an external demand i.e. criticism from a superior.

Finally, at the distal end of the self-determination continuum, amotivation is defined by Markland & Tobin (2004, p. 191) as representing ‘‘a state lacking of any intention to engage in behavior’’, for example ‘I exercise, but I do not know why’. Pelletier, Dion, Tuson, & Green-Demers (1999) have considered amotivation from a multidimensional perspective, proposing four types. Firstly, amotivation due to ‘capacity-ability beliefs’ is related to one’s lack of ability to successfully complete the task in question. Secondly, amotivation due to ‘strategy beliefs’, is related to one’s proposed strategy failing to deliver the desired outcomes. Thirdly, amotivation due to ‘capacity-effort beliefs’ is related to the demands of the task being greater than the necessary effort available to achieve it. Finally, amotivation due to ‘helplessness beliefs’, is related to one’s efforts being inconsequential considering the enormity of the task to be accomplished.

Mullan, Markland, & Ingledew (1997) designed the Behavioral Regulation in Exercise Questionnaire (BREQ) to evaluate exercise motives along the SDT continuum, enabling the examination of how motivations change and become more

internalised. Deci & Ryan (1991, p.254) call this: '…the degree to which the regulation of a non-intrinsically motivated behavior has been internalised', relating to the innate human tendency to actively seek self-regulation through the alignment of externally offered elements within a more coherent sense of self. The process of internalisation is important, as it enables researchers to identify the conditions that sustain and enhance behaviour over time versus those that subdue or diminish it. Further, intercorrelations amongst constructs should be ordered in a simplex-like pattern (Ryan & Connell, 1989), with the strongest correlations exhibited by constructs immediately adjacent to each other and declining in size in proportion to their relative distance from the distal construct.

Whilst Deci & Ryan (2002) acknowledge that all motives are capable of regulating behavior, the study of exercise behaviour through OIT is particularly useful for identifying the associations between different exercise behavioural regulations and cognitive, affective and behavioural outcomes. The originators of SDT argue that participation in regular exercise "is most likely when a person has both intrinsic motivation and well-internalized extrinsic motivation [identified regulation], as both facilitate what is, normatively speaking, a precarious endeavour" (Ryan & Deci, 2007, p. 5).

SDT Research

Research testing the utility of SDT to assess motivation for exercise is broadly consistent with the premise that more autonomous regulations predict important, positive, health related outcomes than can be expected for more externally-imposed obligatory regulations, both for self-report measures (e.g., Duncan, Hall, Wilson, &

Jenny, 2010; Edmunds, Ntoumanis & Duda, 2006; Mullen et al., 1997; Rodgers, Hall, Duncan, Pearson & Milne, 2010; Silva et al, 2011), and for the less frequently obtained objective ones (e.g. Sebire, Standage, & Vansteenkiste, 2011; Shen et al., 2007; Standage, Sebire, & Loney, 2008; Wilson, Rodgers, Blanchard, & Gessell, 2003; Wilson, Markey, & Markey 2012). Standage et al. (2008) for example is one of the few studies to employ objective measures (through accelerometry) by examining moderate intensity physical activity behaviour of British university students (n=55). Behaviour was quantified in terms of physical activity meeting the ACSM's guidelines (Haskell et al., 2007), over a 7 day period, whilst controlling for gender, body mass index and waist circumference. Their findings provided evidence that controlled motivations were unrelated to exercise behaviour, whilst autonomous behavioural regulations (albeit a composite score) positively predicted time spent in moderate physical activity for 10 and 20 minute activity bouts. Silva et al. (2011) conducted a randomized controlled trial as part of wider investigation on the role of autonomous motivation in weight control of premenopausal overweight and mildly obese women. Three-year results showed that intervention related changes in exercise autonomous regulation predicted 2-year self-reported moderate exercise and also 3-year weight control. Further exercise motivation variables during the 12-month program (i.e., self-efficacy, perceived barriers, and intrinsic motivation) were also significantly correlated with 2-year weight change.

Identified regulations for exercise tend to be more prominent than intrinsic motivations (e.g., Duncan et al., 2010; Edmunds et al., 2006; Rodgers et al., 2010) which is wholly consistent with Ryan's (1995) assertion that well-internalised extrinsic motives may reflect that exercise is not intrinsically pleasurable for many individuals

(Eves et al., 2003; Markland & Ingledew, 2007; Wilson, Rodgers, Fraser, & Murray, 2004). The considerable value that society bestows upon exercise for health and aesthetic gains, would suggest that exercise behavior constitutes more of an externally motivated activity that requires internalization to initiate and sustain action.

Although this suggests that exercising for pleasure and its value may be more important than feelings of guilt or external pressure to participate, Ryan (1995) also states that the characteristics of the situation in question will determine the extent to which motivational regulations produce positive behavioural outcomes. Although less common, introjected regulation has been associated with more frequent exercise participation (Edmunds et al., 2006b, Thogersen-Ntoumani & Ntoumanis, 2006) with one investigation noting this effect for women only (Wilson et al., 2004). This suggests that in certain contexts, those choosing to exercise voluntarily, may do so for a self-imposed goal and may feel guilty about failing to achieve their own goal or letting others down by their failure. Introjected motivation is also more likely to facilitate exercise initiation and short-term persistence but unless the introjects are internalised, exercise adherence is unlikely to be maintained over time (Edmunds et al., 2006b). Such a hypothesis is supported in the sporting domain (Pelletier et al., 2001; Perrin, 1979; Ryan et al., 1997). For example, in a prospective study of competitive swimmers, Pelletier and colleagues found that introjected regulation for practicing swimming positively predicted persistence at the 10-month follow-up, yet only intrinsic motivation predicted persistence at the 22 month follow up (Pelletier et al., 2001). In summary, extant research would suggest a trend towards identified regulation predicting initial/short-term adoption of exercise more strongly than

intrinsic motivation, and intrinsic motivation being more predictive of long-term exercise adherence.

Limitations in SDT Research

Ryan & Deci (2007) contend that exercise behaviour will be maintained by those who regulate their exercise activities through autonomous processes. However, to make such assumptions, one would expect a SDT literature rich in prospective studies. A recent review of 66 empirical studies published up to June 2011 (Teixeira, Carraça, Markland, Silva, & Ryan, 2012) reported the design characteristics of 72 reported SDT samples and highlighted a current literature characterised by cross sectional (n=45) or short term prospective studies, including an over reliance on self-report measures (n=56). As cross sectional examinations fail to explain the motivational mechanisms influencing exercise engagement and health outcomes, there is a clear need for more longitudinal methodologies that can examine the internalisation process over time.

Mullen & Markland (1997) contend that 'there is likely to be a shift in an individual's motivational focus from extrinsic to intrinsic between initial exercise adoption and adherence to a program of regular exercise' (p.350). In a summary of four studies that tested for changes in regulations in exercise initiates, Rodgers et al. (2010) is one of a few longitudinal studies in the literature to collect data on exercise behaviour at 6, 12, 18 and 24 weeks. The authors reported significant reductions in external regulation (2/4 studies) accompanied by increases in identified regulation (3/4 studies) and intrinsic motivation (2/4 studies). Interestingly, no changes in SDT

regulations were found beyond 12 weeks, although this may be due to a reliance on self-reported estimates used in the study.

Only three studies to date, all cross sectional, have addressed the relationship between SDT regulations and cardio-respiratory fitness, two in adults (Wilson et al., 2003; Wilson et al., 2012) and one in children (Shen et al., 2007). The study by Shen et al. (2007) tested a transcontextual model of SDT in conjunction with the Theory of Planned Behaviour. The use of a composite score for motivational regulations make it impossible to assess the independent effects of SDT regulations. In the only study to investigate SDT and fitness with a military sample, namely male US air force personnel (n=114), Wilson et al. (2012) reported health related motives (autonomous) to be more strongly related to fitness than exercising to pass the annual fitness test (controlled), a finding consistent with SDT (e.g. Edmunds et al., 2006; Duncan et al., 2010; Ng et al., 2012; Rodgers et al., 2010; Wilson et al., 2004). This finding is noteworthy given the fact that continued employment and promotion is partially dependent on meeting an annual fitness standard within the sample of the present thesis. Unfortunately, the fitness score used in this study included a composite score of cardio-respiratory, muscular strength and body composition components, making it impossible to assess the effects to cardio-respiratory fitness only. Further, a composite score of intrinsic and identified motivation make it impossible to assess the independent effects of either regulation. Finally, Wilson et al. (2003) tested the potential effects of SDT in a relatively small sample (n = 54) of predominantly female participants (83%) enrolled on a 12-week exercise course. The paper reported that identified and intrinsic regulations for exercise were positively related to fitness at the course outset, with no effects of introjected or

external regulations, a finding consistent with the meta-analysis of SDT studies of exercise behaviour (Ng et al., 2012), although the sex of the participants, a major biological constraint on levels of cardio-respiratory fitness, was not included in the modelling. Nonetheless, the authors were interested in mediation and tested potential effects of the regulations singly, despite a substantial correlation between them (Pearson *r* = .65). While the relative contribution of different autonomous regulations was not reported from multivariate testing, follow-up analysis of the provided correlation matrix reveals a significant beta weight only for the relationship between intrinsic motivation and fitness. Unfortunately, no longitudinal relationships were tested in this study either, though the data were available.

In summary, greater frequency of reported effects of autonomous regulations (both intrinsic and identified) over controlled regulations on physical activity (Ng et al., 2012) suggests that exercising for enjoyment and its value may be more important than feelings of guilt or external pressure. This pattern is typical of both self-report (e.g., Brunet & Sabiston, 2010; Rodgers et al., 2010; Silva et al., 2011), and objective measures (e.g., Standage et al.; Wilson et al., 2012). There is, however, a relative dearth of longitudinal research, particularly measuring effects on the important public health outcome of cardio-respiratory fitness, with extant studies reporting only cross-sectional information. Efforts to explain the motivational mechanisms of health related outcomes longitudinally are important in order to confirm the effects and stability of underlying regulations. This can only be done by controlling for the heritable contributions to fitness (Bouchard et al., 1998; Bouchard & Perusse, 1994).

Summary of the Models

In the context of the present thesis, both the SDT and TPB provide a comprehensive explanatory system well suited to study the potential psychological determinants on fitness. The TPB, as a social cognitive theory, is concerned with the decision making process that leads to the enactment of a specific behaviour, whereas SDT, a macro-theory of human motivation, is concerned with the conditions that foster the development of self-determined, autonomous behaviour. As such, the TPB is well placed to identify '*what*' psychological antecedents of behaviour determine changes in cardio-respiratory fitness whilst the SDT's regulatory continuum is well placed to identify '*why'* different motivational regulations change cardio-respiratory fitness. A longitudinal analysis of both theories will provide evidence of how behaviour changes over time.

Following a review of the literature we postulate that self-determined forms of regulation from SDT (intrinsic motivation and identified regulation) and the attitude and PBC constructs of the TPB, will deliver positive consequences (increases in fitness), whereas controlling regulations of the SDT (external regulation and amotivation) would lead to negative outcomes (reductions in fitness).

Methodological considerations

The present review has made the case for the merits of objective (cardio-respiratory fitness) over subjective markers (self-report questionnaire) of behaviour. Given the popularity of the TPB and SDT frameworks it is surprising that, to date, their associated constructs have rarely been used to predict objectively assessed dimensions of physical activity, with none longitudinally. Additionally, self-reported

cognitions and behaviour share common method variance which could make them appear more similar than they are. Indeed Scott et al. (2007) reported that a scale correspondent measure of walking was well predicted by the TPB (35.8% of variance) yet this self-report measure of walking was unrelated to an objective of the actual behaviour.

Progress towards addressing important questions on the long term psychological predictors of health outcomes (fitness) would not only benefit from greater attention to this measurement issue, but also to the application of multi-level modelling that would assess the direction and magnitude of changes in psychological determinants over time (Edmunds et al., 2008). This could also provide a better understanding of their dynamic and temporal patterns and interrelationship with an objective health outcome. The employment of more sophisticated modelling techniques, longitudinally and with an objective marker of health, is clearly warranted and will be explained in more detail.

Structural Equation Modelling (SEM) is an advanced statistical technique which allows researchers to analyse all variables simultaneously, test causal relationships between variables and test complex models in order to support the theory (Gall, Gall, & Borg, 2007). Vallerand (1997) for example, recommends the use of SEM, because it aligns with the multidimensional approach of the SDT. In contrast to most current research where different variables are often combined, through SEM, all variables within this investigation can be assessed both independently and directly onto the behavior itself. In this way, it is possible to ascertain how the different psychological mediators relate to each construct, and in turn, their associations to

cardio-respiratory fitness. Further, changes amongst and within constructs can be monitored over time.

To ensure the underlying statistical assumptions were met within the present investigation, global fit indices were used to evaluate overall model fit. Within all empirical chapters: a) the overall chi-square test of model fit was statistically non-significant, b) the Root Mean Square Error of Approximation (RMSEA), which evaluates the model-data-fit by estimating the overall discrepancy between observed and model-implied covariances, was less than .05, (c) the *p* value for the test of close fit was statistically non-significant, (d) the Comparative Fit Index (CFI), used to evaluate the model's absolute or parsimonious fit relative to the null or hypothetical model, was greater than .95; and (e) the standardized root mean square residual, an estimate of the difference between the hypothesized covariance matrix and actual sample covariance matrix, was less than .07 (Hu & Bentler, 1999).

Finally, in order to meet optimum conditions specific to the theoretical models, a pilot study was undertaken to test both the factor structure of the variables and questionnaire format that we planned to use (unipolar belief statements with a bipolar 6-point scale for agreement). Results indicated that Air Force personnel considered a six month period to be the longest over which they could make meaningful reports of their cognitions about physical activity. Thus, questionnaire items where required were specified with respect to exercising over a six month period. A copy of the questionnaire used at each time point is located at Appendix 1-3.

In summary, the methodological properties of the present investigation (objective and self-report measures at 3 time points, longitudinal design and

advanced statistical analysis through SEM) makes this research unique within the fields of SDT and TPB.

Programme of Study

The aim of the introduction chapter was to substantiate the need to investigate the psychological determinants of changing fitness levels. Epidemiological studies have made clear the link between the relative risk of different contributors to chronic diseases and low fitness. However, often behavior is the precursor of these physiological risks, and the factors that predict behavior are therefore of considerable interest. Modelling that could simultaneously estimate the effects of baseline physiological risk factors and the underlying cognitions that can result in protective behavior during any intervening period would provide public health with a more complete model of the development of a disorder. For such a model, tracking of the cognitions over meaningful public health time frames, with an objective health outcome, would be a first for the literature.

Chapters 2, 3, 4 and 5 will comprise four independent and logically sequenced original empirical investigations, each presented as a self-contained research paper. The purpose of each of these chapters was to explore the cognitive and behavioural correlates of adults' cardio-respiratory fitness using theoretical constructs forwarded in Self-Determination Theory (SDT; Deci & Ryan, 2000) and the Theory of Planned Behaviour (TPB; Azjen, 1991). The studies are part of a series of longitudinal investigations of the effects of SDT and TPB variables on fitness over an extended time period. The studies contained in Chapters 2 and 3 investigate the association

between the psychological variables of the SDT and TPB and *increases* in fitness to meet an end of (9 week) course minimum requirement. Subsequent studies contained in Chapters 4 and 5 investigate how these same variables might be related to *losses* in fitness over a longer time frame of interest to public health, e.g., three years.

Examining the Psychological Determinants of Fitness over 9 Weeks

The studies contained in Chapter 2 (SDT) and 3 (TPB) tests the contribution of potential psychological determinants both cross-sectionally and longitudinally over a period of 9 weeks. In both studies, the association between variables and cardio-respiratory fitness at the start of the fitness course was assessed, controlling for the effects of sex of the participants. We predicted that effects of the SDT's autonomous regulations and TPB's affective components of attitude would be of greater magnitude than controlled regulations (SDT) and instrumental attitude (TPB). Further, for the TPB, we predicted effects of both affective and instrumental components on intentions towards exercise given the important instrumental value for the recruits in passing the fitness course. We assumed that a 9-week fitness course may change variables but would represent only a brief period of an adult's exercise experiences, relative to their earlier history of participation. Consequently, we expected relatively small magnitude changes in variables and considerable stability of the underlying cognitions. Second, the effects of all variables on cardio-respiratory fitness were tested at the end of the fitness course, controlling for the effects of fitness at the beginning of the course and sex of the participants. In essence, this second analysis tested for the effects of psychological variables on *changes* in cardio-respiratory fitness resulting from the course.

Examining the Psychological Determinants of Fitness over 3 Years

The behaviour of recruits during basic training is such that daily physical activity is mandated. A longer term study can therefore test both the SDT and TPB in predicting changes in cardio-respiratory fitness over a timeframe more aligned to a general population. The study contained in Chapter 4 (SDT) and Chapter 5 (TPB) tests contributions of potential psychological determinants both cross-sectionally and longitudinally over a period of 3 years, mediated through planned moderate to vigorous physical activity, whilst controlling for the effects of fitness on entry. It was expected that exercise frequency would be more strongly related to autonomous regulations of the SDT (than to controlling regulations), and to more affective components of attitude (than instrumental components) within the TPB. Finally, we modelled the effects of variables on entry to variables at three years. Importantly for public health, this second analysis tested for the effects of *changes* in variables on *changes* in cardio-respiratory fitness, whilst controlling for gender and prior fitness at baseline. We assumed that a three year period would allow for more extensive changes in SDT/TPB cognitions over time.

In the closing chapter (Chapter 6), the findings from the four empirical chapters are drawn together and discussed in light of previous literature. Limitations of the research are considered in line with directions for future research that build upon the work presented in this thesis and advance the evidence base pertaining to the effects of intrinsic and extrinsic regulations of the SDT perspective, and the underlying cognitions of the TPB.

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Chapter 2

Contributions of Self-Determination Theory Variables to Cardio-respiratory Fitness Before and After a 9-Week Fitness Course.

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Abstract

While low levels of cardio-respiratory fitness represent a major health risk, few studies have investigated the possible contribution of psychological determinants to fitness, and none longitudinally. This study tested the potential contribution of the Self Determination Theory cognitions of autonomous (intrinsic and identified) and controlled (introjected and external) motivation to cardio-respiratory fitness. Potential recruits to the Royal Air Force in the UK (*n* = 420) completed questionnaires and cardio-respiratory fitness tests at the beginning and end of a 9-week fitness course. Structural equation modeling revealed negative effects of external regulation and positive effects of intrinsic motivation on levels of fitness at the course outset. Only intrinsic motivation contributed to changes in fitness from the beginning to the end of the course. There were significant reductions in controlled motivation regulations at the end of the course but no changes in autonomous ones. This study suggests that intrinsic motivation is of major importance to cardio-respiratory fitness, even when individuals may have prominent controlled reasons for participating in exercise.

Key words: *Cardio-respiratory fitness, physical activity, cross-sectional, longitudinal, Self Determination Theory*

Introduction

Cardio-respiratory fitness, a health related component of physical fitness defined as the ability of the circulatory, respiratory and muscular systems to supply oxygen during sustained physical activity, has preventive effects on both premature morbidity and mortality (Lee, Artero, Sui, & Blair, 2010). In a recent review, Lee et al., (2010) reported that high fit men and women had a 43% and 53% lower risk of all-cause mortality, and 47% and 70% lower risk of cardiovascular disease mortality, than low fit men and women respectively. Indeed, the magnitude of risk on mortality from low cardio-respiratory fitness (Relative Risk (RR) = 1.52) is greater than the relative risks from high blood pressure (RR = 1.30), high cholesterol (RR = 1.34), high blood sugars (RR = 1.24) and being overweight (RR = 1.02; Blair et al., 1996).

Increased exercise (i.e. planned physical activity), is the only route to improved cardio-respiratory fitness. Current recommendations to obtain fitness benefits from physical activity are for a minimum of 30 minutes of at least moderate intensity physical activity on five or more days of the week (Haskell et al., 2007). While the Health Survey for England (HSE, 2008) revealed that 61% of men and 71% of women in England reported that they failed to meet this criterion, self-reported levels of activity may be misleading (Troiano et al., 2008). When activity was measured objectively with accelerometers, insufficient levels of activity in the England were true for 94% and 96% of men and women respectively (HSE, 2008), with similar levels of insufficient activity reported in the US (89% men, 91% women; Tucker, Welk, & Beyler, 2011). Motivating individuals to perform sufficient physical activity to achieve the health related outcome of cardio-respiratory fitness is an important issue for public health.

Self-Determination Theory (SDT) is an influential model for the effects of motivation on health behaviour (Deci & Ryan, 2000; Hagger & Chatzisarantis, 2007; Ng et al., 2012; Ryan & Deci, 2007). According to SDT, motivation varies on a self-determination continuum ranging from autonomous motivation to controlled motivation and finally to amotivation. Performing behaviour for the pleasure it gives (intrinsic motivation) or for its valued outcomes (identified regulation) represent examples of autonomous motivation. In contrast, performing behaviour to avoid feeling guilty or to attain contingent self-worth (introjected regulation) or because of external pressure or reward contingencies (external regulation) represent examples of controlled motivations. Within SDT, the absence of autonomous or controlled motivation is indicated by amotivation.

The originators of SDT argue that participation in regular exercise "is most likely when a person has both intrinsic motivation and well-internalized extrinsic motivation [identified regulation], as both facilitate what is, normatively speaking, a precarious endeavor" (Ryan & Deci, 2007, p. 5). Research testing the utility of SDT to assess motivation for exercise is broadly consistent with this premise, both for self-report measures (e.g., Edmunds, Ntoumanis, & Duda, 2006; Mullen, Markland, & Ingledew, 1997; Rodgers, Hall, Duncan, Pearson, & Milne, 2010; Silva et al., 2011), and for the less frequently obtained objective ones (e.g., Sebire, Standage, & Vansteenkiste, 2011; Standage, Sebire, & Loney, 2008). Often, identified regulations for exercise are more prominent than intrinsic motivations (e.g., Duncan, Hall, Wilson, & Jenny, 2010; Edmunds et al., 2006; Rodgers et al., 2010), possibly reflecting the fact that exercise may not be intrinsically pleasurable for many individuals (Eves, Hoppé, & McLaren, 2003; Markland & Ingledew, 2007; Wilson, Rodgers, Fraser, &

Murray, 2004). Nonetheless, the meta-analysis of Ng and co-workers (2012) indicated greater effects of autonomous regulations (both intrinsic and identified) than controlled ones for physical activity and exercise. This result suggests that exercising for pleasure and its value may be more important than feelings of guilt or external pressure to participate.

In this study, we investigate the potential contribution of motivational regulations to cardio-respiratory fitness in a situation where exercise had clear extrinsic value to participants. For trainee aircraft personnel in the UK, a minimum level of fitness is a pre-requisite for progression to training for the profession. Planned physical activity (i.e., exercise) is the only way to achieve this outcome. The behavior of potential recruits before enrolment is voluntarily chosen but, nonetheless, there is a clear external goal. Hence, SDT regulations can test for contributions of autonomous and controlling regulations to fitness at the course outset. During their first nine weeks, recruits participate in a uniform, mandatory fitness course. Participation in this course is obligatory, and passing the fitness assessment at the end of the course is a condition of progression. As a result, there is extrinsic value in the behavior for the recruits during the course and one might expect such a situation could reveal effects of extrinsic autonomous (identified regulation) and extrinsic controlled (introjections and external) regulations at the end of the course, as well as its outset. One key issue with adults is that they will begin any exercise programme with a prior history of physical activity participation. This prior experience could inevitably leave some motivational 'baggage'. Monitoring any changes in motivational regulations longitudinally can test the extent to which regulations can be transformed, or in SDT parlance 'internalized'. This study tests for associations

between motivational regulations and fitness at the end of the course, controlling for motivational regulations present at the start.

We can find only three previous studies addressing the relationship between SDT regulations and cardio-respiratory fitness, two in adults (Wilson, Markey, & Markey 2012; Wilson, Rodgers, Blanchard, & Gessell, 2003) and one in children (Shen, McCaughtry, & Martin, 2007). The cross-sectional study by Shen et al. (2007) tested a transcontextual model of SDT in conjunction with the Theory of Planned Behaviour. The use of a composite score for motivational regulations make it impossible to assess the independent effects of SDT regulations. The cross-sectional study by Wilson et al. (2012) reported that exercising for health related motives (intrinsic) was more strongly related to fitness in male air force personnel (n = 114) than exercising to pass the annual fitness test (extrinsic), a finding consistent with SDT. Unfortunately, the fitness score in that study included cardio-respiratory, muscular strength and body composition components, making it impossible to assess effects specific to cardio-respiratory fitness. Finally, Wilson et al. (2003) tested the potential effects of SDT in a relatively small sample (n = 54) of predominantly female participants (83%) enrolled on a 12-week exercise course. The paper reported that identified and intrinsic regulations for exercise were positively related to fitness at the course outset, with no effects of introjected or external regulations, a finding consistent with the meta-analysis of SDT studies of exercise behaviour (Ng et al., 2012). Nonetheless, the authors were interested in mediation and tested potential effects of the regulations singly, despite a substantial correlation between them (Pearson r = .65). While the relative contribution of different autonomous regulations was not reported from multivariate testing, follow-up analysis of the provided

correlation matrix reveals a significant beta weight only for the relationship between intrinsic motivation and fitness. Importantly, no longitudinal relationships were tested in this study, though the data were available, and sex of the participants, a major biological constraint on levels of cardio-respiratory fitness, was not included in the modelling. In summary, the available data on potential SDT determinants of cardio-respiratory fitness are relatively limited and not very informative.

The distinction between cross-sectional and longitudinal data is particularly relevant to cardio-respiratory fitness. While physical activity can influence fitness, there are major effects of genetics on fitness that are independent of activity (Bouchard et al., 1998; Bouchard & Perusse, 1994). Only longitudinal data can test for changes in fitness that might be influenced by motivation. In this paper, we use structural equation modelling to simultaneously test two relationships. First, the association between SDT regulations and cardio-respiratory fitness at the start of the fitness course was assessed, controlling for the effects of sex of the participants. Given the nature of the training course, we predicted effects for both autonomous and controlled regulations as well as amotivation, though we expected greater magnitude in effects for autonomous regulations, based on theoretical arguments (Deci & Ryan, 2008) and meta-analytic evidence in the SDT literature (Ng et al., 2012). Second, we tested the effects of SDT regulations on cardio-respiratory fitness at the end of a fitness course, controlling for the effects of fitness at the beginning of the course. Additionally, we assessed the effects of motivational regulation prior to the fitness course that might be termed motivational 'baggage' on motivational regulations at the end of the course. In essence, this second analysis tested for the effects of *changes in* SDT variables on *changes* in cardio-respiratory fitness resulting

from the course. We assumed that a 9-week fitness course may change regulations but would represent only a brief period of an adult's exercise experiences, relative to their earlier history of participation. Consequently, we expected relative small magnitude changes in regulations and considerable stability of the underlying cognitions.

Methods

Participants

Participants (*n*=462) for this study were 385 male and 77 female UK Royal Air Force recruits undertaking basic recruit training, with an average age of 20.8 (*SD* = 2.9) years. Ethical approval to conduct the study was obtained from the ethics review committees of the local university and Royal Air Force. Forty two individuals did not complete the second testing session, with the only difference from those retained being lower levels of cardio-respiratory fitness at intake (t (460) = 2.73, p = .046).

Measures

i) Questionnaire

Participants completed a series of questions measuring autonomous and controlled motivational regulations for exercise, as well as amotivation, using a minor adaptation of the questions employed by Mullen et al. (1997). The questionnaire provided unipolar belief statements with a bipolar response format. Thus, participants had to rate whether they agreed or disagreed for each statement, with the options *strongly*, *moderately* and *weakly* for agreement and disagreement. Participants circled the response that most accurately reflects their feelings for each statement. Three questions assessed Intrinsic Motivation e.g., *I enjoy my exercise sessions* (Cronbach's alphas at start/end of course = .91/.93), Identified Regulation, e.g. *I value the benefits I can obtain from exercise* (Cronbach's alphas = .72/.81) and Introjected Regulation, e.g., *I feel guilty if I don't exercise* (Cronbach's alphas = .76/.85). Level of External Regulation were assessed with four questions, e.g., *I exercise because others will be displeased with me if I don't* (Cronbach's alphas =

.75/.81), as was Amotivation, e.g., *I exercise but I can't see what I'm getting out of exercise* (Cronbach's alphas = .75/.79). In addition, the demographic information of age and gender was obtained.

ii) Physical fitness

To assess cardio-respiratory fitness, the $\dot{V}O_{2\,max}$ proxy from the Multi-Stage Fitness Test (MSFT) which allows simultaneously testing of large numbers of participants was used (Leger & Lambert, 1982). The MSFT, also known as the 'bleep test', involves a 20 meter shuttle run between two points. Each shuttle must be completed before a bleep is played over a loudspeaker. The time between each bleep progressively decreases, requiring participants to increase their pace to reach the point before the next bleep. Eventually, the performer is unable to complete a shuttle run before a bleep and the test ends. The final level and bleep reached can be used to estimate $\dot{V}O_{2\,max}$. In the current study, the testing was carried out in groups of about 10 recruits. The relationship between MSFT score and $\dot{V}O_{2\,max}$ has been found to be independent of sex and age (Armstrong & Duggan, 1990).

Procedure

All participants completed a questionnaire pack and undertook a maximal fitness test on the same day. Prior to the distribution of the questionnaire, the purpose of the study and all experimental procedures were explained to the participants by way of a briefing and an informed consent form, which was signed by all participants. It was explained that there were no 'right' or 'wrong' answers, that answers would be confidential, and that participants did not have to put their names on the questionnaires. To protect anonymity, the recruits were matched based on their

dates of birth, gender, and service number. The questionnaire was administered in the presence of a researcher in quiet conditions. This procedure was repeated at the end of their training program nine weeks later.

Statistical Analyses

All of the main analyses were conducted using structural equation modeling (SEM) and variance/covariance matrices using EQS (version 6.1; Bentler & Wu, 2002).

Results

Summary Statistics and Correlations

Table 2.1 contains the inter-correlations between the variables, the means (*SD*) and Cronbach's alphas. Inspection of the means at time 1 reveals that, overall, participants' agreed with statements that their exercise regulations were autonomous (intrinsic and identified), particularly so for identified regulation, and disagreed that they were regulated externally or amotivated. Introjected regulation was intermediate but above the mid-point of the scale. Similar patterns were seen at both time points. Concerning associations with fitness, significant correlations between intrinsic regulation (positive) and amotivation (negative) at time 1 were non-significant at time 2. Finally, the positive correlations between sex and fitness confirm higher fitness scores in men than women.

Bonferroni corrected analyses testing for any changes in motivational regulations as a result of the 9-week course revealed significant decreases in introjected (t (419) = 5.61, $p < .001$) and external regulations (t (419) = 6.29, $p < .001$), as well as amotivation (t (419) = 3.12, $p = .01$). In contrast, there were no significant changes in intrinsic ($p = .67$) or identified regulations ($p = 1.00$)).

Path Analysis

The tested model assumed that (a) fitness at time 1 would be predicted by the SDT variables and sex of the participant, and (b) that fitness at time 2 would be predicted by fitness at time 1, sex and any changes in the SDT variables at time 2.

Time 1 (Enlistment)

	2	*3*	*4*	*5*	*6*	*7*	*α*	*M*	*SD*
1. Intrinsic Motivation	.47***	.28***	-.25***	-.41***	.00	.25***	0.93	4.73	1.07
2. Identified Regulation	-	.35***	-.17**	-.48***	.03	.10*	0.72	5.49	0.64
3. Introjected Regulation	-	-	.13	-.12	.09	.03	0.76	4.06	1.19
4. External Regulation				.46***	-.07	-.14	0.75	2.33	1.04
5. Amotivation					-.02	-.17*	0.80	1.82	0.90
6. Sex (male 1, female 2)						-.61***	-	-	-
7. Fitness Time 1							-	45.07	6.98

***p < .001 ** p < .01 * p < .05

Table 2.1 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 1.

Time 2 (9 Weeks)

	2	*3*	*4*	*5*	*6*	*7*	*α*	*M*	*SD*
1. Intrinsic Motivation	.55***	.34***	-.32***	-.49***	.07	.14	0.91	4.77	1.03
2. Identified Regulation	-	.42***	-.24***	-.52***	.11	.02*	0.81	5.44	0.72
3. Introjected Regulation	-	-	.07	-.25***	.07	.04	0.85	3.76	1.32
4. External Regulation				.43***	-.13	-.06	0.81	2.02	1.01
5. Amotivation					-.14	-.01	0.79	1.69	0.81
6. Sex (male 1, female 2)						-.73***	-	-	-
7. Fitness Time 2							-	46.64	6.03

***p < .001 ** p < .01 * p < .05

Table 2.2 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 2.

Structural equation modeling analysis (*n*=420) with questionnaire items serving as indicators of the underlying factors (with the exception of sex and fitness which were modeled as observed variables) was conducted. All items loaded well on the underlying factors (Time 1 *M* of factor loadings = .731, range = .590 - .919; Time 2 *M* = .763, range = .674 - .900). As the normalized estimate of Mardia's coefficient was large (multivariate kurtosis = 91.16), the data were analysed using robust maximum likelihood analysis (Bentler, 1995). Acceptable indices of global model fit were evident: Sattora-Bentler chi-square (741) = 931.48, $p < .001$; SRMR= .066; CFI= .956; NNFI= .951; RMSEA= .031 (95% CI= .026 -.036). Figure 2.1 depicts the final structural model (the measurement model is omitted for simplicity of presentation), with non-significant paths represented by broken lines.

The final model (Figure 2.1) reveals two important points. First, intrinsic motivation (positive) and external regulation (negative) were associated with fitness at time 1, whereas only changes in intrinsic motivation positively predicted changes in fitness at time 2. Further, inspection of potential indirect effects in the model revealed indirect effects on fitness at the end of the course from intrinsic motivation (0.181) and external motivation (-0.117) at the course's outset. Second, the stability coefficients (i.e., time 1 to time 2 associations) for all SDT variables, as well as for fitness, were considerably greater than the associations between SDT variables and fitness.

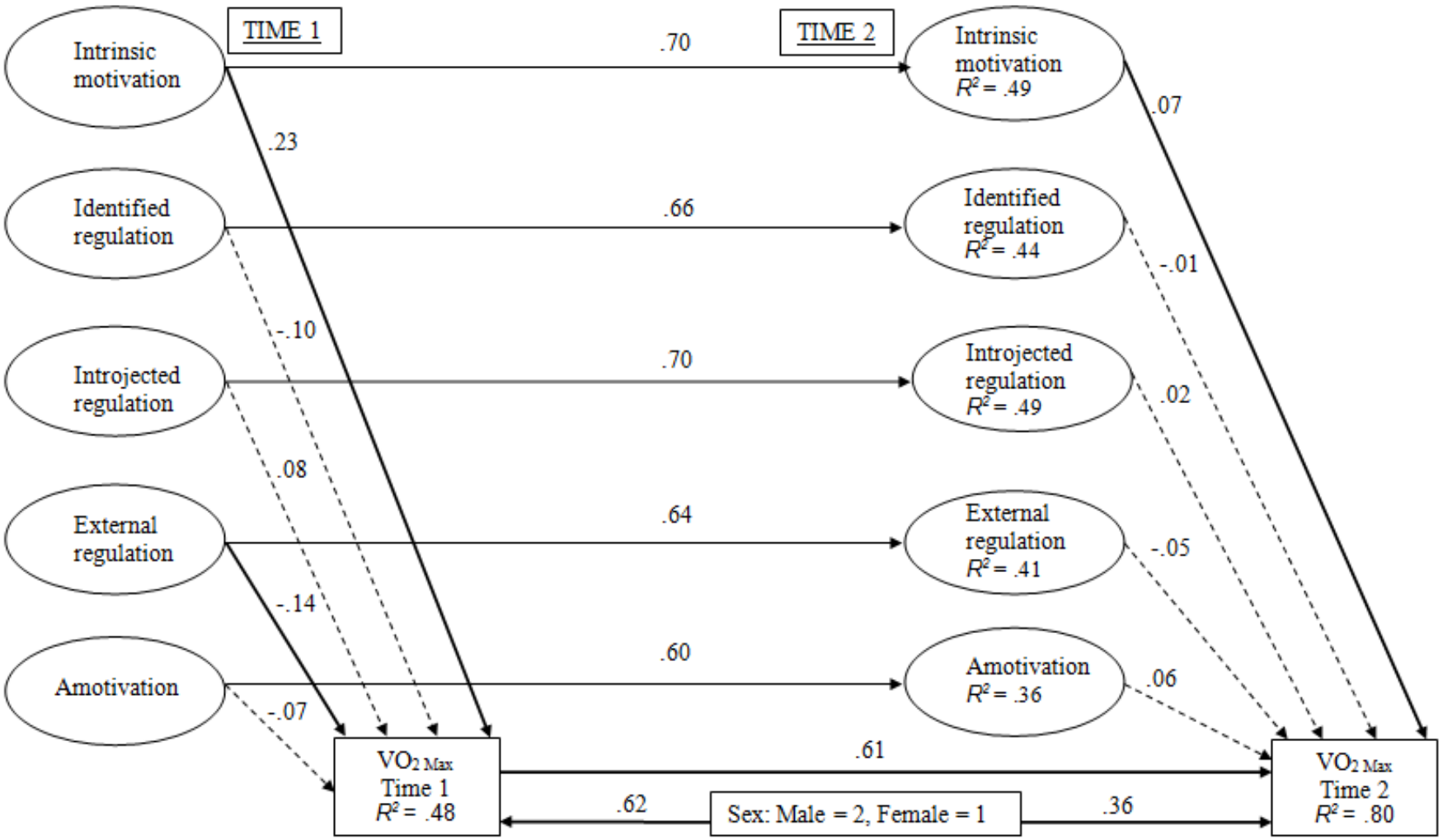

Figure 2.1. Final model including only significant, standardized paths (p<.05). Ovals represent latent factors.

Discussion

We investigated the potential contribution of motivational regulations to cardio-respiratory fitness in a 9-week compulsory fitness training course for Royal Air Force recruits. In summary, we found that intrinsic motivation for exercise was associated with greater fitness at the start of the course whereas external regulation was negatively associated with this important health-related outcome of exercise. Changes in fitness as a result of the course were only associated with changes in intrinsic motivation. There were modest reductions in controlled motivational regulations (i.e., introjected and external) at the end of the course but no changes in autonomous regulations. Finally, there was no association between cardio-respiratory fitness and either identified or introjected regulations in air force recruits.

The effects for intrinsic motivation and external regulation are consistent with the tenets of SDT. External regulation prior to the course is less likely to promote exercise that could influence cardio-respiratory fitness at the course's outset, whereas only intrinsic motivation is beneficial to fitness levels at both the start and the end of the course. Surprisingly, there was no contribution from the autonomous component of identified regulation despite the clear instrumental value of cardio-respiratory fitness for recruits. Previous research suggests that those who voluntarily choose exercise, recognize its importance in terms of health and well-being, making identified regulation an important potential predictor of exercise behavior (e.g., Edmunds et al., 2006; Duncan et al., 2010; Ng et al., 2012; Rodgers et al., 2010; Wilson et al., 2004). In this study, higher levels of identified regulation than intrinsic motivation matched this common finding in the exercise literature. As noted in the introduction, however, the one previous study with available data did not reveal any

contribution of identified regulations to fitness (Wilson et al., 2003). Here, the absence of any contribution from this type of motivation may reflect, in part, measurement issues. Average levels of identified regulation were high, 5.5 on a 6-point scale, consistent with the importance of exercise for career progression for *all* participants. Relatively uniform high levels of this variable suggest that a truncation of the available range could account for the failure of the variable to contribute to the prediction of fitness.

Introjected regulation also failed to contribute to cardio-respiratory fitness in this study, despite its positive role in predicting exercise behaviour in some cross-sectional studies of exercise (Edmunds et al., 2006; Thogersen-Ntoumani & Ntoumanis, 2006; Wilson et al., 2004). Those choosing to exercise voluntarily, do so for a self-imposed goal and may feel guilty about failing to achieve their own goal or letting others down by their failure. In contrast, the goal of adequate levels of cardio-respiratory fitness here has been imposed on the recruits by their potential employers, the air force. It is possible that imposed goals are less likely to engender feelings of guilt that influence behaviour should they not be met.

While the effects for intrinsic motivation are consistent with previous SDT research, and more broadly with contributions of affective cognitions to physical activity (Rhodes, Fiala, & Conner, 2009), some of these effects may be unique to the outcome variable of cardio-respiratory fitness. To increase fitness levels, individuals obtain greater benefits the more vigorously they exercise. As the intensity of the exercise increases, however, affective experiences during exercise become negative, particularly beyond the ventilatory threshold (Ekkekakis, Parfitt & Petruzzello, 2011; Parfitt & Hughes, 2009; Parfitt, Markland & Holmes, 1994).

Inevitably, the maximal levels of exertion that have greatest effects on fitness are associated with negative affect during the behavior itself which is an important consideration particular for exercise initiates.

It has been argued previously that the immediate experiences during physical activity may be more important determinants of the behavior than the delayed consequences of participation for health (Eves & Hoppé, 2009; Eves et al., 2003). Effects of immediate experience appear particularly likely for the delayed benefit of cardio-respiratory fitness, given the negative affect produced by the intensity of exercise required for substantial improvement. In addition, the way fitness is assessed may be relevant. To measure maximal fitness, participants exercise to exhaustion which will maximize negative affect during the behavior. As a result, individual differences in tolerance of this negative affect may lead to variation in the level at which individuals reach 'exhaustion' that is partially independent of cardio-respiratory capability. Attempts to increase fitness levels, and measurement of maximal fitness itself, can be associated with negative affect. Both of these fitness-specific effects mean that lower levels of fitness could co-occur with lower intrinsic enjoyment of the behavior.

One important feature of this study was the inclusion of SDT regulations at the outset of the fitness course in the modelling. There were modest reductions in introjected and external regulations, as well as amotivation, at the end of the course but no changes in autonomous regulations. In contrast, a summary of four studies that tested for changes in regulations as a result of exercise (Rodgers et al., 2010), reported significant reductions in external regulation (2/4 studies) accompanied by increases in identified regulation (3/4 studies) and intrinsic motivation (2/4 studies).

Similarly, the one previous study of fitness and SDT reported increases in autonomous regulations but no changes in controlling ones (Wilson et al., 2003). While ceiling effects for identified regulation noted earlier may have precluded any increase here, levels of intrinsic motivations were not similarly constrained. The samples in Rodgers et al. (2010) were exercise initiates who were reported as relatively sedentary at the course outset, as were the participants for Wilson and co-workers (2003). The exercise courses were undertaken as a means of improving health in these samples. Wilson et al. (2003) reported that overall, their sample was below the 35th percentile for fitness. For our recruit sample, it is probable that exercise to improve their fitness levels was performed prior to course onset, given the importance of sufficient fitness to enrolment. Consistent with this suggestion, 74% of the recruits were above the 50th percentile for fitness in the US, with 31% above the 80th percentile (Wang et al., 2010). It is possible that any changes in autonomous regulations pre-dated the start of the course resulting in motivations at the end of the course that were well predicted by those at its outset. It is noteworthy, however, that the magnitudes of the longitudinal paths for all SDT variable were considerably greater than the effects of the SDT variables on fitness scores. These data suggest considerable stability of individual variation in the SDT cognitions over this 9-week course.

While the large non-student sample, the objective measure of fitness and the longitudinal modelling were strengths of this study, there were a number of limitations. In keeping with previous research, regulations were specified with respect to exercise in general, and not exercise for fitness reasons. It is possible that if reference was made to fitness in the measures of motivational regulations, e.g., *I*

enjoy exercising <u>to improve my fitness</u>, the predictive effects of motivational regulations on fitness would have been stronger. While it could be argued that recruits to the armed services who require fitness for their job are unrepresentative of a general population that requires fitness for health reasons, individuals trying to improve cardio-respiratory fitness for health reasons from a low initial level may also be unrepresentative. The study here tested the contributions of SDT regulations for individuals with higher levels of fitness, an understudied population. A more easily addressed concern is the time course of the study; changes in fitness over a 9-week period were tested and a longer term study could better investigate the role of motivation in predicting changes in fitness over a timeframe more relevant to public health concerns. It is noteworthy, however, that the Rodgers et al. (2010) summary of four studies reported no changes in SDT regulations beyond 12 weeks, even when the course was of twice this duration.

Conclusions

In conclusion, this is one of only three studies to investigate potential contributions of SDT to cardio-respiratory fitness in adults, and the only one to assess this relationship longitudinally. The results indicate that, similar to optional physical activity contexts, autonomous motivation (intrinsic motivation in this study) for exercise engagement is the most beneficial type of motivation.

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Chapter 3

Contributions of Theory of Planned Behavior Variables to Cardio-respiratory Fitness Before and After a 9-Week Fitness Course.

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Abstract

Background

Low cardio-respiratory fitness represents a major health risk yet few studies have investigated psychological determinants related to fitness.

Purpose

To test the contribution of potential psychological determinants to cardio-respiratory fitness at beginning and end of a fitness training course, within the Theory of Planned Behavior (TPB) framework.

*Method*s

Royal Air Force (UK) recruits (n=433) completed a questionnaire to measure TPB variables and cardio-respiratory fitness tests at the beginning and end of a 9-week fitness course.

Results

Structural equation modeling revealed that affective attitude, i.e. liking exercise, was related to intentions and fitness at the start of the course. Instrumental attitude, i.e. perceiving exercise as beneficial, was related to intentions but made no contribution to fitness. Neither intention, nor perceived behavioral control, contributed to changes in fitness as a result of the course.

Conclusions

While individuals may be positive about the benefits of exercise, it is the affective components of attitude that are related to its health related outcome of cardio-respiratory fitness.

Key words: Cardio-respiratory fitness, Exercise, Theory of Planned Behavior, Affective attitude, Instrumental attitude.

Introduction

Physical activity and fitness are protective against chronic disease making increased physical activity levels a public health goal [1,2]. In 2007, 61% of men and 71% of women in England self-reported that they failed to meet the recommended amounts of physical activity to achieve benefits to cardio-respiratory fitness [3]. When physical activity was measured objectively, these inactivity percentages were 94% and 96% for men and women respectively [3]. While less men and women in the US reported failing to meet recommendations (34% and 42%), objective measures revealed percentages of inactivity closer to those found in the UK (89% men, 91% women) [4]. These data indicate that physical inactivity affects a larger percentage of the adult population than the combined effects of misuse of alcohol (6-9%), smoking (20%) and obesity (24%) [2].

Cardio-respiratory fitness has preventive effects on both premature morbidity and mortality [5,6]. Low aerobic fitness confers a relative risk for all-cause mortality more than three and five times that of high fitness levels in men and women respectively [5,6]. Low fitness is a precursor of cardiovascular disease [7]; the magnitude of risk on mortality from low cardio-respiratory fitness (Relative Risk (RR) = 1.52) is greater than the relative risks from high blood pressure (RR = 1.30), high cholesterol (RR = 1.34), high blood sugars (RR = 1.24) and being overweight (RR =1.02). For women, low cardio-respiratory fitness (RR = 2.10) represented the highest relative risk for all-cause mortality and cardiovascular disease compared to all other risk factors, including smoking. Cardio-respiratory fitness may be one major mediator of the health outcomes of physical activity and understanding psychological determinants of cardio-respiratory fitness represents a major unfilled gap in the

literature. This paper tests the contribution of potential psychological determinants both cross-sectionally and longitudinally. As noted above, insufficient physical activity for cardio-respiratory fitness is characteristic of the US and the UK populations. Here, we test a sample for whom minimum levels of fitness are a necessity, namely recruits to the armed forces in the UK. These individuals need to be physically active to achieve this desired outcome and the sample can test potential factors relevant to increased fitness.

The Theory of Planned Behavior (TPB) is an influential model for the effects of social psychological determinants on health behavior [8]. Within the TPB, intention is the immediate antecedent of behavior. Intentions include both the planned behavior and the effort the individual will expend to achieve that outcome [8]. Intentions, in turn, are determined by attitudes towards the behavior, perceptions of normative pressure (termed subjective norms), and perceived behavioral control (PBC), namely, perceptions that one has control over participation in the behavior should one wish. These relationships are characteristic of several meta-analytic reviews covering a range of health behaviors [9,10], including physical activity and exercise [10-12]. For example, the Armitage & Conner review found that the TPB accounted for 39% and 31% of the variance of intentions and behavior respectively of a broad range of health behaviors [9]. For physical activity, Hagger et al [11] concluded that the TPB explained 46% and 27% of the respective variances of intention and behavior, with McEachan et al [10] reporting similar effects when the data were confined to prospective designs (46% and 24%).

Attitudes towards physical activity comprise two separable aspects, namely, instrumental and affective components [13-23]. Instrumental components relate to

the outcomes of the behavior (e.g. healthy or unhealthy), whereas affective components are emotion-laden judgments about the experience of the behavior (e.g. pleasant or unpleasant). Attitudes will be favorable toward behaviors with outcomes that are believed to be both beneficial (instrumental) and experiences that are pleasant (affective). Importantly for physical activity, affective components may be more important determinants of intention than instrumental ones, both for voluntarily chosen physical activity [16, 19-22] and for situations where behavior is constrained but, nonetheless, a modicum of choice remains [22]. In this study, we investigate the TPB in a situation where physical activity had clear instrumental value to participants. Trainee aircraft personnel in the UK must meet a minimum level of fitness to progress to training for the profession and physical activity is the only way to achieve this outcome. The behavior of potential recruits before enrolment is voluntarily chosen and, hence, the TPB variables can test for contributions to fitness at the course's outset. During their first nine weeks, recruits participate in a uniform fitness course. While participation is obligatory, passing the fitness assessment at the end of the course is a condition of progression. As a result, there is instrumental value in the behavior for the recruits during the course and one might expect such a situation would reveal effects of instrumental components of attitude on intention at the course's outset. Further, despite the constraint on behavior of a mandatory course, participant's attitudes and PBC towards physical activity are potentially important predictors of the fitness outcome they sought to achieve through physical activity during the course. Intentions encompass not only the intended behavior but also the expected effort and how hard the individual is willing to try to achieve the outcome [8,24]. As fitness change is directly related to the effort expended during physical

activity, effects of intention on fitness might be expected, despite the constraints on behavioral choice during the course.

While the meta-analysis of McEachan et al [10] documents over 100 prospective studies of the TPB and physical activity, we can find only one previous study of the relationship between TPB variables and cardio-respiratory fitness in adults. Sassen and co-workers tested the cross-sectional relationship between the TPB and fitness in 1,298 police officers [25]. The association between attitudes (2 items), subjective norm (2 items) and PBC (5 items) for participating in 60 minutes of physical activity each day and maximal aerobic fitness was tested. Analyses of the data revealed that attitude and PBC accounted for 5.8% of the variance of cardio-respiratory fitness, with minimal contribution from subjective norm, a common finding in physical activity studies with the TPB [11]. Unfortunately, attitude was not separated into affective and instrumental components that would allow assessment of their relative contributions to fitness. This distinction is important. Health promotion typically targets instrumental attitudes by outlining the potential benefits obtainable from physical activity [26]. If, however, instrumental attitudes are poorly related to intention, then one potential route to encourage the behavior may be ineffective [16]. Further, the modeling of Sassen and co-workers did not include sex of the participant, a major biological constraint on levels of cardio-respiratory fitness present in the data set, and could not test any longitudinal relationships [25].

The distinction between cross-sectional and longitudinal data is particularly important for cardio-respiratory fitness. Physical activity can influence fitness but there are major effects of genetics that are independent of any activity [27,28]. Longitudinal data are required to test for effects of motivation on fitness if the results

are not to be obscured by genetic contributions. Effectively, researchers need to test for *changes* in fitness, i.e. control for initial fitness levels. The study here is part of a series of longitudinal investigations of the effects of TPB variables on fitness over an extended time period. This member of the series tested how TPB variables might be related to increases in fitness to meet a minimum requirement. Subsequent studies test how TPB variables might be related to loss of fitness over the longer time frames of interest to public health, e.g., three years. Typically, TPB studies cover relatively brief time frames in public health terms; five weeks was the median of over 100 prospective studies in the McEachen et al meta-analysis [10]. Changes in variables over time can weaken the effects of the model [8, 10]. In a previous study, use of a six month time frame allowed prediction of only 8% of self-reported behavior [21], considerably less than the 25.7% average reported by McEachan et al [10]. We chose to specify all TPB variables with respect to a six month period in this series of studies. Any longer time frame might have risked testing a model that was able to predict only minor amounts of the behavior of interest. Nonetheless, a 6-month period would include the nine weeks of the fitness course and the difference in the time frames for the specification of the variables and the course are of minimal relevance to the results here.

One further measurement issue should be made explicit. The theory we use is one of planned *behavior* not of behavioral outcomes such as fitness. Measures of intentions, attitudes, social norm and PBC for this theory specify the behavior of interest, not its outcome. While attitudes to cardio-respiratory fitness are a plausible cognition, social pressure towards the outcome and perceptions of control over it are less so. Further, specifying intention to achieve an outcome, rather than perform a

behavior, fits poorly within the theory's measurement framework. This measurement conundrum may explain the paucity of studies into social-cognitive determinants of cardio-respiratory fitness itself. Here, we test a TPB-based model towards exercise to investigate possible effects on one outcome of that behavior, cardio-respiratory fitness. Inevitably, this important outcome variable fits imperfectly within the measurement framework and modelling is likely to underestimate effects of the TPB variables.

In this paper, we use structural equation modelling. Figure 3.1 depicts the structural model that we sought to test. First, the association between TPB variables and cardio-respiratory fitness at the start of the fitness course was assessed, controlling for the effects of sex of the participants. We predicted that effects of affective components of attitude would be of greater magnitude than those of instrumental ones. Additionally, we tested the effects of the TPB variables on intentions at the course outset. Given the important instrumental value for the recruits of passing the fitness course, we predicted effects of both affective and instrumental components on intentions towards exercise. Second, we tested the effects of TPB variables on cardio-respiratory fitness at the end of a fitness course, controlling for the effects of fitness at the beginning of the course and sex of the participants. In essence, this second analysis tested for the effects of TPB variables on *changes* in cardio-respiratory fitness resulting from the course.

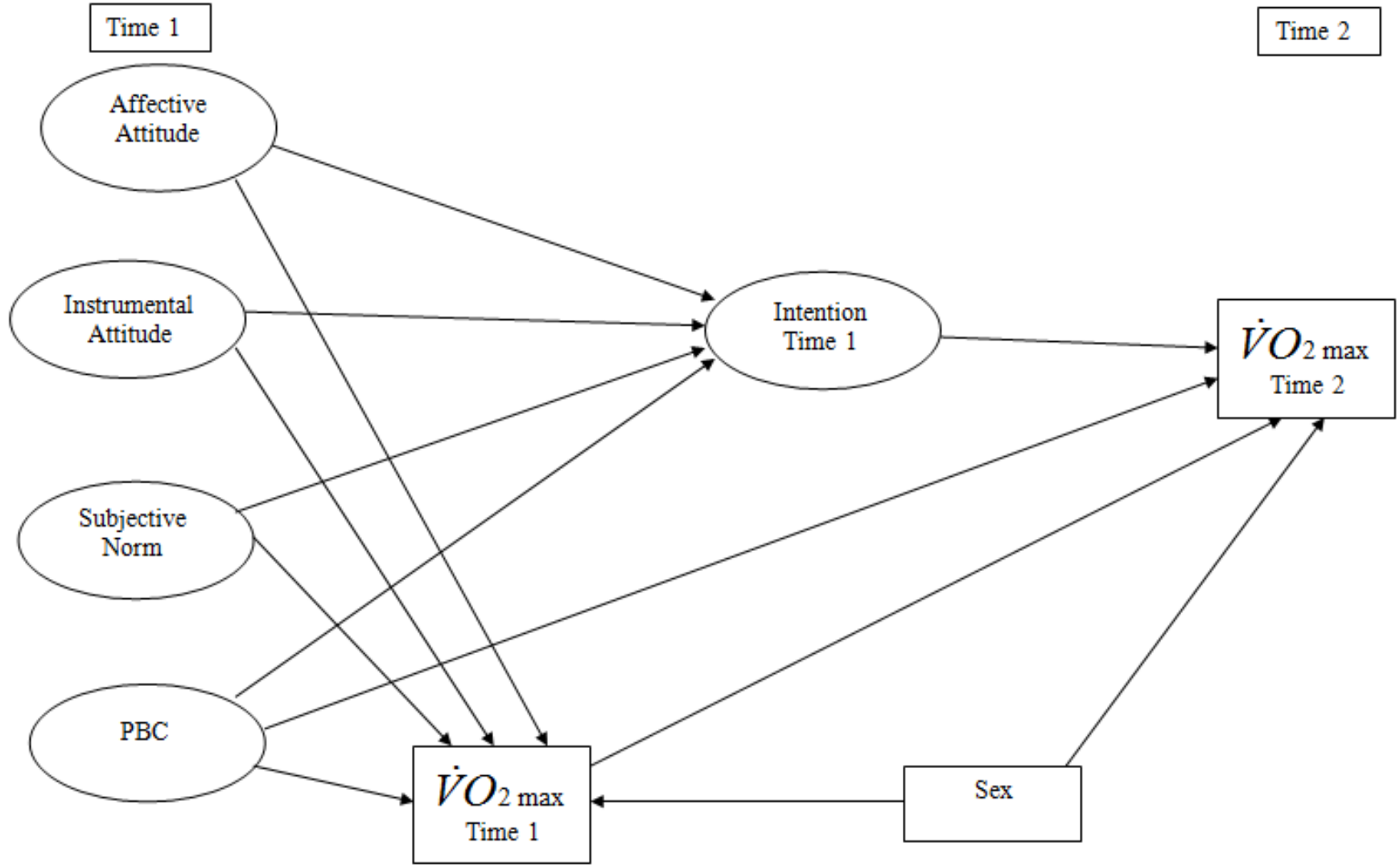

Figure 3.1. Proposed TPB Motivational Sequence. (Note. Ovals represent latent factors.)

Methods

Participants

Participants (n = 462) for this study were 385 male and 77 female recruits to the UK Royal Air Force undertaking basic recruit training, with an average age of 20.8 (*SD* = 2.9) years. Ethical approval to conduct the study was obtained from the ethics review committees of the local university and Royal Air Force. Twenty nine individuals did not complete the second testing session nine weeks later, with the only difference from those retained being lower levels of cardio-respiratory fitness at intake ($t(460) = 3.42$, $p = .004$).

Measures

i) Questionnaire

Participants completed a series of questions measuring intention, affective and instrumental attitudes, subjective norm and PBC based on Bagozzi & Kimmel [29] Connor & Sparks [30], and adapted from previous research [16,21]. The questionnaire provided unipolar belief statements with a bipolar response format. Thus, participants had to rate whether they agreed or disagreed for each statement, with the options *strongly*, *moderately* and *weakly* for agreement and disagreement. The participants circled the response that most accurately reflects their feelings for each statement. Exercise intention was assessed with three items, e.g., *I intend to exercise in the next 6 months* (Cronbach's alpha = .85). For attitude, affective components used four items, e.g., *Exercising in the next 6 months would be pleasant* (Cronbach's alpha = .83) whereas instrumental components used three items, e.g., *Exercising in the next 6 months would be beneficial* (Cronbach's alpha = .72). The

Cronbach's alpha for the three items assessing subjective norm, e.g., *My work colleagues would approve of me exercising in the next 6 months* was just below conventional acceptability, but adequate (Cronbach's alpha = .69). Finally, PBC was assessed with three items, e.g., *I am confident that I can exercise in the next 6 months if I want to* (Cronbach's alpha = .72). In addition, the demographic information of age and gender was obtained.

To assess physical activity at the end of the course, participants indicated the number of times they had engaged in a range of vigorous (e.g., jogging, racket sports) and moderate intensity physical activities (e.g., dancing, swimming, golf) within the last week, with the opportunity to specify any exercise not included in the list. To improve reporting, only those activities for which participants could specify the place, time of day and whether they had company while they exercised were included in the measure. For the summary score used in analysis, the frequencies of vigorous and moderate-intensity activity were weighted by 9 and 5, respectively. While this weighting procedure was originally devised to produce metabolic equivalents of exercise [31], here it is better considered to be a way of combining vigorous and moderate-intensity exercise resulting in a Weighted Exercise Score. Preliminary inspection of the data revealed a minimal correlation between physical activity and fitness (Pearson's r = 0.045) consistent with the obligatory nature of the physical activity undertaken. Testing a model in which physical activity mediated effects of TPB variables on fitness was precluded by the absence of a significant correlation between the fitness and activity. As a result, physical activity was excluded from modelling to allow a test of the relationship between TPB variables and fitness.

ii) Physical fitness

To assess cardio-respiratory fitness, the $\dot{V}O_{2\,max}$ proxy from the Multi-Stage Fitness Test (MSFT) which allows simultaneously testing of large numbers of participants was used [32]. The MSFT, also known as the 'bleep test', involves a 20 meter shuttle run between two points. Each shuttle must be completed before a bleep is played over a loudspeaker. The time between each bleep progressively decreases, requiring participants to increase their pace to reach the point before the next bleep. Eventually, the performer is unable to complete a shuttle run before a bleep at which point the test ends. The level and bleep reached can be used to estimate $\dot{V}O_{2\,max}$. In the current study, the testing was carried out in groups of about 10 recruits. The relationship between MSFT score and $\dot{V}O_{2\,max}$ has been found to be independent of sex and age [33].

Procedure.

All participants completed a questionnaire pack, were measured for height and weight, and undertook a maximal fitness test on the same day. Prior to the distribution of the questionnaire, the purpose of the study and all experimental procedures were explained to the participants by way of a briefing and an informed consent form, which was signed by all participants. It was explained that there were no "right" or "wrong" answers, that answers would be confidential, and that participants did not have to put their names on the questionnaires. To protect anonymity, the recruits were matched based on their dates of birth, gender, and service number. The questionnaire was administered in the presence of a

researcher in quiet conditions. The fitness test was repeated at the end of their training programme nine weeks later.

Statistical analysis

All of the main analyses were conducted using structural equation modelling (SEM) with EQS (version 6.1; [34]).

Results

Summary statistics and correlations

Table 3.1 contains the inter-correlations between the variables, the means (*SD*) and Cronbach's alphas. Inspection of the means reveals strong agreement with the statements for all TPB variables, particularly so for intention and instrumental attitude. Additionally, the correlations indicate inter-relationships between all of the TPB variables as expected. Concerning fitness, however, only affective attitude and PBC were correlated with assessments at time 1 and 2 and there was no significant association between intention and fitness. Finally, the positive correlations between sex and fitness confirm higher fitness scores in men than women.

Path analysis

The proposed model to be tested, depicted in Figure 1, assumed that a) fitness at time 1 would be associated with the TPB determinants and sex of the participant, and b) that fitness at time 2 would be predicted by fitness at time 1, sex and the TPB variables of intention and PBC.

Path analysis (n=433) was conducted using EQS 6.1 [34]. As the normalized estimate of Mardia's coefficient was large (multivariate kurtosis = 140.35), the data were analyzed using robust maximum likelihood analysis [35]. Analysis of the TPB model for fitness at time 2 revealed no effects of either intention or PBC, despite acceptable fit indices [Sattora-Bentler chi-square = 186.14, p = .003; SRMR = .043; CFI = .959 ; NNFI = .948; RMSEA = .029 (90% CI= .018, .039)]. Figure 3.2 depicts the final model, with non-significant paths from the initially proposed model represented by broken lines.

	2	*3*	*4*	*5*	*6*	*7*	*8*	*α*	*M*	*SD*
1. Intention	.48***	.64***	.34***	.56***	.00	.10	.08	.85	5.68	0.64
2. Affective Attitude	-	.36***	.26***	.45***	.05	.20*	.15**	.83	4.82	0.95
3. Instrumental Attitude	-	-	.44***	.44***	.06	.01	-.03	.72	5.81	0.46
4. Subjective Norm				.20***	-.01	-.00	-.02	.69	5.39	0.75
5. PBC					-.05	.25***	.17**	.72	5.25	0.83
6. Sex (male 1, female 2)						-.61***	-.73***	-	-	-
7. Fitness Time 1							.84***	-	45.05	6.97
8. Fitness Time 2								-	46.63	6.00

Note. PBC = perceived behavioural control
***p < .001 ** p < .01 * p < .05

Table 3.1 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables.

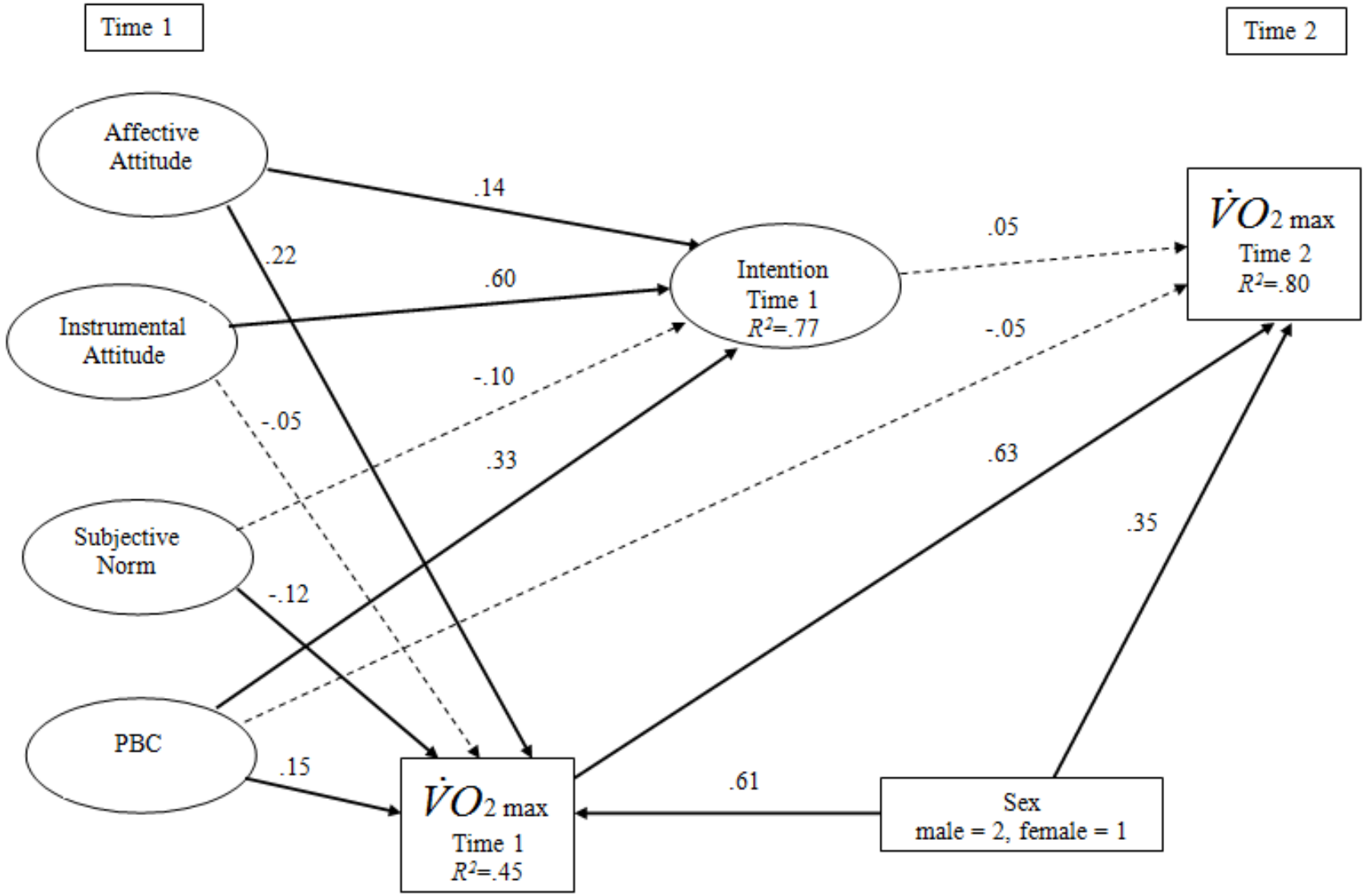

Figure 3.2. *Final model including paths. (Note.* Ovals represent latent factors).

The final model reveals three important points. First, TPB associates of fitness at time 1 differed from determinants of intention. An appreciable magnitude path from instrumental attitude to intention contrasted with a non-significant association between the same variable and fitness. Affective attitude, however, contributed to both fitness and intention. For subjective norm, there was a significant negative association with fitness and a similar magnitude, though non-significant, path to intention. Inspection of potential indirect effects in the model also revealed indirect effects on fitness at the end of the course of affective attitude (0.191), subjective norm (-0.101) and PBC (0.175) at the course's outset. Second, there were no significant paths between either intention or PBC and fitness at time 2. Finally, the R^2 values indicate that both intention and fitness were well predicted by the model variables.

Discussion

Cross-sectionally, fitness at the start of the course was associated with affective components of attitude, as predicted, and PBC, consistent with the cross-sectional data of Sassen and co-workers [25]. As has been reported for participation in exercise, instrumental components were not associated with fitness at the course outset [16,22]. The greater prediction of initial fitness in our study, 45% of the variance, compared to 5.8% of the variance in the earlier report [25] reflects, in part, the inclusion of participants' sex in the modeling. While we can offer no explanation for the unexpected negative association between subjective norm and fitness suggesting a suppressor effect in the data set, the results clearly do not reveal positive associations between normative pressure and fitness, consistent with the weak associations between this TPB variable and exercise participation [11].

To increase fitness levels, individuals must exercise, with greater effects the more vigorous the intensity of exercise. Thus, similar contributors to cardio-respiratory fitness, and the route through which it is achieved, are unsurprising. For intentions towards exercise, however, instrumental components of attitude were prominent, with a standardized coefficient more than four times the magnitude of affective components. These data contrast sharply with the absence of any significant contribution from instrumental components of attitude to the generic term exercise [21] or specific exercise behaviors in previous research [16,22]. It seems likely that this unusual result reflects the instrumental value of physical activity for recruits who need to pass the fitness test at the end of the course to progress. More importantly, the result demonstrates sensitivity of the measure of instrumental attitude, despite a high average value. The absence of significant paths from

instrumental attitudes to fitness at the courses' outset seems unlikely to reflect reduced variability of the variable.

The model for changes in fitness during the course contained no statistically significant effects of intention, as was apparent in the correlation matrix. The TPB is primarily a model of behavioral choice and not exercising was not an option for recruits during the fitness course. Nonetheless, intention is expected to encompass how hard an individual will try, i.e. the effort exerted to achieve the outcome [8,24], and recruits could choose the intensity at which they exercised. Hence, some effects of the effort and trying components of intention on fitness change could have been expected. Further, there were also no contributions of PBC to changes in fitness, despite a contribution to fitness at the start of the course. This pattern of results suggests the significant correlation between PBC and fitness at time 2 simply reflects associations between PBC and fitness overall. Taken together, these data do not indicate that intention or PBC specified with respect to exercise can predict changes in the fitness outcome of exercising.

We made explicit in the introduction that TPB theory was better suited to test for effects of attitude towards fitness than for the other variables in the model. Nonetheless, the primacy for effects of affective components of attitude on exercise participation is a consistent finding [16,21,22,36,37]. In all of these studies, TPB variables were specified with respect to the behavioral outcome of exercise. Further, in their review of affective judgments and physical activity, Rhodes, Fiala & Conner note a consistent relationship between affective judgments and a range of different exercise behaviors [38]. Thus, these effects of attitude are consistent with previous

research and it is the absence of effects for intention and PBC that may reflect poor specification with respect to the outcome variable, namely fitness.

The contribution from affective cognitions to fitness may result, in part, from the way in which fitness is assessed. To measure maximal fitness, participants are pushed to exercise to exhaustion. Affective experiences during exercise become negative as the intensity of the exercise is increased [39-41]. Inevitably, maximal levels of exertion are associated with negative affect during the behavior itself. During exercise to exhaustion, the negative experiences of some individuals may lead to cessation of the exercise at a lower level than dictated by cardio-respiratory capability. As a result, lower estimates of fitness for those individuals could co-occur with lower affective attitudes towards the behavior, resulting in an association between the two variables. At the other end of the scale, individuals who find maximal exertion less aversive may exercise to a greater proportion of their cardio-respiratory capacity.

The absence of any contribution from instrumental cognitions to fitness, despite a prominent effect of these cognitions on intention is important. We have argued elsewhere that the experiences during physical activity, represented by affective components of attitude, may be more important determinants of the behavior than the delayed consequences of participation reflected in instrumental components [16,42]. Negative experiences during exercise of vigorous intensity may act as a barrier to participation and contributions of affective attitude to cardio-respiratory fitness are to be expected. The failure of instrumental cognitions to contribute to cardio-respiratory fitness, despite strong instrumental reasons for achieving this outcome in the recruits, should not be taken as evidence that

promotion of cardio-respiratory fitness for instrumental reasons will inevitably be unproductive. Undoubtedly, vigorous intensity exercise will produce a greater fitness dividend per unit time spent exercising than moderate intensity activity. Nonetheless, Blair and co-workers emphasize that moderate levels of fitness are protective [43]. Such an outcome can be attained without vigorous exercise and brisk walking, one current recommendation of public health, will produce a fitness dividend [1]. Despite this, affective attitude may still be relevant. A recent study has reported that affect experienced during exercise of moderate intensity contributed to physical activity levels six and twelve months later [44], as it did for vigorous exercise three months later in a different study [45]. Ways to circumvent the potential barrier of affective experiences during physical activity represent an important unsolved public health issue for the promotion of increased cardio-respiratory fitness in the population.

There are number of limitations to this research. As noted above, the TPB is a model of behavior not outcomes and, inevitably, this research will underestimate the contribution of the TPB to the health related outcome of cardio-respiratory fitness. Despite this reservation, the models of fitness bettered the one previous study [25] and the model for intention was comparable to previous research [9-11]. It is possible that specifying TPB variables to include the outcome, e.g. *I intend to exercise in the next six months to increase cardio-respiratory fitness,* would improve the modelling though such an approach would be outside the conventional measurement framework of the TPB. Additionally, the relative uniformity of the exercise undertaken during the course precluded a test of the mediating role of exercise levels on fitness. Secondly, recruits to the armed services require a minimum level of fitness for their job whereas individuals in the general population

require fitness for health reasons. While recruits may be considered atypical, the same could be said of individuals trying to improve cardio-respiratory fitness for health reasons; the majority of the population in the UK and US are insufficiently active to achieve benefits to cardio-respiratory fitness. Without a major change in normative behaviour, any study of individuals exercising to improve fitness may be atypical. A more tractable issue concerns the time course of the study; changes in fitness over a nine week period were tested and a longer term period would better address the public health question. Finally, the multi-stage fitness test slightly underestimates cardio-respiratory fitness when compared to incremental tests in a laboratory to exhaustion [46]. Nonetheless, the logistics of individual fitness tests on large samples are likely to remain a major barrier to the use of the more accurate laboratory protocol.

Conclusions

In summary, affective attitudes and PBC were related positively to cardio-respiratory fitness at baseline and to intentions to exercise during the period of the fitness course. A negative association between subjective norm and fitness suggests a suppressor effect, consistent with the weak associations between this TPB variable and exercise participation. Instrumental attitudes were only related to intentions. The prediction of initial fitness, 45% of the variance, reflects, in part, the inclusion of participants' sex in the modeling, which was related positively to cardio-respiratory fitness at baseline and follow up. Changes in fitness as a result of the course were not predicted by any TPB variables.

There were no conflicts of interest for the researchers conducting this study.

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Chapter 4

Prediction of Cardio-respiratory Fitness with Self-Determination Theory Variables over a 3-Year Period.

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Abstract

Low cardio-respiratory fitness represents a major health risk, with physical activity the only way to change this important health outcome. Despite the low prevalence of sufficient physical activity in the population, few studies have investigated the possible contribution of psychological determinants to physical activity and fitness simultaneously. None has tested for longitudinal effects. The current study investigated the contribution of Self Determination Theory cognitions of autonomous (intrinsic and identified) and controlled (introjected and external) motivation to cardio-respiratory fitness over a three year period in serving air force personnel, through the influence of these cognitions on the frequency of moderate to vigorous physical activity. Participants (*n* = 230) completed questionnaires and cardio-respiratory fitness tests on enrolment and after three years of active duty. Structural equation modeling revealed negative effects of external regulation and positive effects of intrinsic motivation on levels of fitness on enrolment. Only intrinsic motivation contributed to changes in fitness after three years. There were reductions in intrinsic and identified regulation, coupled with an increase in amotivation over the three year period suggesting a change to more controlled motivations over time. The results indicate that in a partially constrained physical activity context for adults, intrinsic motivation is the most beneficial type of motivation for gains in cardio-respiratory fitness.

Key words: Cardio-respiratory fitness, physical activity, cross-sectional, longitudinal, Self Determination Theory

Introduction

Cardio-respiratory fitness is a measure of the body's ability to consume oxygen when performing physical work. Epidemiological research has consistently revealed an inverse, curvilinear relationship between cardio-respiratory fitness and the risk of premature morbidity and all-cause mortality (Blair et al., 1989; 1995; Lee & Skerritt, 2001). For example, a review of 33 studies reported that every metabolic equivalent (MET) increment in cardio-respiratory fitness, (i.e. each increase in oxygen consumption of 3.5 $ml.Kg^{-1}.min^{-1}$), resulted in a 13% and 15% risk reduction from all-cause mortality and cardiovascular disease events respectively (Kodama et al., 2009). Data from the Aerobics Centre Longitudinal Study reveal similar estimated effects (Blair et al., 1995). Influences on cardio-respiratory fitness are of major public health interest.

Physical activity represents the only way to change fitness (Blair, Cheng, & Holder, 2001), with insufficient activity associated with a loss of fitness. The current recommendations are for a minimum of 30 minutes of moderate to vigorous physical activity on five or more days of the week to maintain cardio-respiratory fitness (Haskell et al., 2007). When physical activity was measured objectively, however, 94% of men and 96% of women in England failed to meet the recommended amounts of physical activity to achieve fitness benefits (Health Survey for England, 2008), with similar estimates in the USA (89% men, 91% women; Tucker, Welk, & Beyler, 2011). Given this low prevalence for sufficient activity in the population, information about potential motivations that would influence both physical activity and fitness is an important public health question.

Self-Determination Theory (SDT) specifically addresses the quality of people's motivation from a multidimensional perspective. Performing behavior for the pleasure it gives (intrinsic motivation), the prototype of self-determined behavior or for its valued outcomes (identified regulation), represents the upper and lower limit of autonomous motivation. In contrast, performing behavior to avoid feeling guilty or to attain contingent self-worth (introjected regulation) or because of external pressure or reward contingencies (external regulation), represent the upper and lower limits of controlled motivations. Finally, within SDT, the absence of autonomous or controlled motivations is indicated by amotivation.

Greater frequency of reported effects of autonomous regulations (both intrinsic and identified) over controlled regulations on physical activity suggests that exercising for enjoyment and its value may be more important than feelings of guilt or external pressure. This pattern is typical of both self-report (e.g., Brunet & Sabiston, 2010; Edmunds, Ntoumanis, & Duda, 2006; Mullen, Markland, & Ingledew, 1997; Rodgers, Hall, Duncan, Pearson, & Milne, 2010; Silva et al., 2011), and objective measures (e.g., Sebire, Standage, & Vansteenkiste, 2011; Standage, Sebire, & Loney, 2008; Wilson, Markey, & Markey, 2012). There is, however, a relative dearth of longitudinal research using SDT to predict physical activity (Edmunds et al., 2006; Standage & Vallerand, 2008), particularly measuring effects on the important public health outcome of cardio-respiratory fitness. We can find only two previous studies testing the relationship between SDT regulations and cardio-respiratory fitness in adults (Wilson et al., 2012; Wilson, Rodgers, Blanchard, & Gessell, 2003). Both studies indicated that autonomous motivations were more important to overall fitness than controlled ones consistent with

SDT (Ng et al., 2012). Nonetheless, both studies report only cross-sectional information, even though a longitudinal sample was available in one study (Wilson et al., 2003).

The distinction between cross-sectional and longitudinal data is particularly important for cardio-respiratory fitness. Physical activity can influence fitness but there are major effects of genetics that are independent of any activity (Bouchard et al., 1998; Bouchard & Perusse, 1994). Longitudinal data are required to test for effects of motivation on fitness if the results are not to be obscured by genetics contributions. Effectively, researchers need to test for *changes* in fitness, i.e. control for initial fitness levels. A recent study by Reay, Eves, Ntoumanis, Treweek, & White (Submitted) was the first to examine the influence of SDT on fitness longitudinally. In this study, Royal Air Force recruits underwent a 9-week fitness course prior to enrolment, with fitness and SDT regulations measured at the start and the end of the course. The study suggested that intrinsic motivation was of major importance to cardio-respiratory fitness, both at the course's outset and the only contributor to changes in fitness during the course. Despite this evidence consistent with SDT, the fitness course was mandatory for all recruits, rendering their physical activity levels during the course relatively uniform. As a result, Reay and co-workers were obliged to test effects of SDT regulations directly on cardio-respiratory fitness as there was no relationship between physical activity and fitness at the end of the course. Hence, the influence of these cognitions between the frequency of moderate to vigorous physical activity and fitness could not be assessed. Additionally, the 9-week course aimed to increase fitness.

For public health, however, it is the loss of fitness over time that is of major importance and a longer term investigation into the role of motivation is more relevant to public health concerns. While Mullen & Markland (1997) have suggested a shift from controlled to autonomous regulation should accompany exercise maintenance, Rodgers et al. (2010) only observed changes in autonomous regulations and these changes were confined to the first 12 weeks of a 6-month study. How motivation changes over a longer time frame, and how changes may be related a fitness outcome, has yet to be tested. For aircraft personnel in the UK, a minimum level of cardio-respiratory fitness after 9 weeks of service is required to progress to Phase 2 professional training; effects of SDT regulation on fitness during Phase 1 was the topic of Reay et al. (Submitted). During Phase 2, personnel are required to meet a prescribed fitness standard each year, yet have complete autonomy over their exercise regime.

In this paper, we test the effects of SDT regulations on fitness over a three year period. We use structural equation modelling to simultaneously test two relationships. First, the association between SDT regulations and cardio-respiratory fitness on enlistment was assessed, controlling for the effects of sex of the participants. Given the importance of the course to enrolment, we predicted effects for both autonomous and controlled regulations as well as amotivation, though we expected greater magnitude effects for autonomous regulations than controlling ones, based on theoretical arguments (Deci & Ryan, 2008) and meta-analytic evidence in the SDT literature (Ng et al., 2012). Second, we tested the effects of SDT regulations on cardio-respiratory fitness after three years of service, through the influence of these cognitions on the frequency of moderate to vigorous physical activity (MVPA) and controlling for the

effects of fitness on entry. It was expected that exercise frequency would be more strongly related to autonomous regulations than to controlling regulations. Finally, we modeled the effects of motivational regulations on entry to regulations at three years. In essence, this second analysis tested for the effects of *changes* in SDT variables on *changes* in cardio-respiratory fitness. We assumed that a three year period would allow for more extensive changes in SDT cognitions over time. The high stability coefficients over nine weeks in Reay et al. (Submitted) represented only a brief period of an adult's exercise experiences, relative to their earlier history of participation. Here, a three year period would allow for a more accurate test of potential effects of these longer term changes in cognitions as the behavior was voluntarily selected and not mandated by the Phase 1 fitness course. Consequently, we expected a greater magnitude of changes in regulations and less stability of the underlying cognitions.

Methods

Participants

Participants (*n*=251) for this study were 216 male and 35 female UK Royal Air Force recruits undertaking basic training, with an average age of 20.9 years (*SD* = 2.8). Ethical approval to conduct the study was obtained from the ethics review committees of the local university and Royal Air Force. Twenty one individuals did not complete the second testing session, with no differences between the drop-outs and those retained on any measure at intake (*all prob.* > .34).

Measures

i) Questionnaire

Participants completed a series of questions measuring autonomous and controlled motivational regulations for exercise, as well as amotivation, using a minor adaptation of the questions employed by Mullen, Markland, & Ingeldew (1997). The questionnaire provided unipolar belief statements with a bipolar response format. Thus, participants had to rate whether they agreed or disagreed for each statement, with the options *strongly*, *moderately* and *weakly* for agreement and disagreement. Participants circled the response that most accurately reflects their feelings for each statement. Three questions assessed Intrinsic Motivation e.g., *I enjoy my exercise sessions* (Cronbach's alphas at start/end of course = .92/.94), Identified Regulation, e.g. *I value the benefits I can obtain from exercise* (Cronbach's alphas = .77/.86) and Introjected Regulation, e.g.,

I feel guilty if I don't exercise (Cronbach's alphas = .77/.83). Level of External Regulation were assessed with four questions, e.g., *I exercise because others will be displeased with me if I don't* (Cronbach's alphas = .75/.62), as was Amotivation, e.g., *I exercise but I can't see what I'm getting out of exercise* (Cronbach's alphas = .79/.85). In addition, the demographic information of age and gender was obtained.

ii) Physical fitness.

To assess cardio-respiratory fitness, the $\dot{V}O_{2\,max}$ proxy from the Multi-Stage Fitness Test (MSFT) which allows simultaneously testing of large numbers of participants was used (Leger & Lambert, 1982). The MSFT, also known as the 'bleep test', involves a 20 meter shuttle run between two points. Each shuttle must be completed before a bleep is played over a loudspeaker. The time between each bleep progressively decreases, requiring participants to increase their pace to reach the point before the next bleep. Eventually, the performer is unable to complete a shuttle run before a bleep and the test ends. The final level and bleep reached can be used to estimate $\dot{V}O_{2\,max}$. In the current study, the testing was carried out in groups of about 10 recruits. The relationship between MSFT score and $\dot{V}O_{2\,max}$ has been found to be independent of sex and age (Armstrong & Duggan, 1990).

iii) *Self Report of Physical Activity*.

To assess physical activity at the end of the course, participants indicated the number of times they had engaged in a range of vigorous (e.g., jogging, racket sports) and moderate intensity physical activities (e.g., dancing, swimming, golf) within the last week, with the opportunity to specify any exercise not included in the list. To improve reporting, only those activities for which participants could specify the place, time of day and whether they had company while they exercised were included in the measure. For the summary score used in analysis, the frequencies of vigorous and moderate-intensity activity were weighted by 9 and 5, respectively. While this weighting procedure was originally devised to produce metabolic equivalents of exercise (Godin & Shepherd, 1985), here it is better considered to be a way of combining vigorous and moderate-intensity exercise resulting in a Weighted Exercise Score.

Procedure

All participants completed a questionnaire pack and undertook a maximal fitness test on the same day. Prior to the distribution of the questionnaire, the purpose of the study and all experimental procedures were explained to the participants by way of a briefing and an informed consent form, which was signed by all participants. It was explained that there were no 'right' or 'wrong' answers, that answers would be confidential, and that participants did not have to put their names on the questionnaires. To protect anonymity, the recruits were matched based on their dates of birth, gender, and service

number. The questionnaire was administered in the presence of a researcher in quiet conditions. This procedure was repeated 3 years later.

Statistical analysis

All of the main analyses were conducted using structural equation modeling (SEM) and variance/covariance matrices using EQS (version 6.1; Bentler & Wu, 2002).

Results

Summary statistics and correlations

Table 4.1 contains the inter-correlations between the variables, the means (*SD*) and Cronbach's alphas. Inspection of the means reveals that, overall, participants' agreed with statements that their exercise regulations were autonomous (intrinsic and identified), particularly so for identified regulation, and disagreed that they were regulated externally or amotivated. Introjected regulation was intermediate but above the mid-point of the scale. Similar patterns were seen at both time points. Inter-relationships between the SDT variables were broadly consistent across time, despite some minor changes in the magnitude of correlations. Concerning associations with fitness, the only major change was that the non-significant positive correlation between identified regulation at time 1 was significant three years later. Finally, the positive correlations between sex and fitness confirm higher fitness scores in men than women.

Bonferroni corrected analyses testing for any changes in motivational regulations after 3 years revealed significant decreases in intrinsic motivation (t (229) = 5.06, p < .001), identified (t (229) = 5.62, p < .001) and introjected regulations (t (229) = 4.55, p <.001), as well a significant increase in amotivation (t (229) = 2.82, p = .01). In contrast, there were no significant changes in extrinsic regulation or fitness over the three year period (both *prob.* > 0.70).

Enlistment – Time 1

	2	*3*	*4*	*5*	*6*	*7*	*α*	*M*	*SD*
1. Intrinsic Motivation	.49***	.27***	-.28***	-.41***	-.02	.24**	0.92	4.78	1.01
2. Identified Regulation		.37***	-.14	-.43***	-.04	.10	0.77	5.47	0.67
3. Introjected Regulation			.09	-.10	-.10	-.02	0.77	4.10	1.19
4. External Regulation				.46***	.03	-.20*	0.75	2.30	1.01
5. Amotivation					-.04	-.23**	0.79	1.80	0.86
6. Sex (male 2, female 1)						.57***	-	-	-
7. Fitness Time 1							-	45.41	6.68

***p < .001 ** p < .01 * p < .05

Table 4.1 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 1.

Three Years – Time 2

	2	*3*	*4*	*5*	*6*	*7*	*8*	*α*	*M*	*SD*
1. Intrinsic Motivation	.58***	.38***	-.19	-.52***	-.07	.29***	.31***	0.94	4.45	1.07
2. Identified Regulation		.54***	-.22*	-.66***	-.06	.21*	.22*	0.86	5.17	0.79
3. Introjected Regulation			.04	-.28***	-.11	.11	.20	0.83	3.73	1.32
4. External Regulation				.41***	.02	-.24**	-.14	0.62	2.33	1.21
5. Amotivation					.03	-.21	-.16	0.85	1.97	0.78
6. Sex (male 1, female 2)						.54***	.07	-	-	-
7. Fitness Time 2							.32***	-	45.17	6.48
8. MVPA Score									47.65	

***p < .001 ** p < .01 * p < .05

Table 4.2 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 2.

Path Analysis

The tested model assumed that (a) cardio-respiratory fitness at time 1 would be predicted by the SDT variables and sex of the participant, and (b) that cardio-respiratory fitness at time 2 would be predicted by cardio-respiratory fitness at time 1, sex and any changes in the SDT variables at time 2, through the influence of these cognitions on the frequency of moderate to vigorous physical activity participation. Figure 4.1 depicts the final structural model.

Structural equation modeling (*n*=230) with questionnaire items serving as indicators of the underlying factors (with the exception of sex and fitness which were modeled as observed variables) was conducted. All items loaded well on the underlying factors (Time 1 *M* of factor loadings = [749], range = .532 - .908; Time 2 *M* = [804], range = .713 - .926). As the normalized estimate of Mardia's coefficient was large (multivariate kurtosis = 32.91), the data were analysed using robust maximum likelihood analysis (Bentler, 1995). Acceptable indices of global model fit were evident: Sattora-Bentler chi-square (780) = 900.12, $p < .001$; SRMR= .066; CFI= .952; NNFI= .946; RMSEA= .049 (95% CI= .043 -.054).

The final model (Figure 4.1) reveals two important points. First, intrinsic motivation (positive) and external regulation (negative) were associated with cardio-respiratory fitness at time 1, whereas only changes in intrinsic motivation positively predicted changes in cardio-respiratory fitness at time 2, through the influence of this cognition on the frequency of moderate to vigorous physical activity participation. Inspection of potential indirect effects in the model also revealed indirect effects on fitness at follow-up of intrinsic motivation at the follow-up time point (0.052), as well as

intrinsic motivation (0.142) and external motivation (-0.142) at the course's outset. For indirect effects on physical activity, intrinsic motivation at the course's outset was significant (0.120). Second, the stability coefficients (i.e., time 1 to time 2 associations) for all SDT variables, as well as for fitness, were somewhat greater than the associations between SDT variables and cardio-respiratory fitness at time 1, and associations between SDT variables and physical activity at time 2.

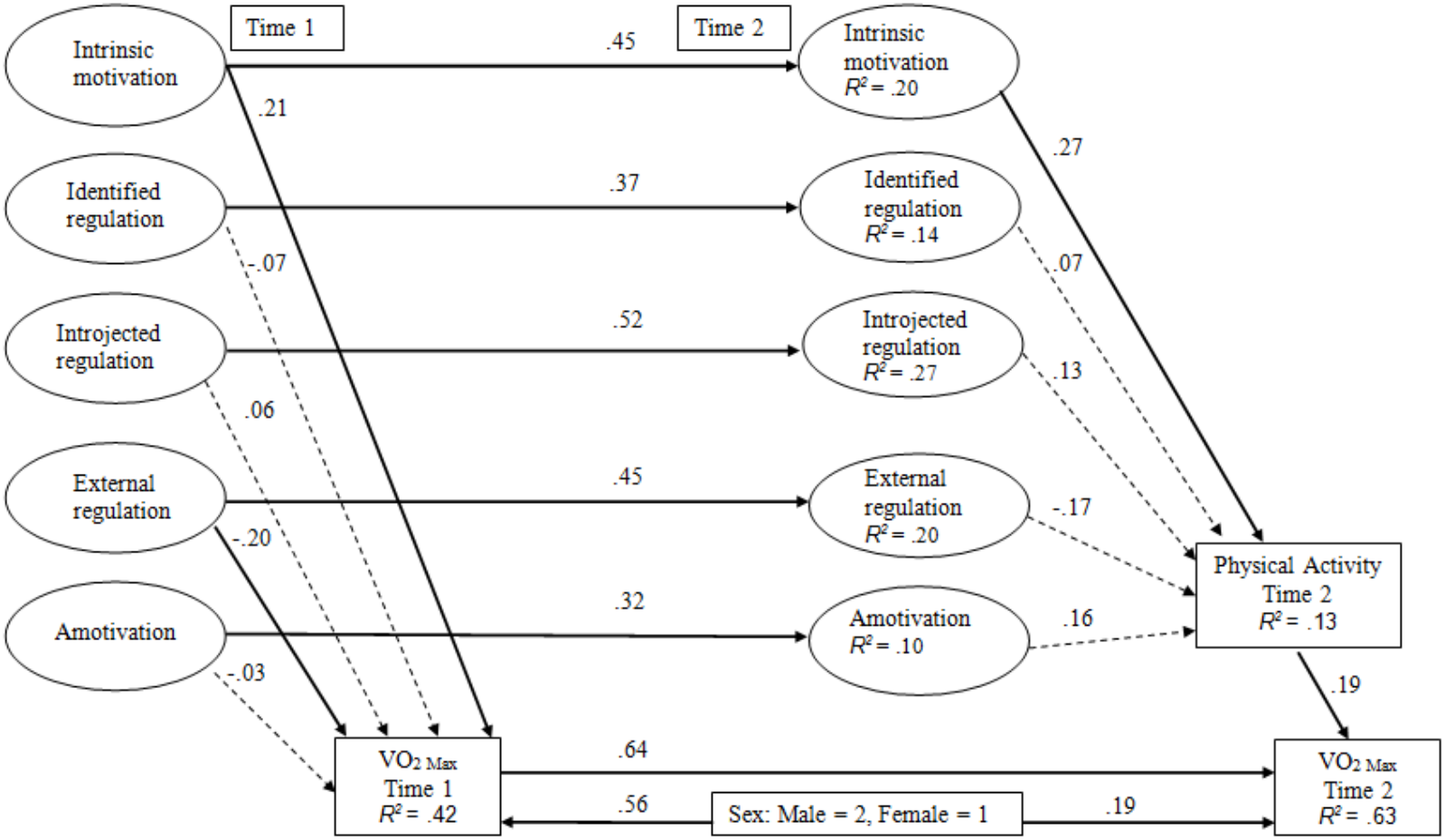

Figure 4.1 Final model with significant, standardized paths (p<.05) as unbroken lines. Ovals represent latent factors.

Discussion

The current study employed SDT as a framework within which to investigate the motivational regulations and cardio-respiratory fitness over a three year period in serving air force personnel. As with the earlier study over a nine week period (Reay et al., Submitted), intrinsic motivation was the only contributor to changes in fitness after three years. There were no contributions from controlling regulations over this time period, despite the need for serving personnel to maintain fitness for their job.

One important contention of SDT is that controlling regulations are less adaptive in nature whilst autonomous regulations result in more positive motivational consequences. Unsurprisingly, the positive effects of intrinsic motivation and negative effects of external regulation on initial fitness matched the 9-week data set, of which this was a subset. Nonetheless, the well-fitting model, despite a sample size reduced from 420 to 230, suggests a robust result, despite the commonalities in the underlying data used in modelling. More importantly, changes in intrinsic motivation contributed to changes in fitness after three years, as they had done over the 9-week course, despite the shift from completely constrained exercise behavior on the fitness course to a voluntarily chosen exercise regime. Deci & Ryan (1987) have suggested that an individual may no longer perform a behavior for intrinsic reasons when there is a shift from an internal perceived locus of control (i.e. to get fit to meet the course fitness requirements) to a more external locus (i.e. to avoid the negative consequences of administrative action or potential risk of involuntary discharge). Here, the data indicate contributions from intrinsic motivation, despite a potential change in locus of control.

Furthermore, these effects were influenced through frequency of MVPA. A direct consequence of intrinsic motivation is feelings of exercise enjoyment, which can, in turn, leads to perseverance, less stress and positive psychological feelings (Wankel & Mummery, 1993; Ryan & Deci, 2000; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Perseverance with exercise is the key to maintenance of fitness in this study.

In the only other study to investigate SDT and fitness with a military sample, namely male air force personnel, Wilson et al., (2012) reported that exercising for health related motives (autonomous) was more strongly related to fitness than exercising to pass the annual fitness test (controlled), a finding consistent with SDT (e.g. Edmunds et al., 2006; Duncan, Hall, Wilson, & Jenny, 2010; Ng et al., 2012; Rodgers et al., 2010; Wilson, Rodgers, Fraser, & Murray, 2004). In the study here, however, we found no significant contributions from identified regulation, despite an average score in the sample higher than intrinsic motivation at both time points. Further, there was clear instrumental value in adequate levels of cardio-respiratory fitness for service personnel. Part of this difference may reflect the fact that Wilson et al., (2012) used a composite score of intrinsic and health motivation in which the relationship might have been determined only by the intrinsic part of the composite. Alternatively, the use of a fitness composite that included muscular strength and body composition components might obscure simple relationships with the cardio-respiratory component investigated here.

The only other study that has investigated SDT contributions to cardio-respiratory fitness alone (Wilson et al., 2003), tested the potential effects of SDT in a relatively small sample (n = 54) of predominantly female exercise initiates (83%) enrolled on a 12-week exercise course. Follow-up analysis of the provided correlation matrix reveals a

significant beta weight only for the relationship between intrinsic motivation and fitness when treated as a multivariate data set. Unlike these cross-sectional studies, the longitudinal data here that can control for heritable contributions to fitness, confirm effects of intrinsic motivation (Bouchard et al., 1998; Bouchard & Perusse, 1994). An apparent commonality of effects across samples composed of primarily unfit, female exercise initiates, voluntarily trying to improve their health, and relatively fit male air force personnel whose employment and promotion was partially dependent on their fitness, attests to the generality of the influence of intrinsic motivation.

These data echo Dishman's (1990) observation that 'knowledge and belief in the health benefits of physical activity may motivate initial involvement….but feelings of enjoyment and well-being seem to be stronger motives for continued participation' (p.83). What they underscore is the importance of ensuring that individual's exercise experiences are positive, an outcome more likely at less energetic levels of exertion (Ekkekakis, Parfitt, & Petruzzello, 2011; Parfitt & Hughes, 2009; Parfitt, Markland, & Holmes, 1994). Fortunately, Blair et al. (1989) identified a protective, asymptotic level of cardio-respiratory fitness in adults equivalent to an age-adjusted peak score of approximately 10 METs in men ($\dot{V}O_{2\,max}$ of 35 ml.Kg^{-1}.min^{-1}) and 9 METs in women (31.5 ml.Kg^{-1}.min^{-1}). More recently, Kodama et al. (2009) estimated a minimum 'protective' cardio-respiratory fitness level for men and women aged 40 years as 9 METs and 7 METs respectively. To put this in perspective, male personnel aged 16-24 in the air force must meet a minimum fitness standard of 13.3 METS (46.6 ml.Kg^{-1}.min^{1}). The protective levels of fitness are relatively modest and easily accessible to most of the

population. For example, moderate intensity physical activity at 40-55% peak VO_2 intensity will improve cardio-respiratory fitness (Church, Earnest, Skinner, & Blair, 2007). Participation in the moderate intensity physical activity of brisk walking on a regular basis would be beneficial (Haskell et al., 2007).

Inclusion of SDT regulations at the outset of the three year period in the modelling was informative. When the previous analysis involved only the 9-week fitness course, there were no increases in intrinsic or identified regulation that have been reported by others over 10-12 week periods of a course (Rodgers et al., 2010; Wilson et al., 2003), though reductions in controlled regulation did occur (Reay et al., Submitted). We reasoned previously that some changes in autonomous regulations might have pre-dated enlistment, if potential recruits exercised prior to the fitness course, and prevented any further increase as part of the course that matched the result of Rodgers and co-workers. Here, the drop in intrinsic and identified regulation, coupled with an increase in amotivation over the three year period suggests a change to more controlled motivations over time. Further, the drop in intrinsic and identified regulations would be consistent with an 'artificial' increase prior to enrolment as a result of physical activity. Of particular interest, are the magnitudes of the longitudinal paths for SDT variables. In effect, these reflect motivational 'baggage' that any adult will bring to a course as a result of prior experience of physical activity. The average stability coefficient over three years, 0.42, accounted for an average on 18.2% of the variance of regulations over three years. In contrast, average stability for the 9-week course, 0.66, accounted for 42.0% of regulation's variance. Stability was much lower over a three year period, indicating that changes in intrinsic regulations with participation in physical activity were a realistic aim

for public health. After all, it was only these regulations that contributed to changes in the important public health target of cardio-respiratory fitness.

While the large non-student sample, the objective measure of fitness and the longitudinal modelling were strengths of this study, improvements would be possible. The prominence of intrinsic motivation suggests Vallerand's (1997) finer differentiation of intrinsic motivation into more specific motives (intrinsic motivation: to know; to accomplish; to experience stimulation) would have been informative in a similar way that the multidimensional perspective of extrinsic motivation has received recent attention (Ng et al., 2012). Additionally, personnel in the armed services who require fitness for their job are unrepresentative of a general population that requires fitness for health reasons. One can argue, however, that individuals trying to improve cardio-respiratory fitness for health reasons from a low initial level may also be unrepresentative. Nonetheless, the study here tested the contributions of SDT regulations for individuals with higher levels of fitness, an understudied population. As such, the effect of intrinsic motivation within such a high fit population indicates more general effects of this component of motivation.

In conclusion, this study was the first to investigate longitudinally the effects of SDT variables on changes in fitness. These changes were investigated over a meaningful public health time frame, namely three years. As with studies of physical activity, autonomous motivation, i.e., intrinsic motivation, was the most beneficial type of motivation for potential gains in cardio-respiratory fitness.

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Chapter 5

Prediction of Cardio-respiratory Fitness with Theory of Planned Behavior Variables over a 3-Year Period.

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Abstract

Background

While low cardio-respiratory fitness represents a major health risk, no studies have investigated psychological determinants related to changes in fitness.

Purpose

To test the contribution of potential psychological determinants to cardio-respiratory fitness within the Theory of Planned Behavior (TPB) framework over a meaningful public health time frame, i.e., three years.

Methods

Royal Air Force (UK) recruits (n=234) completed a questionnaire to measure TPB variables and cardio-respiratory fitness tests at enlistment and three years later.

Results

Structural equation modeling revealed that affective attitude, i.e. liking exercise, was related to fitness at the start of the course and changes in fitness, mediated through physical activity, three years later. Instrumental attitude, i.e. perceiving exercise as beneficial, was related to intentions but made no contribution to fitness. Neither intention, nor perceived behavioral control, contributed to changes in fitness after 3 years.

Conclusions

While individuals may be positive about the benefits of exercise, it is the affective components of attitude that are related to its health related outcome of cardio-respiratory fitness. Other TPB variables may track poorly over time.

Introduction

Cardio-respiratory fitness, a component of health related physical fitness, is an important outcome of regular physical activity (American College of Sports Medicine [ACSM], 2006). Whilst cardio-respiratory fitness is prone to genetic heritability (Bouchard et al., 1998), estimated to be in the range of 25% to 40% (Bouchard & Perusse, 1994), a dose response relationship exists between primarily aerobic physical activity and cardio-respiratory fitness (Blair et al., 1995; Church, Earnest, Skinner, & Blair, 2007). Further, minimum levels of fitness are protective against many chronic diseases (Blair et al., 1989; Blair et al., 1995; Kodama et al., 2009; Lee & Skerritt, 2001). Unfortunately, insufficient physical activity levels to obtain fitness benefits are characteristic of US and UK populations.

The current guidelines are for a minimum of 30 minutes of at least moderate intensity physical activity on 5 or more days of the week (Haskell et al., 2007). When activity levels are measured objectively, however, national surveys reveal that only 6% of men and 4% of women meet current guidelines in England (Health Survey for England, 2008), with similar levels of insufficient activity in the US, i.e., 89% men and 91% women (Tucker, Welk, & Beyler, 2011). Given that increased levels of exercise (i.e. planned physical activity) is the only route to improved cardio-respiratory fitness, information about potential psychological determinants that influence both physical activity and fitness is of major public health interest.

This paper tests the contribution of potential psychological determinants to fitness within the Theory of Planned Behavior framework (TPB), both cross-sectionally and longitudinally (Ajzen, 1991). Central to this theory is the principle that

any behaviour is determined by intention, representing an individual's motivation and planned participation in the behaviour. Intentions, in turn, are determined by attitudes towards the behavior, perceptions of normative pressure (termed subjective norms), and perceived behavioral control (PBC), namely, perceptions that one has control over participation in the behavior should one wish. These relationships have been confirmed in several meta-analytic reviews covering physical activity and exercise (Hagger, Chatzisarantis, & Biddle, 2002; Hausenblas, Carron, &. Mack, 1997; McEachan, Conner, Taylor, & Lawton, 2011). For example Hagger et al. (2002) concluded that the TPB explained 46% and 27% of the variances of intention and behavior respectively, with McEachan et al. (2011) reporting similar effects when only prospective designs were considered (46% and 24%).

Attitudes comprise two separable components, with outcomes being favourable toward behaviors that are believed to be both beneficial (instrumental components) and pleasant (affective components). Concerning physical activity, affective components may be more important determinants of intention than instrumental ones, both for voluntarily chosen physical activity (Ajzen & Driver, 1992; Eves, Hoppé, & McLaren, 2003; Godin, 1987; Lawton, Conner, & Parker, 2007; Lawton, Conner & McEachan, 2009; Lowe, Eves, & Carroll, 2002) and in situations where behavior may be constrained (Reay, Eves, Ntoumanis, Treweek, & White, Submitted; Scott, Eves, Hoppé, & French, 2010). Therefore, studies testing for the potential contribution of the TPB need to distinguish between the two components of attitude.

While the recent meta-analysis of McEachan et al. (2011) employed over 100 prospective studies of the TPB and physical activity, we could find only one previous study of the relationship between TPB variables and cardio-respiratory fitness in adults when we started this line of research. Sassen and co-workers tested the cross-sectional relationship between the TPB and fitness in 1,298 police officers (Sassen, Kok, Schaalma, Kiers, & Vanhees, 2010). While analyses revealed that attitude and PBC accounted for 5.8% of the variance of cardio-respiratory fitness, failure to include gender in the modeling restricted the conclusion one could draw; there are major gender differences in cardio-respiratory fitness. More importantly, the distinction between cross-sectional and longitudinal data may be critical to tests of the determinants of cardio-respiratory fitness. While physical activity can influence fitness, there are major effects of genetics on fitness that are independent of activity (Bouchard et al., 1998). Only longitudinal data can test for changes in fitness that might be influenced by psychological determinants, unconfounded by potential genetic influences.

This study is part of a series of longitudinal investigations of the effects of TPB variables on fitness over an extended time period. While an earlier study tested for effects of TPB variables on increases in cardio-respiratory fitness during a 9-week exercise course to meet a minimum fitness requirement in air force recruits (Reay et al., Submitted), this member of the series tested how TPB variables might be related to changes in fitness over a longer time frame, i.e., three years. After initial training, air force personnel are required to meet a prescribed fitness standard each year, yet have complete autonomy over their exercise regime. Insufficient activity would be associated with reductions in fitness levels and it is these potential losses in fitness

over time that are of major interest to public health. As well as an improved focus on the public health question, this study was better able to test the contribution of the TPB. The 9-week fitness course was mandatory for all recruits, rendering their exercise levels during the course relatively uniform. Hence, potential effects of TPB variables on chosen levels of physical activity that would influence fitness could not be assessed in the previous study. Here, the voluntary nature of the exercise meant that the study could test how TPB variables might be related to exercise that could influence changes in fitness over a three year period.

Typically, TPB studies cover relatively brief periods of time; five weeks was the median of over 100 prospective studies in the McEachan et al. (2011) meta-analysis. While longer time frames are required to address public health questions, changes in TPB variables with the passage of time can weaken the effects of the model (Ajzen, 1991; McEachan et al., 2011). In a previous study, use of a six month time frame allowed prediction of only 8% of self-reported behavior (Lowe et al., 2002), considerably less than the 25.7% average for prospective studies in McEachan et al., (2011). For this series of studies, we chose to specify all TPB variables with respect to a six month period. Any longer time frame might have risked testing a model that was able to predict only minor amounts of the outcome of interest. While the time frame of six months inevitably differs from that over which behavior is assessed, it is unclear whether one could meaningfully ask individuals to specify their cognitions with respect to a 3-year period that might be more informative for public health. In the analyses, we provide preliminary information on stability of the cognitions over three years.

In this paper, we use structural equation modelling. First, the association between TPB variables and both cardio-respiratory fitness at enlistment and intentions were assessed. As the data set here was a subset of that employed in the 9-week study, we expected a contrast between prominent effects of affective components of attitude on initial fitness and large magnitude effects of instrumental components of attitude on intentions (Reay et al., Submitted). Next, we tested the effects of TPB variables on cardio-respiratory fitness after three years of service, through the influence of these cognitions on the frequency of moderate to vigorous physical activity (MVPA), whilst controlling for the effects of cardio-respiratory fitness on enlistment and sex of the participants. For the longitudinal part of the model, we formally assessed stability coefficients of the TPB variables over the three year period. While the TPB would predict effects of intention and PBC on future physical activity, we were unsure how it would perform over a three year period so we added paths from attitude and subjective norm at time 2 to fully test for potential effects of TPB variables.

Methods

Participants

Participants (n = 256) for this study were 221 male and 35 female personnel of the UK Royal Air Force enlisted for basic recruit training in 2006 and who were still serving in 2009, with an average age of 20.9 years (*SD* = 2.8). Ethical approval to conduct the study was obtained from the ethics review committees of the local university and Royal Air Force. Twenty two individuals did not complete the second testing session three years later, with no significant differences between those lost and those retained on any study variable (all $p = 0.50$).

Measures

i) Questionnaire

Participants completed a series of questions measuring intention, affective and instrumental attitudes, subjective norm and PBC based on Bagozzi & Kimmel (1995) and Connor & Sparks (1996), and adapted from previous research (Eves et al., 2003; Lowe et al., 2002). The questionnaire provided unipolar belief statements with a bipolar response format. Thus, participants had to rate whether they agreed or disagreed for each statement, with the options *strongly*, *moderately* and *weakly* for agreement and disagreement. The participants circled the response that most accurately reflects their feelings for each statement. Exercise intention was assessed with three items, e.g., *I intend to exercise in the next 6 months* (Cronbach's alpha at enlistment/3-years = .87/.96). For attitude, affective components used four items, e.g. *Exercising in the next 6 months would be pleasant* (Cronbach's alpha = .86/.88) whereas instrumental components used three items, e.g. *Exercising in the*

next 6 months would be beneficial (Cronbach's alpha = .75/.72). The three items assessing subjective norm, e.g. *My work colleagues would approve of me exercising in the next 6 months* had acceptable reliability in this subset of the larger data set (Cronbach's alpha = .70/.80). Finally, PBC was assessed with three items; e.g. *I am confident that I can exercise in the next 6 months if I want to*. (Cronbach's alpha = .76/.79). In addition, the demographic information of age and gender was obtained.

ii) Physical Activity

To assess physical activity at the end of the course, participants indicated the number of times they had engaged in a range of vigorous (e.g., jogging, racket sports) and moderate intensity physical activities (e.g., dancing, swimming, golf) within the last week, with the opportunity to specify any exercise not included in the list. To improve reporting, only those activities for which participants could specify the place, time of day and whether they had company while they exercised were included in the measure. For the summary score used in analysis, the frequencies of vigorous and moderate-intensity activity were weighted by 9 and 5, respectively. While this weighting procedure was originally devised to produce metabolic equivalents of exercise (Godin & Shepherd, 1985), here it is better considered to be a way of combining vigorous and moderate-intensity exercise resulting in a Weighted Exercise Score.

iii) Physical fitness

To assess cardio-respiratory fitness, the $\dot{V}O_{2\,max}$ proxy from the Multi-Stage Fitness Test (MSFT) which allows simultaneously testing of large numbers of participants was used (Leger & Lambert, 1982). The MSFT, also known as the 'bleep test',

involves a 20 meter shuttle run between two points. Each shuttle must be completed before a bleep is played over a loudspeaker. The time between each bleep progressively decreases, requiring participants to increase their pace to reach the point before the next bleep. Eventually, the performer is unable to complete a shuttle run before a bleep at which point the test ends. The level and bleep reached can be used to estimate $\dot{V}O_{2\,max}$. In the current study, the testing was carried out in groups of about 10 recruits. The relationship between MSFT score and $\dot{V}O_{2\,max}$ has been found to be independent of sex and age (Armstrong & Duggan, 1990).

Procedure

All participants completed a questionnaire pack, were measured for height and weight, and undertook a maximal fitness test on the same day. Prior to the distribution of the questionnaire, the purpose of the study and all experimental procedures were explained to the participants by way of a briefing and an informed consent form, which was signed by all participants. It was explained that there were no “right” or “wrong” answers, that answers would be confidential, and that participants did not have to put their names on the questionnaires. To protect anonymity, the recruits were matched based on their dates of birth, gender, and service number. The questionnaire was administered in the presence of a researcher in quiet conditions. This procedure was repeated 3 years later.

Statistical analysis

All of the main analyses were conducted using structural equation modelling (SEM) with EQS (version 6.1; Bentler & Wu, 2002).

Results

i) Summary statistics and correlations

Table 5.1 contains the inter-correlations between the variables, the means (*SD*) and Cronbach's alphas. Inspection of the means at time 1 reveals strong agreement with the statements for all TPB variables, particularly so for intention and instrumental attitude. Additionally, the correlations indicate inter-relationships between intention and its potential TPB determinants, with a particularly strong association with instrumental attitude. There were no significant correlations between subjective norm and either affective attitude or PBC. Concerning cardio-respiratory fitness, only affective attitude and PBC were associated with assessments at time 1, the start of the fitness course. Finally, the positive correlation at time 1 between sex and cardio-respiratory fitness confirms higher fitness scores in men than women, with a similar effect seen at time 2.

Inspection of the correlations at time 2 reveals no significant correlations between intention and PBC at time 1 and either physical activity or fitness at time 2. While cardio-respiratory fitness and physical activity were correlated, only affective attitude at time 2 was associated with either outcome variable. The means at time 2 revealed continued strong agreement with the statements for all TPB variables.

Bonferroni corrected analyses testing for any changes in variables after 3 years revealed a significant decreases in affective attitude (t (233) = 3.64, p = .002) and subjective norm (t (233) = 3.04, p = .016), coupled with an increase in PBC (t (233) = 3.28, p = .007). In contrast, there were no significant changes in intention (t (233) = 0.82, p =1.00), instrumental attitude (t (233) = 2.01, p =.27) and fitness (t (233) = 0.75, p =1.00).

Enlistment – Time 1

	2	3	4	5	6	7	α	*M*	*SD*
1. Intention	.37***	.70***	.32***	.56***	.03	.12	.87	5.72	0.62
2. Affective Attitude	-	.32***	.19	.44***	.07	.21*	.86	4.80	1.02
3. Instrumental Attitude	-	-	.46***	.46***	.03	.06	.75	5.80	0.51
4. Subjective Norm				.12	.05	-.05	.70	5.36	0.84
5. PBC					.10	.28***	.76	5.27	0.78
6. Sex (male 2, female 1)						.55***	-	-	-
7. Fitness Time 1							-	45.64	6.62

Note. PBC = perceived behavioural control
***p < .001 ** p < .01 * p < .05

Table 5.1 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 1.

3 Years – Time 2

	2	3	4	5	6	7	8	α	*M*	*SD*
1. Intention (Time 1)	.56***	.18	.12	.12	.03	.02	.10	.96	5.72	0.62
2. PBC (Time 1)	-	.24**	.13	.11	.10	.18	.11	.88	5.27	0.78
3. Affective Attitude	-	-	.31***	.40***	-.05	.26**	.30***	.72	4.55	1.02.
4. Instrumental Attitude				.51***	.01	.02	.10	.80	5.71	0.48
5. Subjective Norm					-.10	.02	.17	.79	5.14	0.83
6. Sex (male 2, female 1)						.54***	.07	-	-	-
7. Fitness Time 2							.32***	-	45.39	6.71
8. MVPA Score									47.67	32.65

Note. PBC = perceived behavioural control
***p < .001 ** p < .01 * p < .05

Table 5.2 Means, Standard Deviations, Cronbach's Alphas and Intercorrelations for All Variables At Time 2.

ii) Path analysis

The proposed model to be tested assumed that a) cardio-respiratory fitness at time 1 would be associated with the TPB determinants and sex of the participant, and b) that cardio-respiratory fitness at time 2 would be predicted by cardio-respiratory fitness at time 1, sex, intention and PBC at time 1 and any changes in the TPB variables at time 2, through the influence of these cognitions on the frequency of moderate to vigorous physical activity.

Path analysis (n=234) was conducted using EQS 6.1 (Bentler, 2002). As the normalized estimate of Mardia's coefficient was large (multivariate kurtosis = 91.75), the data were analyzed using robust maximum likelihood analysis (Bentler, 1995). Analysis of the TPB model for fitness at time 2 revealed no effects of either intention or PBC, despite acceptable fit indices [Sattora-Bentler chi-square = 569.57, p = .002; SRMR = .071; CFI = .948 ; NNFI = .939; RMSEA = .060 (90% CI= .054, .066)]. Figure 5.1 depicts the final model, with non-significant paths represented by broken lines.

The final model reveals three important points. Cross-sectionally, TPB associates of cardio-respiratory fitness at time 1 differed from determinants of intention. An appreciable magnitude path from instrumental attitude to intention contrasted with a non-significant association between the same variable and cardio-respiratory fitness. Affective attitude, however, contributed to cardio-respiratory fitness alone in this analysis. For subjective norm, there was a significant negative association with cardio-respiratory fitness yet a non-significant path to intention. Neither of the paths from PBC to intention or fitness at time 1 was significant with

robust estimation. Second, longitudinally, there were no significant paths between either intention or PBC at time 1 and physical activity at time 2. Nonetheless, changes in fitness were mediated by physical activity levels at time 2, with affective attitude the only significant path to physical activity. Inspection of potential indirect effects in the model revealed indirect effects on fitness at follow-up of affective attitude (0.043) and PBC (0.055), as well as affective attitude (0.159) and subjective norm (-0.107) at the course's outset. The only significant indirect effects on physical activity came from affective attitude at the course's outset (0.086). Finally, the stability coefficients for the TPB variables were relatively low, with only the R^2 for affective components of attitude indicating appreciable tracking of the variable over the three year period.

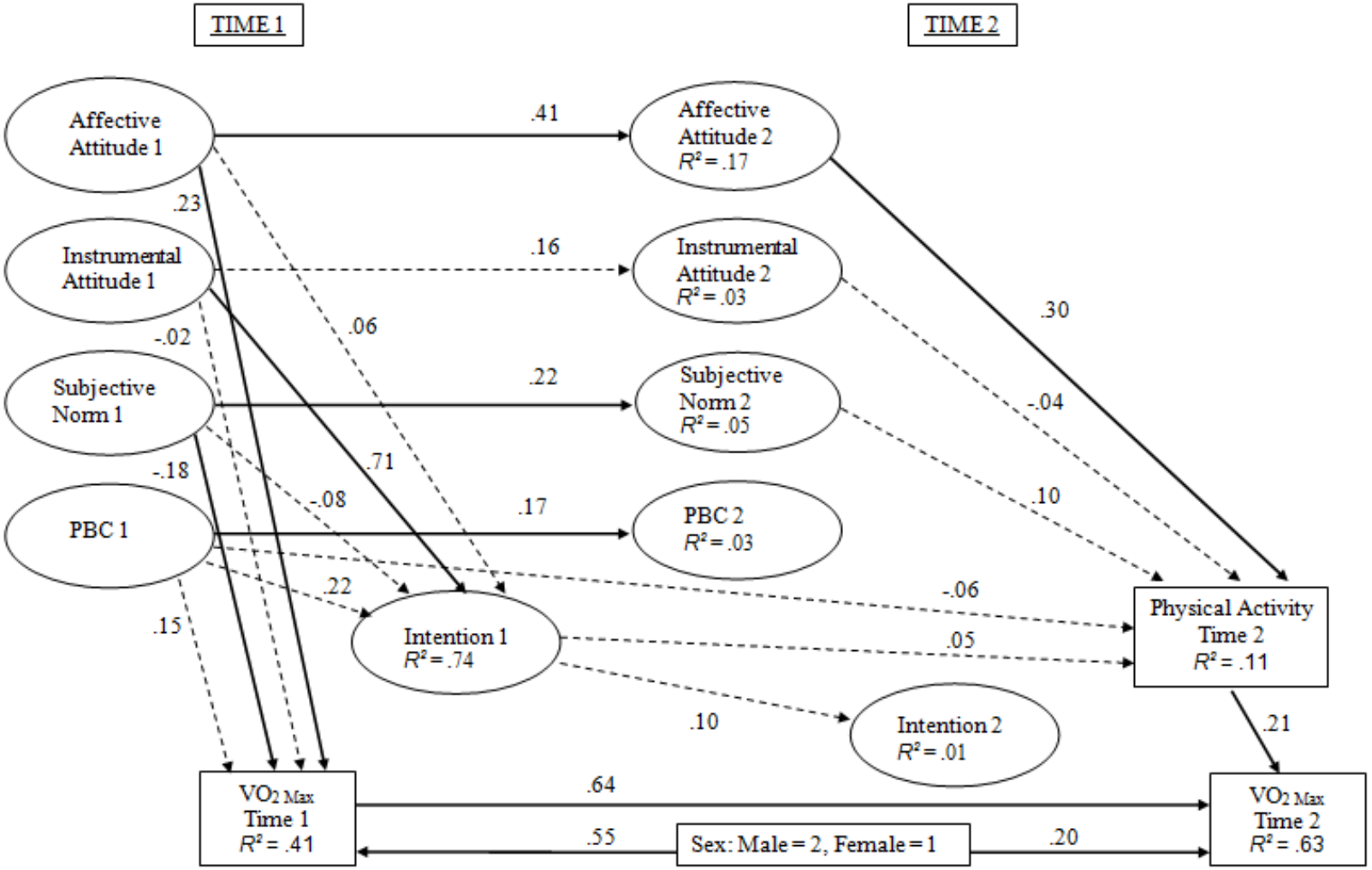

Figure 5.1. Final model with significant, standardized paths (p<.05) as unbroken lines. Ovals represent latent factors. 1=enlistment, 2 = 3-years.

Discussion

In summary, this study revealed separable effects for affective and instrumental components on physical activity and cardio-respiratory fitness. Affective attitude towards exercise was associated with fitness levels at baseline and to changes in fitness three years later, through the influence of this cognition on the frequency of moderate to vigorous physical activityphysical activity. Further, affective attitudes tracked over time such that attitude at baseline explained 17% of the variance of the affective attitude three years later. In contrast, instrumental attitude was related only to intention at baseline and made no contribution to physical activity or its health-related outcome of cardio-respiratory fitness. There was no evidence that instrumental components of attitude tracked over time. Finally, neither intention nor PBC at baseline made significant contributions to physical activity three years later.

In the only other previous longitudinal analysis of contributors to cardio-respiratory fitness (Reay et al., Submitted), neither intention nor PBC contributed to fitness at the end of a 9-week course. The uniformity of behaviour imposed by the course, however, meant that modelling of the effects of TPB variables on fitness, through the influence of these cognitions on the frequency of moderate to vigorous physical activity, could not be assessed. Here, there were no contributions of intention or PBC on fitness when modelled through the influence of these cognitions on the frequency of moderate to vigorous physical activity. For the 9-week course, constraints on the behaviour could partially preclude effects of intention, though it is unclear why these constraints would necessarily preclude effects of PBC. Here, the mismatch in specification of the behaviour over a 6-month period and measurement of the outcome three years later is important; intention did not track over the three

year period, and tracking of PBC was weak. Clearly, intention and PBC can predict future physical activity behaviour over shorter time frames (Hagger et al., 2002; McEachan et al., 2011). Further, McEachan and co-workers emphasize that, in particular, attenuation of the intention-behaviour relationship for physical activity occurred as the length of follow-up increased. Hence, the failure of intention and PBC to track over time seems the most likely explanation for the absence of effects on physical activity here.

The effect of the extended time frame of this study is a minor issue for social cognition, simply moderating the relationships in the model. For applications of the TPB to public health, however, it may be of more importance. Typically, epidemiology estimates the relative risk of different contributors to a disorder; elevated blood pressure, cholesterol, blood sugar and weight, as well as reduced fitness, all contribute to cardiovascular disease (e.g. Blair et al., 1996). Often behaviour is the precursor of these physiological risks, and the factors that predict behaviour are of considerable interest. Health enhancing behavior is protective and the cognitions that precede it should also be so. Modelling that could simultaneously estimate the effects of baseline physiological risk factors and the underlying cognitions that can result in protective behaviour during any intervening period would provide public health with a more complete model of the development of a disorder. For such a model, tracking of the cognitions over meaningful public health time frames would be important.

To put this in perspective, the TPB predicted 32% of variance of physical activity for studies over five weeks or less and 15.7% of the variance for longer follow-up periods (McEachan et al., 2011). Disorders that develop within five weeks

are obviously rare. A decrease in the explanatory power of the TPB over extended time a frame was expected (Ajzen, 1991) and may reflect effects of temporal stability of intention (Conner & Godin, 2007). While a recent study over a 15 year period has claimed that TPB constructs can predict 9% and 22% of the variance in physical activity at baseline and follow up (Plotnikoff, Lubans, Trinh, & Craig, 2012), there were major problems with the study. Intention was operationalised as a predicted frequency of exercise sessions on a 6-point scale in the coming year, a measure demonstrating substantial correlation with frequency of behaviour reported for the preceding year. More importantly, all models included a path from intention for the coming year to behaviour in the past year. In effect, Plotnikoff et al., (2012) used a theory of *planned* behaviour to predict the past not the future and is not interpretable. At this point in time, we do not know the temporal boundary for the underlying cognitions that are protective.

Concerning instrumental components of attitude, the data were informative. Unsurprisingly, instrumental components of attitude made a substantial contribution to intention, as they had done for the 9-week course of a previous study (Reay et al., Submitted); the sample here was a subset of the previous sample. Nonetheless, the well-fitting model, despite a sample size reduced from 433 to 234, suggests a robust result, despite the commonalities in the underlying data used in modelling. More importantly, both studies demonstrate that instrumental attitude *can* contribute to intention to be physically active when the outcome of that activity has important instrumental value to a near term goal, i.e. passing a fitness test at the end of nine weeks. In contrast, previous research suggests minimal contribution of instrumental components of attitude to intention for volitionally chosen physical activity, whether

measured as the generic term ‘exercise’ (Lowe et al., 2002) or specific types of physical activity (Eves et al., 2003; Scott et al., 2010), and for physical activity where behaviour is constrained but unrelated to a specific near term goal (Scott et al., 2010). The failure of instrumental components of attitude to contribute to either fitness at baseline or physical activity that influenced fitness three years later represents a potential issue to the promotion of physical activity for its health benefits outlined elsewhere (Eves et al., 2003; Eves & Hoppé, 2009; Reay et al., Submitted).

The contrast between instrumental and affective components of attitude was striking. Affective components were related to baseline fitness and changes in fitness through their mediator, levels of physical activity. Furthermore, affective components of attitude were the only cognition that showed substantial tracking over the three year period of the study. Affective attitude within the TPB has been consistently related to physical activity (Ajzen & Driver, 1992; Lowe et al., 2002; Eves et al., 2003; Scott et al., 2010). Further, in a review of a range of different types of affective judgments and physical activity, Rhodes, Fiala and Conner (2009) reported a consistent relationship between affective judgments and different behaviors. A distinction made by Sallis and Hovell (1990) between proximal and distal determinants of behavior is relevant here. These authors pointed out the immediate, proximal experience of participation in exercise can be negative, an experience that becomes more negative the higher the intensity at which an individual exercises (Ekkekakis, Parfitt, & Petruzzello, 2011; Parfitt & Hughes, 2009; Parfitt, Markland, & Holmes, 1994). In contrast, health enhancement is a delayed, distal outcome of physical activity (Eves, 1995; Sallis & Hovell, 1990). As Sallis & Hovell (1990) emphasized, proximal determinants of exercise were more important than distal ones

(see also Eves & Hoppé, 2003), a finding echoed here. Affective components of attitude contributed to the important health outcome of cardio-respiratory fitness whereas instrumental components did not. If experiences during exercise are not perceived as pleasant, it seems unlikely that the behavior could self-sustain (see also Bryan, Hutchison, Seals, & Allen, 2007; Kwan & Bryan, 2010; Williams et al., 2008).

Conclusion

In summary, this longitudinal study of the effects of TPB variables on cardio-respiratory fitness over a meaningful public health time frame confirmed the importance of affective components of attitude. Pleasure from physical activity was related to both fitness at baseline and changes in this important public health outcome three years later.

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CHAPTER 6

DISCUSSION

Rationale

Worrying data from the Health Survey for England (2008) showed that physical inactivity affected a larger percentage of the adult population in the UK than the combined effects of misuse of alcohol (6-9%), smoking (20%) and obesity (24%). As detailed previously, physical activity is the only method of increasing cardio-respiratory fitness. The minimum level of fitness, known to be protective towards health in adults was reported by Blair et al. (1989) as an age-adjusted peak score of approximately 10 METs in men ($\dot{V}O_{2\,max}$ of 35 ml.Kg^{-1}.min^{-1}) and 9 METs in women (31.5 ml.Kg^{-1}.min^{-1}). We also know that physical inactivity causes reductions in fitness over twice the reported rate of active populations from age 25 years (Hawkins & Wiswell, 2003). Placed in the context of recorded levels of cardio-respiratory fitness in UK men aged 16-24 (40.9 ml.Kg^{-1}.min^{1} in 2008), when the inadvertent reductions in fitness associated with increases in age are considered, this average fitness statistic predicts an alarming trend. Addressing this modifiable risk factor is clearly of major importance to public health.

Such national priorities highlight the importance for understanding the motivational dynamics for exercise in adults, and to this end, the psychological determinants that motivate individuals to perform sufficient physical activity to achieve the health related outcome of cardio-respiratory fitness was an important question never before addressed in the literature.

A 'Typical' Population

Utlilising a research sample for whom minimum levels of fitness are a necessity, neatly addressed the public health problem three-fold. Firstly, serving members of

the Royal Air Force need to be physically active in order to achieve their pre-determined fitness standard. To put this in perspective, 74% of the participants on enrolment were above the 50th percentile for fitness in the US, with 31% above the 80th percentile (Wang et al., 2010). Secondly, given the recent figures which reported the proportion of UK men and women meeting current activity guidelines (6% and 4% respectively), the population under investigation would be considered just as 'typical' as the small proportion of UK adults trying to remain active to improve fitness. Thirdly, physical activity is a function of both genes and environment, and genetic variation can determine to a large extent whether a person is prone to engaging in physical activities. For example, a twin study by Joosen, Gielen, Vlietinck, & Westerterp (2005), which measured behaviour objectively, concluded that the added genetic component explained 72-78% of inter-individual variation in habitual physical activity. This implies that the employment of a longitudinal design and an objective marker of health within the present analysis, has enabled the results to be not obscured by genetic contributions and associated psychological 'baggage'.

Aims

The present investigation tested the contribution of potential psychological determinants both cross-sectionally and longitudinally from two popular models within the exercise literature. For the first of a two part investigation, Chapters 2 and 3 captured important information on the psychological determinants related to *improvements* in fitness, given that behavior was completely constrained during a 9 week training programme. The second part of this investigation, detailed in Chapters 4 and 5, focused on the determinants of exercise perseverance that would prevent

losses in fitness over time. The effect of the extended time frame was considered to be of more importance for public health given that behaviour, and the cognitions which precede it, are often the precursors of the physiological risks reported in epidemiological literature linking physical activity and fitness to health (Blair et al, 1989; 1995; 1996; Kodama et al., 2008). The longitudinal modelling presented within the current investigation would provide public health with a more complete and meaningful framework for the need to track cognitions over time in order to understand the development of chronic disease.

New Directions

Our findings provide support for the theoretical tenants of the Theory of Planned Behaviour and the Self-Determination Theory. More specifically, a common thread across all four studies addressed a series of methodological limitations pertinent to the application of both theories within the current literature, which included a move from: an emphasis on self-report to more objective measures, namely fitness; cross-sectional to longitudinal design, including structural equation modelling; short term prospective follow up to a long term follow up of 3 years (McEachan, Conner, Taylor, & Lawton, 2011; Teixeira, Carraça, Markland, Silva, & Ryan, 2012).

Most importantly, the longitudinal nature of the investigation better addressed the theoretical tenets of both models. Whereas the central feature of the TPB is that of 'planned' or intentional behaviour, for the SDT, Mullen & Markland (1997) suggest that 'there is likely to be a shift in an individual's motivational focus from extrinsic to intrinsic between initial exercise adoption and adherence to a program of regular exercise' (p.350). The current investigation therefore addressed concerns raised over the magnitude of cross-sectional data, which at its very best, has only been able to

measure past or current behavior, not future behavior (McEachen et al., 2011; Teixeira et al., 2012).

Findings

The investigations within Chapters 2 and 4 were the first studies in the SDT literature to report the positive and unique role of intrinsic motivation on changes in cardio-respiratory fitness over a period of both 9 weeks and 3 years. No other contributions were made from any other motivational regulation which is an important finding for the literature. Further, the use of more advanced statistical modelling techniques enabled stability coefficients of regulations to be monitored more accurately. The magnitudes of the longitudinal paths for all SDT variables were considerably greater than the effects of the SDT variables on fitness scores. Previous analyses have revealed no change in intrinsic or identified regulation over 10-12 week periods (Rodgers et al., 2010; Wilson et al., 2003). This study however reported the average stability coefficient over three years, 0.42, accounted for an average on 18.2% of the variance of regulations over three years. In contrast, average stability for the 9-week course, 0.66, accounted for 42.0% of regulation's variance. The drop in intrinsic and identified regulation, coupled with an increase in amotivation over the three year period suggests a change to a more controlled motivational climate over time.

The longitudinal investigation also demonstrated the magnitude of motivational 'baggage' that prior history of physical activity can add to a theoretical model (Hagger, Chatzisarantis, & Biddle, 2002; McEachan et al., 2011; Outlette & Wood, 1988). This not only exemplifies the predictive superiority of longitudinal

methodologies, which controlled for regulations at baseline to establish the true effects of regulations at follow up, yet also highlights the limitations of cross sectional data. Interestingly, despite the high reported value for identified regulation and the clear instrumental value to participants of cardio-respiratory fitness (for progression into service at 9 weeks and as an annual requirement thereafter), our findings did not match previous theoretical arguments (Deci & Ryan, 2007), meta-analytic (Ng et al., 2012) and empirical evidence reporting the importance of identified regulation as a predictor of exercise behavior (e.g., Edmunds, Ntoumanis, & Duda, 2006; Duncan, Hall, Wilson, & Jenny, 2010; Ng et al., 2011; Rodgers, Hall, Duncan, Pearson, & Milne, 2010; Wilson, Rodgers, Fraser, & Murray, 2004).

Standage, Sebire, & Loney (2008) stated within the first SDT study to employ accelerometry that "if an individual does not come to self-endorse and personally value engagement in exercise behavior, do the negative repercussions assumed to be associated with controlled motivation eventually manifest?" (p.347). This investigation suggests that for positive effects on cardio-respiratory fitness, it is more important to focus on the type of autonomous regulation, with exercising for enjoyment being more important than its value, a finding also reported within the only previous study to have fitness data (Wilson, Rodgers, Blanchard, & Gessell, 2003).

For the investigations within Chapters 3 and 5, a number of important findings were reported. Firstly was the finding of the positive and unique role of affective attitude on changes in cardio-respiratory fitness over time. No other contributions on this health outcome were made by any of the other constructs of the TPB. Secondly was the finding that instrumental attitude, although related to intentions, made no contribution to fitness, even when individuals had prominent instrumental reasons for

participating in exercise. Standardized coefficients were 4 times the magnitude of the affective component at 9 weeks. This suggests that although held central to an individual's decision to exercise, only the proximal effects of exercise determine changes in cardio-respiratory fitness. Thirdly, the fact that intention failed to contribute to fitness at any time point, as did PBC for changes in fitness, was unexpected, especially when modelling at 3 years was through the influence of these cognition on the frequency of moderate to vigorous physical activity. Even for constrained behavior within the 9 week study, the intention construct would still have been expected to encompass how hard an individual would try, i.e. the effort exerted to achieve the outcome, and was expected to contribute. Taken together, the absence of any effects on physical activity suggests the failure of both constructs to track over time, a novel finding related to the objective measures and modeling techniques employed. In summary, the prediction of fitness on enrolment, 9 weeks and after 3 years (41%, 80% and 63% of the variance respectively) compares favorably to the objective data (5.8%) reported by Sassen, Kok, Schaalma, Kiers, & Vanhees (2010).

Implications

Collectively, the findings presented in this thesis make a unique contribution of the long term psychological predictors of cardio-respiratory fitness within the exercise literature that have utilised SDT and TPB theoretical foundations. The findings add particular strength to the contention that for the maintenance of physical activity, the proximal, emotion laden components of both theoretical models (intrinsic motivation of the SDT and affective attitude of the TPB) may be more important determinants of

cardio-respiratory fitness over time than other more value or externally based constructs from each of their respective frameworks. These findings are consistent with previous research which also noted a consistent relationship between affective judgments and a range of different exercise behaviors (Rhodes, Fiala, & Conner, 2009).

What this means in practice

The failure of any contribution to fitness from the instrumental cognitions of the TPB and identified regulations of the SDT, despite prominent path sizes both at the 9 week and 3 year follow up points, suggest that the immediate (proximal) effects of exercise are more important determinants of behavior than the delayed (distal) consequences of participation (Ekkekakis, Parfitt, & Petruzzello, 2011; Eves, Hoppé, & McLaren, 2003; Lowe, Eves, & Carroll, 2002). These results also highlight the limitations of studies that fail to employ longitudinal methodologies with objective measures. For example, the instrumental components of attitude in the TPB had a standardized coefficient more than four times the magnitude of affective components. The results of a study based purely on this finding would continue to conclude that exercising for instrumental reasons would achieve important health outcomes.

The findings from this investigation are due in part to the fact that the consequences of both the identified and instrumental constructs are not immediately apparent to the individual, given the delay between participation and the consequence. Conversely, the consequences of the intrinsic and affective constructs, such as the enjoyable or interesting nature of physical activity, are immediate. These findings have been known for a long time in the physical activity domain (Frederick &

Ryan, 1993; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997; Sallis & Hovell, 1990), which makes the results of the present investigation all the more important for the public health.

Importantly, if exercise promotion campaigns continue to focus on the instrumental benefits of exercise participation, promoting physical activity as something that is beneficial is likely to fail to yield any benefits in cardio-respiratory fitness. Whilst more vigorous intensity exercise will produce a greater fitness dividend per unit time spent exercising than moderate intensity activity, a failure to address the immediate effects could mean that the negative experiences of exercise at intensities beyond those considered pleasurable, may act as a barrier to future participation. Fortunately, Blair and co-workers have reported findings which demonstrate that moderate levels of fitness are not only protective for health (Blair et al., 1989; Kodama et al., 2008), yet such intensities will also produce a fitness dividend outcome without the need for vigorous exercise (Blair, Cheng, & Holder, 2001; Church, Earnest, Skinner, & Blair, 2007). This is particularly important for adherence and perseverance, with studies reporting how affect experienced during exercise of moderate intensity contributed to physical activity levels six and twelve months later (Williams et al., 2008), as it did for vigorous exercise three months later in a different study (Kwan & Bryan, 2010). Further, the systematic review by Murphy, Blair, & Murtagh (2009) confirmed no differences in cardio-respiratory fitness between accumulated bouts (i.e. 10 minute sessions) or continuous bouts of exercise (>10 minutes). These are important findings as physical activity is also more likely to be maintained when it is undertaken in smaller bouts (Murphy et al., 2009).

A move towards proximal determinants

Consistent with the proximal and distal distinction of exercise determinants (Sallis & Hovell, 1990), lack of enjoyment of exercise is a prominent barrier to participation for sedentary members of the population (Clarke & Eves, 1997; Scott, Eves, French, & Hoppé, 2007). However, experiences which are pleasant to individuals who do not find exercise intrinsically pleasurable is also problematic; immediate personal experiences also contradict health promotion messages. Ways to circumvent the potential barrier of affective experiences during physical activity represent an important unsolved public health issue for the promotion of increased cardio-respiratory fitness in the population, which echo Dishman's (1990) concern that 'knowledge and belief in the health benefits of physical activity may motivate initial involvement….but feelings of enjoyment and well-being seem to be stronger motives for continued participation' (p.83). What this underscores is the importance of ensuring that individual's exercise experiences are positive, an outcome more likely at less energetic levels of exertion (Ekkekakis et al., 2011; Parfitt & Hughes, 2009; Parfitt, Markland, & Holmes, 1994).

The 'quality' of physical activity through affective experiences, is clearly an important consideration for exercise practitioners and intervention programmers. The empirical findings suggest that there is potential for practitioners to be successful in attempts to improve fitness levels through the careful planning and monitoring of intensity of effort (Ekkekakis et al., 2011; Parfitt & Hughes, 2009; Parfitt et al., 1994). Not only will higher levels of enjoyment more likely to lead to higher adherence rates (Dishman & Sallis, 1994), these proximal affects are now known to increase cardio-respiratory fitness directly. Ekkekakis et al. (2011) have previously argued that the

bipartite model underpinning current exercise prescription guidelines (based on intensity levels through a percentage range of VO_2 or Heart Rate Reserve) is outdated. A move towards a tripartite model, to include an affective threshold of intensity through pleasure, seems relevant based on the results of both the 9 week and 3 year investigations. Higher levels of enjoyment would be more likely to lead to higher adherence rates (Dishman, 1990) with significant associations with pleasure ratings (Williams et al., 2008).

Future Directions

Motivation is not only an intra-personal phenomenon but also a social one and intra and inter-personal forces can influence global, contextual and situational motivation at their respective levels of generality (Vallerand, 2007). Although collected at baseline, no analysis was conducted in the present investigation between cardio-respiratory fitness and the conditions that foster or forestall the satisfaction of basic psychological needs. Thus, SDT's Cognitive Evaluation and Basic Needs theories could provide a template on which to explore the relationship between self-determined motivation and cardio-respiratory fitness levels due to individuals' perceptions of competence (i.e., feelings of effectiveness in interacting with one's environment and in producing desired outcomes), autonomy (i.e., feelings of volition and that one has ability to make their own decisions) and relatedness (i.e., feelings of connectedness to others). Given the relationship between intrinsic motivation and cardio-respiratory fitness reported in the present thesis, and studies which have focused on the social conditions that promote internalisation through greater consideration of the design, delivery and evaluation of exercise intervention and

referral schemes (Edmunds et al., 2006; 2008; Wilson et al., 2003; Wilson et al., 2004), is an area worthy of enquiry using objective measures. Within SDT, a number of guidelines for creating autonomy-supportive client practitioner interactions have been proposed to enhance the internalisation of a given behaviour and thus facilitate autonomous behavioural regulation. To create autonomy and structure an instructor should for example, listen with empathy, communicate clear and meaningful rationales (clear expectations and effective unambiguous feedback), and provide choice (involve clients in the goal setting process). For interpersonal involvement, the instructor should develop quality relationships with the client, through time, energy and affection and acknowledge the participants perspective in the case of disinterest (Deci & Ryan, 2002). This is clearly a further avenue to explore and in sum, practitioners represent a very important source of influence on an individual's contextual and situational motivation.

The prominence of intrinsic motivation suggests Vallerand's (1997) finer differentiation of intrinsic motivation into more specific motives (intrinsic motivation: to know; to accomplish; to experience stimulation) would be informative in a similar way that the multidimensional perspective of extrinsic motivation has received much attention (Ng et al., 2012). Firstly, intrinsic motivation towards 'knowledge' means to engage in an activity to learn something new i.e. exercisers discovering and trying new training techniques. Secondly, intrinsic motivation toward 'accomplishment' means to interact with one's environment in order to feel competent and to create unique accomplishments i.e. mastering difficult training techniques. Thirdly, intrinsic motivation toward 'stimulation' means to experience the pleasant sensations derived from the activity itself. These three sub-dimensions have been reported to be highly

interrelated (Li, 1999; Pelletier, Fortier, Vallerand, Tuson, & Briere, 1995), and the role of intrinsic motivation in the present thesis clearly warrants further investigation.

Limitations

Firstly, due to the fitness course being mandatory for all recruits, rendering their physical activity levels during the course relatively uniform, the influence of these cognitions between the frequency of moderate to vigorous physical activity and fitness could not be assessed during the 9 week investigation. As a result, constructs from each of the theoretical frameworks were loaded directly on cardio-respiratory fitness.

Secondly, it is possible that if reference was made to term *fitness* in each of the questionnaire items rather than to the term *exercise*, the predictive effects of certain constructs on fitness may have been stronger. TPB variables were also specified with respect to a six month period. Whilst this time frame inevitably differs from the 9 week and 3 year investigation period, it is unclear whether such specific time frames would have been any more informative for public health. For example, during the 9 week study, although recruits could choose the intensity at which they exercised and, hence, influence the fitness outcome through differences in effort, TPB variables were not specified with respect to intensity. Further, a 6-month period would include the nine weeks of the fitness course and so the difference in the time frames for the specification of the variables and the course are minimal. For the 3 year investigation, given the failure of intention and PBC to track over time, it seems likely that these two constructs are more suited to predict physical activity behaviour over shorter time frames of 5 weeks or less (McEachan et al., 2011). A longer time

frame on questionnaire items might therefore have risked testing a TPB model that was able to predict only minor amounts of the behavior of interest.

Thirdly, a further potential source of systematic error stems from the over-reporting of physical activity owing to socially desirable responses (Sallis & Saelens, 2000). Social desirability is “the need for subjects to obtain approval by responding in a culturally appropriate and acceptable manner” (Crowne & Marlowe, 1960, p. 353). As being perceived as inactive can confer a number of negative social image- and personality-based evaluations (Martin, Sinden, & Flemming, 2000), it is logical to hypothesise that individuals in a military context may over-report their physical activity levels.

Conclusion

The work undertaken in the present thesis aimed to systematically broaden the theoretical perspectives on the determinants of objective health outcomes in adults. In achieving this objective, the present work adds to the literature pertaining to exercise motivation for cardio-respiratory fitness outcomes. The systematic approach ensured theoretical alignment from the outset and the more advanced methodology facilitated the examination of a number of novel theoretical hypotheses in the exercise context.

Our research is the first known longitudinal study of both the TPB and SDT for changes in fitness. Findings suggest that the proximal effects of exercise are key determinants of cardio-respiratory fitness, therefore strategies aimed at eliciting affective and intrinsic constructs appear critical. Further, given that value based constructs failed to contribute to health outcomes, promoting physical activity as

something that is beneficial for health is unlikely to lead to positive changes in cardio-respiratory fitness. Systematically addressing the factors that make participating in exercise fun and enjoyable appear to be more important public health goals.

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APPENDIX 1

Questionnaire: Enrolment

Form 1A

This questionnaire asks you a series of questions about exercise. The answers you give will be treated in the strictest confidence and will not be available to your NCO's or officers. You will not be identified as an individual at any point. Please answer all the questions as accurately as possible.

Identification Number: ……. **Date:** ……

Gender, (please tick): Male [ ] Female [ ]

Date of birth: ……..

Which of the following are you, (please tick):

Single	[ ]	Widowed	[ ]
Married	[ ]	Divorced	[ ]
Cohabiting	[ ]	Separated	[ ]

Ethnic origin, (please tick):

White	UK	[ ]	Asian	Indian	[ ]
	Irish	[ ]		Pakistani	[ ]
	European	[ ]		Kashmiri	[ ]
	Other	[ ]		Bangladeshi	[ ]
Black	Caribbean	[ ]	Other	Chinese	[ ]
	African	[ ]		Vietnamese	[ ]
	Other	[ ]		Other	[ ]

Age finished full time education, (please tick):

Under 14	[ ]	16	[ ]	19-21	[ ]
14	[ ]	17	[ ]	21+	[ ]
15	[ ]	18	[ ]	Still in full-time education	[ ]

On the next four pages, there are a number of statements about exercise. The possible answers go from 'strongly agree' to 'strongly disagree'. For example, some people strongly agree with the statement 'I exercise because it is fun'. Other people might definitely agree with the statement but not feel that strongly and hence 'moderately agree'. For others, however, exercise is not fun and hence they would disagree with the statement. There are no right or wrong answers so circle the answer that <u>best</u> describes how you feel for each question.

I exercise because other people say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I value the benefits I can obtain from exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel guilty if I don't exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because it's fun

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I take part in exercise because my friends/family/spouse say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I enjoy my exercise sessions

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really don't know why

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to get the benefits of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel ashamed when I miss an exercise session

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I find exercise a pleasurable activity

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel like a failure when I haven't exercised in a while

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because others will be displeased with me if I don't

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I don't see why I should still exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I get pleasure and satisfaction from participating in exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to make the effort to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It's a real effort to go out and do some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really feel I'm wasting my time exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I really have to push myself to take some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel under pressure from my family/friends to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is something I wouldn't necessarily choose to do but is something I feel I ought to do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I can't see what I'm getting out of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Most people who are important to me think I should exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would maintain or improve my fitness

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be punishing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I intend to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would feel uncomfortable for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be healthy

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would keep me supple

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I will exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be hard work for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be interesting

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my heart

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be enjoyable

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My work colleagues would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I want to exercise in the next 6 months but I don't really know if I can

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be wise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help control my weight

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be pleasant

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am confident that I can exercise in the next 6 months if I want to

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be sociable and friendly for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I plan to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help my sporting performance

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be beneficial

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be satisfying for me to do it

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My family and friends would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am sure that I can exercise in the next 6 months if I want to

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be boring

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Most people who are important to me would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my body shape

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be fun for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Below are a number of questions about exercise and physical activity you might choose to do. Please tick any boxes that apply to you. If you are unsure about the answer, tick the 'Unsure' box

What type of activity would this be?

Unsure..... [ ]
Hockey……..... [ ]
Aerobics/keep fit..... [ ]
Golf..... [ ]
Netball/Basketball..... [ ]
Other..... [ ] Please specify.....

For the physical activity(s) you've indicated above (if any), please answer ***all*** of the following questions by ticking each box that applies to you.

Where would this activity be?

Unsure..... [ ]
At home..... [ ]
In a park..... [ ]
In the countryside..... [ ]
Other..... [ ] Please specify.....

When would this activity be?

Unsure..... [ ]
In the morning..... [ ]
At lunch time..... [ ]
In the afternoon..... [ ]
Other..... [ ] Please specify.....

Would this activity be done with another person?

Unsure..... [ ]
With a friend..... [ ]
With a spouse/partner..... [ ]
Other..... [ ] Please specify.....

Now please answer a number of questions about the importance to yourself of different outcomes in your life. Please circle the answer that <u>best</u> describes how you feel for each question.

It is important to me that I enjoy what I am doing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I have a healthy heart

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that my sporting performance is good

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I have control over what I am doing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am friendly and get on well with my colleagues

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am supple

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I control my weight

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am good at what I do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that my body is in good shape

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I get satisfaction from what I do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I maintain or improve my fitness

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

For the question below, regular exercise means either:

Exercise and Sport: e.g. football, weight training, aerobics etc. 3 times a week
or
Physical Activity: e.g. walking, gardening for 30 minutes etc, 5 times a week

Please tick ONE box below which best describes your level of exercise over the *last six months.*

I did not exercise and I did not intend to starting regular exercise in the next 6 months. [ ]

I did not exercise but I was thinking about starting regular exercise in the next 6 months. [ ]

I did not exercise but I was thinking about starting regular exercise in the next 30 days. [ ]

I exercised sometimes, but not regularly. [ ]

I exercised regularly but had only started doing so in the last six months. [ ]

I exercised regularly and had done so for longer than six months. [ ]

1) Please circle below any physical activities that you were doing in the last week. If you were doing activities not on the list, please write them under Other.

(1) Going for walks of at least 15 minutes **(2)** Walking to work for at least 15 minutes. **(3)** Cycling to work **(4)** Cycling for leisure **(5)** Jogging or Running

(6) Keep fit or Home exercise **(7)** Weight training **(8)** Home decorating **(9)** Basketball or Netball **(10)** Outdoor bowls **(11)** Table tennis

(12) Aqua-aerobics **(13)** Aerobics **(14)** Dancing **(15)** Swimming **(16)** Yoga **(17)**Golf

(18) Gardening **(19)** Hockey **(20)** Football **(21)** Athletics **(22)** Tennis **(23)**Squash

Other **(24)**…… Other **(25)**…….

2) For any of the physical activities you did, please complete the questions below.
Write down the number, printed next to the activity above, in the space on the left and then circle how often the activity was done in the last week. On the right, indicate where it was done (e.g. leisure centre, at the home, in the park, in the garden, in the country etc), when during the day you did your physical activity (eg. morning, afternoon, lunchtime etc) and whether you had company.

	How often it was done in the week								**Where it was done**	**When it was done**	**Did you have company?**
i)…….	1	2	3	4	5	6	7	7+	……	……..	Yes / No
ii)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iv)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
v)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vi)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
viii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No

Was this amount of exercise (Tick one box)
a) More than usual **[ ]**
b) the same as usual **[ ]**
c) less than usual **[ ]**

Thank you for completing the questionnaire

APPENDIX 2

Questionnaire: 9 Weeks

Form 1A

This questionnaire asks you a series of questions about exercise. The answers you give will be treated in the strictest confidence and will not be available to your NCO's or officers. You will not be identified as an individual at any point. Please answer all the questions as accurately as possible.

Identification Number: ……. **Date:** ……

Gender, (please tick): Male [ ] Female [ ]

Date of birth: ……..

Which of the following are you, (please tick):

Single	[ ]	Widowed	[ ]
Married	[ ]	Divorced	[ ]
Cohabiting	[ ]	Separated	[ ]

Ethnic origin, (please tick):

White	UK	[ ]	Asian	Indian	[ ]
	Irish	[ ]		Pakistani	[ ]
	European	[ ]		Kashmiri	[ ]
	Other	[ ]		Bangladeshi	[ ]
Black	Caribbean	[ ]	Other	Chinese	[ ]
	African	[ ]		Vietnamese	[ ]
	Other	[ ]		Other	[ ]

Age finished full time education, (please tick):

Under 14	[ ]	16	[ ]	19-21	[ ]
14	[ ]	17	[ ]	21+	[ ]
15	[ ]	18	[ ]	Still in full-time education	[ ]

On the next four pages, there are a number of statements about exercise. The possible answers go from 'strongly agree' to 'strongly disagree'. For example, some people strongly agree with the statement 'I exercise because it is fun'. Other people might definitely agree with the statement but not feel that strongly and hence 'moderately agree'. For others, however, exercise is not fun and hence they would disagree with the statement. There are no right or wrong answers so circle the answer that <u>best</u> describes how you feel for each question.

I exercise because other people say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I value the benefits I can obtain from exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel guilty if I don't exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because it's fun

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I take part in exercise because my friends/family/spouse say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I enjoy my exercise sessions

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really don't know why

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to get the benefits of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel ashamed when I miss an exercise session

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I find exercise a pleasurable activity

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel like a failure when I haven't exercised in a while

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because others will be displeased with me if I don't

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I don't see why I should still exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I get pleasure and satisfaction from participating in exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to make the effort to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It's a real effort to go out and do some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really feel I'm wasting my time exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I really have to push myself to take some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel under pressure from my family/friends to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is something I wouldn't necessarily choose to do but is something I feel I ought to do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I can't see what I'm getting out of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Most people who are important to me think I should exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would maintain or improve my fitness

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be punishing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I intend to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would feel uncomfortable for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be healthy

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would keep me supple

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I will exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be hard work for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be interesting

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my heart

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be enjoyable

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My work colleagues would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I want to exercise in the next 6 months but I don’t really know if I can

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be wise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help control my weight

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be pleasant

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am confident that I can exercise in the next 6 months if I want to

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be sociable and friendly for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I plan to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help my sporting performance

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be beneficial

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be satisfying for me to do it

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My family and friends would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am sure that I can exercise in the next 6 months if I want to

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be boring

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Most people who are important to me would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my body shape

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be fun for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Below are a number of questions about exercise and physical activity you might choose to do. Please tick any boxes that apply to you. If you are unsure about the answer, tick the 'Unsure' box

What type of activity would this be?

Unsure..... [ ]
Hockey……..... [ ]
Aerobics/keep fit..... [ ]
Golf..... [ ]
Netball/Basketball..... [ ]
Other..... [ ] Please specify.....

For the physical activity(s) you've indicated above (if any), please answer ***all*** of the following questions by ticking each box that applies to you.

Where would this activity be?

Unsure..... [ ]
At home..... [ ]
In a park..... [ ]
In the countryside..... [ ]
Other..... [ ] Please specify.....

When would this activity be?

Unsure..... [ ]
In the morning..... [ ]
At lunch time..... [ ]
In the afternoon..... [ ]
Other..... [ ] Please specify.....

Would this activity be done with another person?

Unsure..... [ ]
With a friend..... [ ]
With a spouse/partner..... [ ]
Other..... [ ] Please specify.....

Now please answer a number of questions about the importance to yourself of different outcomes in your life. Please circle the answer that <u>best</u> describes how you feel for each question.

It is important to me that I enjoy what I am doing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I have a healthy heart

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that my sporting performance is good

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I have control over what I am doing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am friendly and get on well with my colleagues

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am supple

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I control my weight

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I am good at what I do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that my body is in good shape

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I get satisfaction from what I do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me that I maintain or improve my fitness

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

For the question below, regular exercise means either:

Exercise and Sport: e.g. football, weight training, aerobics etc. 3 times a week
or
Physical Activity: e.g. walking, gardening for 30 minutes etc, 5 times a week

Please tick ONE box below which best describes your level of exercise over the *last six months.*

I did not exercise and I did not intend to starting regular exercise in the next 6 months. [ ]

I did not exercise but I was thinking about starting regular exercise in the next 6 months. [ ]

I did not exercise but I was thinking about starting regular exercise in the next 30 days. [ ]

I exercised sometimes, but not regularly. [ ]

I exercised regularly but had only started doing so in the last six months. [ ]

I exercised regularly and had done so for longer than six months. [ ]

1) Please circle below any physical activities that you were doing in the last week. If you were doing activities not on the list, please write them under Other.

(1) Going for walks of at least 15 minutes **(2)** Walking to work for at least 15 minutes. **(3)** Cycling to work **(4)** Cycling for leisure **(5)** Jogging or Running

(6) Keep fit or Home exercise **(7)** Weight training **(8)** Home decorating **(9)** Basketball or Netball **(10)** Outdoor bowls **(11)**Table tennis

(12) Aqua-aerobics **(13)** Aerobics **(14)** Dancing **(15)** Swimming **(16)** Yoga **(17)** Golf

(18) Gardening **(19)** Hockey **(20)** Football **(21)** Athletics **(22)** Tennis **(23)**Squash

Other **(24)**…… Other **(25)**…….

2) For any of the physical activities you did, please complete the questions below.
Write down the number, printed next to the activity above, in the space on the left and then circle how often the activity was done in the last week. On the right, indicate where it was done (e.g. leisure centre, at the home, in the park, in the garden, in the country etc), when during the day you did your physical activity (eg. morning, afternoon, lunchtime etc) and whether you had company.

	How often it was done in the week								**Where it was done**	**When it was done**	**Did you have company?**
i)…….	1	2	3	4	5	6	7	7+	……	……..	Yes / No
ii)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iv)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
v)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vi)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
viii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No

Was this amount of exercise (Tick one box)
a) More than usual **[ ]**
b) the same as usual **[ ]**
c) less than usual **[**

Thank you for completing the questionnaire

APPENDIX 3

Questionnaire: 3 Year

Form R3a

This questionnaire asks you a series of questions about exercise. The answers you give will be treated in the strictest confidence and will not be available to your NCO's or officers. You will not be identified as an individual at any point. Please answer all the questions as accurately as possible.

Identification Number:

Date: ……

Gender, (please tick): Male [ ] Female [ ]

Date of birth: ……..

On the next pages, there are a number of statements about exercise. The possible answers go from 'strongly agree' to 'strongly disagree'. For example, some people strongly agree with the statement 'I exercise because it is fun'. Other people might definitely agree with the statement but not feel that strongly and hence 'moderately agree'. For others, however, exercise is not fun and hence they would disagree with the statement. There are no right or wrong answers so circle the answer that <u>best</u> describes how you feel for each question.

Most people who are important to me think I should exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would maintain or improve my fitness

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be punishing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I intend to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would feel uncomfortable for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be healthy

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would keep me supple

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I will exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be hard work for me when exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be interesting

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my heart

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be enjoyable

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My work colleagues would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I want to exercise in the next 6 months but I don't really know if I can

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be wise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help control my weight

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be pleasant

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am confident that I can exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be sociable and friendly for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I plan to exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would help my sporting performance

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be beneficial

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be satisfying for me to do it

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My family and friends would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I am sure that I can exercise in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercising in the next 6 months would be boring

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Most people who are important to me would approve of me exercising in the next 6 months

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be good for my body shape

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

If I exercise in the next 6 months, it would be fun for me

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because other people say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I value the benefits I can obtain from exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel guilty if I don't exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because it's fun

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I take part in exercise because my friends/family/spouse say I should

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I enjoy my exercise sessions

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really don't know why

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to get the benefits of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel ashamed when I miss an exercise session

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I find exercise a pleasurable activity

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel like a failure when I haven't exercised in a while

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise because others will be displeased with me if I don't

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I don't see why I should still exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I get pleasure and satisfaction from participating in exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It is important to me to make the effort to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

It's a real effort to go out and do some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I really feel I'm wasting my time exercising

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I really have to push myself to take some exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel under pressure from my family/friends to exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is something I wouldn't necessarily choose to do but is something I feel I ought to do

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I exercise but I can't see what I'm getting out of exercise

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

Please respond to a number of statements about your current exercise, fitness or sports programme you regularly undertake. Your answers to these questions will be confidential. There are no right or wrong answers so circle the answer that <u>best</u> describes how you feel for each question.

I feel I can make a lot of inputs into deciding what activities to participate in.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I really like the people I exercise with.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel competent when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

People tell me that I am good at what I do when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I get along with other people in the facility/team whilst I exercise/play sport.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel free to express my ideas and opinions when an exercise programme is devised for me.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I consider the people I exercise with/ play sports with to be my friends.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I have been able to learn interesting new skills whilst exercising.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

When I perform an exercise programme, I choose the things I want to do.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel a sense of accomplishment from exercising.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

My feelings/suggestions are taken into consideration when an exercise programme is devised for me.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

People I exercise with care about me.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel close to the people I exercise with.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel I can be myself when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

The people I exercise with seem to like me.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I often feel very capable when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

There are a lot of opportunities for me to decide as to what activities to do when exercising.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

People are friendly towards me when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

Now please answer some questions about the importance of exercise to the fulfilment of different outcomes in your life. Circle the answer that <u>best</u> describes how you feel for each question.

Exercise is a good way for me to have a healthy heart.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to make my sporting performance good

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to have control of what I am doing.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to be friendly and get on well with my colleagues.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to keep myself supple.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to control my weight.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to be good at what I do.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to keep my body in good shape.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to enjoy what I am doing

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

Exercise is a good way for me to keep fit

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

Below are a number of statements about the PEd Staff on your station. Remember, your instructors will never know how you respond to the questions and there are no right or wrong answers. Please circle the answer that <u>best</u> describes how you feel for each question.

I feel that the PEd staff provide me with choices and options to exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

I feel understood by the PEd staff.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

The PEd staff convey confidence in my ability to do well when I exercise.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

The PEd staff encourage me to ask questions.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

The PEd staff listen to how I would like to do things.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

The PEd staff try to understand how I see things before suggesting a new way to do things.

strongly disagree	moderately disagree	weakly disagree	weakly agree	moderately agree	strongly agree

---

Please circle yes or no to the questions below about the level of service you receive from the gymnasium staff.

I would like more help devising my exercise training programme	**Yes**	**No**
I would like more follow-up advice on my exercise training programme	**Yes**	**No**
I would like more organised exercise classes/activities	**Yes**	**No**
I would like more help/information about the use of equipment	**Yes**	**No**
I would like more general information regarding health/fitness issues	**Yes**	**No**
I would like more personal assistance with fitness programmes/gym use	**Yes**	**No**
The gymnasium is not staffed at the times I wish to use it	**Yes**	**No**
The gymnasium is too busy at the times I would wish to use it	**Yes**	**No**

I would like more help with
(Please specify)……..

I feel dissatisfied with the following service
(Please specify)……..

Please circle yes or no to the questions below about your current gymnasium use and membership.

I currently use the station's fitness facilities	**Yes**	**No**
I currently use the station's sports facilities	**Yes**	**No**
My current exercise programme does not require a gym/sport facility	**Yes**	**No**
I use a private gymnasium/health club	**Yes**	**No**
I am a member of a civilian sports club	**Yes**	**No**
I have no wish to use the Stn's gymnasium or sporting facilities	**Yes**	**No**

Finally on the next page you will find some questions about the physical activity that you have been doing in the past week and the place in which you have been doing it. Please answer all of the questions as accurately as possible.

1) Please circle below any physical activities that you were doing in the last week. If you were doing activities not on the list, please write them under Other.

(1) Going for walks of at least 15 minutes **(2)** Walking to work for at least 15 minutes. **(3)** Cycling to work **(4)** Cycling for leisure **(5)** Jogging or Running

(6) Keep fit or Home exercise **(7)** Weight training **(8)** Home decorating **(9)** Basketball or Netball **(10)** Outdoor bowls **(11)** Table tennis

(12) Aqua-aerobics **(13)** Aerobics **(14)** Dancing **(15)** Swimming **(16)** Yoga **(17)** Golf

(18) Gardening **(19)** Hockey **(20)** Football **(21)** Athletics **(22)** Tennis **(23)** Squash

Other **(24)**…… Other **(25)**…….

2) For any of the physical activities you did, please complete the questions below. Write down the number (printed next to the activity above) in the space on the left and then circle how often the activity was done in the last week. On the right, indicate where it was done (e.g. leisure centre, at the home, in the park, in the garden, in the country etc), when during the day you did your physical activity (eg. morning, afternoon, lunchtime etc) and whether you had company (friend, spouse etc).

	How often it was done in the week								**Where it was done**	**When it was done**	**Did you have company?**
i)…….	1	2	3	4	5	6	7	7+	……	……..	Yes / No
ii)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
iv)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
v)……	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vi)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
vii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No
viii)……..	1	2	3	4	5	6	7	7+	……	……..	Yes / No

Was this amount of exercise (Tick one box)
a) More than usual **[ ]**
b) the same as usual **[ ]**
c) less than usual **[ ]**

Thank you for completing the questionnaire

APPENDIX 4

Letter to RAF Heads of Physical Education

ROYAL AIR FORCE SCHOOL OF PHYSICAL TRAINING

[redacted]

[redacted]

INVESTOR IN PEOPLE

Your Reference

Our Reference [redacted]

See Distribution

Date Jun 05

RESEARCH TO DETERMINE THE EFFECTIVENESS OF THE RAF FHS

1. The RAF FHS was introduced in 1994 and its delivery has not changed since its inception. Considerable resources are invested in the FHS and it is important that the RAF gets a return on its investment. However the effectiveness of the FHS in achieving its aims, namely incorporating health and lifestyle education, fitness testing and counselling as a means of enhancing the cost effectiveness of the workforce, has not been objectively and comprehensively assessed. I will be starting, in the near future, a research study, with the help of the Sport and Exercise Science Department at Birmingham University, to determine the effectiveness of the RAF FHS in improving the fitness of RAF personnel during training and productive Service. I will also assess the effect the FHS has on attitudes to health, fitness and lifestyle. The study will provide useful and meaningful information and it is anticipated that the fitness and attitudes of personnel will continue to be assessed year on year. The study will hopefully provide an insight into the efficacy of the RAF FHS and pointers as to how it could be improved or developed.

2. The applicability of the research will depend to a large extent on the sample size and I hope to assess as many airmen as possible going through IRT at RAF Halton over the next 6 months. I would also wish to monitor the fitness and attitudes of the same personnel as they progress through specialist/trade training. Although I would hope to utilise the expertise of PTIs to assist me in collecting the data for the study, the fitness of subjects will be assessed by the RAFFT.

3. I hope you appreciate the requirement for the research and believe it is worthwhile. I will contact you in the near future to describe the research in more detail, explain the impact the study could have on your PEd flt and perhaps arrange a time for me to visit to discuss further. In the meantime may I thank you for your anticipated support and cooperation.

Distribution:

External:

Action:

RAF Boulmer (SNCO PEd Flt)
RAF Brize Norton (OC PEd Flt)
DISC Chicksands (QSMI Gymnasium)
RAFC Cranwell (OC PEd Sqn)
RAF Digby (OC PEd Flt)
RAF Halton (OC Mil & PEd Sqn)
RAF Honington (OC PEd Flt)
RAF Leeming (OC PEd Flt)
RAF Linton-On-Ouse (OC PEd Flt)
RAF Lyneham (OC PEd Flt)
RAF Manston (OC PEd Flt)
RAF Northolt (SNCO IC PEd Flt)
RAF St Athan (OC PEd Flt)
RAF Shawbury (OC PEd Flt)
RAF Stafford (OC PEd Flt)
RAF Valley (OC PEd Flt)

Information:

TPEd 3 (minus encl)

Internal:

Action:

RAF Cosford (OC PEd Flt)

Information:

CI (minus encl)

APPENDIX 5

Letter to RAF Heads of Physical Education: 2008

HEADQUARTERS PERSONNEL AND TRAINING COMMAND
PHYSICAL EDUCATION DEPARTMENT
ROYAL AIR FORCE INNSWORTH, GLOUCESTER, GL3 1EZ,
Please reply to TPEd3
Telephone: Mil Network:
Fax: Fax:
E-Mail: PTC-TGDA-TPEd
www.ped.raf.r.mil.uk

Reference: [redacted]

See Distribution Date: 4 Aug 08

FOLLOW-UP STUDY: LONG TERM PREDICTORS OF CHANGING FITNESS LEVELS IN THE ROYAL AIR FORCE

Your execs will be aware that GCPEd is currently undertaking a major review of the current RAF Fitness and Health Strategy. In order to support the key threads of this revised Strategy, it will be imperative that the PEd branch is able to identify how and why the current fitness and exercise levels and trends of its personnel are influenced by inherent and/or acquired exercise behaviours.

Whilst we have accurate data on the fitness levels and exercise behaviour of the personnel tested in an earlier study, we do not know what their current fitness levels are and how their exercise behaviour has changed following recruit trg (with formalised, mandatory PT sessions) and exposure to the wider RAF and the requirement to undertake PT and sport on a voluntary basis. The question that needs to be answered therefore is whether the current RAF Fitness and Health Strategy influences a person's exercise behaviour to an extent where they voluntarily adopt a physically active lifestyle?

It is for this reason that I have agreed for a follow up study to be conducted at the 3-year point from entry (point 3) using all remaining personnel from the original sample. The testing protocols will remain the same as at point one and two, yet in addition to the physical and psychological assessments, I have agreed that an anthropometric measurement[1] also be recorded on each person to provide key data for future strategy amendments. This will be the first study of its kind that will be conducted longitudinally, using a large sample size over a substantial monitoring period.

Each stn has been allocated a 1-2 day testing period where the Proj Off will be present to conduct all testing. The Proj Off will have to conduct at least two testing periods each day to ensure that all personnel are given sufficient opportunities to attend. A number of units with larger numbers required for testing will be visited on two occasions. The Proj Off will brief all PEd staff at 0800hrs on the first designated date for testing at each stn. It is imperative that all staff are present for this brief as any personnel who are unable to attend the designated testing dates will have to be tested by a PTI at the relevant stn and the results forwarded to DCAE Cosford. The Proj Off will also require the assistance of one PTI during each of the testing protocols. I ask for your full support in ensuring that all personnel required for testing on your Stn attend the gymnasium within the designated dates.

The Proj Off throughout the study will be Flt Lt Andy Reay. He will be conducting all testing over the period 1 Sep to 16 Dec. A full list of all the testing dates for each Stn is located at Annex A as

[1] BMI and waist circumference measurements will be taken on all personnel.

well as the total number of target personnel on your stn. A brief summary of the procedures and equipment requirements is located at Annex B.

If you have any questions relating to the study please do not hesitate to contact me or alternatively contact Flt Lt Reay. He will contact you soon with regards to finalising testing times over your designated dates.

for CinC

Distribution:

PEdO/OC PEd Flt (For all Stns at Annex A)

Annexes:

A. Proposed Testing Dates.
B. Testing Procedures and Equipment Requirements.

247

ANNEX A TO
PTC/571350/3/PEd
DATED 4 AUG 08

TESTING DATES

DATE	STATION
1 Sep	DCAE Cosford
2 Sep	RDMC Birmingham
5-6 Sep	RAF Shawbury
7 Sep	RAF High Wycombe
8 Sep	RAF Northolt
9 Sep	RAF Halton
12-14 Sep	RAF Brize Norton
26-27 Sep	RAF Odiham
28-29 Sep	RAF Benson
3-4 Oct	RAF Lyneham
5 Oct	RNAS Yeovilton
6-7 Oct	RAF St Mawgan
10-11 Oct	RAF Cranwell
12-13 Oct	RAF Waddington
14 Oct	RAF Digby
17-18 Oct	RAF Cottesmore
19-20 Oct	RAF Conningsby
21 Oct	RAF Wittering
24-25 Oct	RAF Coltishall
26-27 Oct	RAF Marham
28 Oct	RAF Honnington
31 Oct – 1 Nov	RAF Linton-on-Ouse
2-3 Nov	RAF Leeming
4 Nov	RAF Boulmer
14-15 Nov	RAF Leuchars
16-17 Nov	RAF Lossiemouth
17-18 Nov	RAF Kinloss
22-23 Nov	RAF Brize Norton
24 Nov	RAF Odiham
25 Nov	RAF Brampton
29 Nov	RAF Coltishall
30 Nov	RAF Marham
31 Nov	RAF Waddington
1 Dec	RAF Cranwell
12-13 Dec	RAF Leuchars
14 Dec	RAF Kinloss
15 Dec	RAF Lossiemouth

ANNEX B
TO PTC/571350/3/PTC
DATED 4 AUG 08

TESTING PROCEDURES AND EQUIPMENT REQUIREMENTS

1. The Proj Off will send out booking sheets and instructions to all PEd Flts by 12 Aug 08. All bookings are to be made and recorded by each individual PEd Flt.

2. The Proj Off will brief all PEd staff at 0800hrs on the first day of a stn's designated testing period.

3. There must be at least two 1-hour periods available per day for testing (ideally mid am/pm).

4. A PTI should be made available to assist with the testing protocols.

5. An area large enough to conduct the RAFFT must be available on at least two occasions per day. The times of the testing will be confirmed by the Proj Off and the Stn PEdO by Fri 12 Aug 08.

6. A stereo, MSFT CD/tape should be made available at each testing period.