Psychological Need Satisfaction in Physical Activity: Implications for Well-Being and Physical Activity Behaviour

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Abstract

Within Self-Determination Theory (Deci & Ryan, 2002) the satisfaction of competence, autonomy, and relatedness needs are thought to directly predict psychological well-being and behavioural outcomes (Deci & Ryan, 2000). The purpose of this program of research was to examine the role of psychological need satisfaction in association with psychological well-being and physical activity in participants drawn from the general population. Study 1 examined aspects of score validity and reliability for an instrument modified to assess psychological need satisfaction in physical activity contexts. Results of this investigation supported the merit of the modified instrument for use in the general population. Study 2 supported a sequence based on 3 mini-theories within SDT wherein changes in relative intrinsic goals → changes in motivation → psychological need satisfaction → changes in well-being and physical activity behaviour over 6 months. Examination of the indirect effects highlighted the role of psychological need satisfaction as potential mediators within this sequence of SDT. Next, a randomized controlled trial was conducted to examine the effect of a best possible physical activity self writing intervention on outcomes such as psychological need satisfaction, exercise self-schema, well-being, and physical activity behaviour. Study 3 was conducted using baseline data from the intervention to examine the indirect effect of psychological need satisfaction in the relationship between exercise self-schema and well-being/physical activity. Results from study 3 suggested that satisfaction of all 3 psychological needs mediated the link between descriptive exercise self-schema and well-being and that competence produced an indirect effect between descriptive exercise self-schema and physical activity. Results from the intervention investigation (study 4) revealed that a once a week writing intervention over 4 weeks increased participants’ positive affect at post-test relative to the control group; however, the intervention was largely
unsuccessful at increasing psychological need satisfaction, exercise self-schema, well-being and physical activity across post-test and 1-month follow-up. Taken together, the results from the four studies in this program of research highlight the salience of psychological need satisfaction in physical activity contexts and their potential mediational role between antecedents such as goals, motivation, and self-schema and consequences such as well-being and physical activity.
Preface

Study 1 (outlined in Chapter 2) was conducted at the University of British Columbia. The final and definitive form, the Version of Record, has been published in *Measurement in Physical Education and Exercise Science* (date of publication: 03 Aug 2012; copyright Taylor & Francis), available online at:

http://www.tandfonline.com/doi/abs/10.1080/1091367X.2012.693340#.UZFEacqN6So. The citation is as follows: [Gunnell, K. E., Wilson, P. M., Zumbo, B. D., Mack, D. E., & Crocker P. R. E. (2012). Assessing psychological need satisfaction in exercise contexts: Issues of score invariance, item modification, and context. *Measurement in Physical Education and Exercise Science, 16*, 219-236. doi: 10.1080/1091367X.2012.693340]. Print form is also available through the journal. Ethical approval was granted by the University of British Columbia Research Ethics Board (H10-02671) and Brock University (08-049 and 04-327). Dr. Philip Wilson, Dr. Bruno Zumbo, Dr. Diane Mack, and Dr. Peter Crocker are co-authors on this manuscript. My co-authors aided in manuscript preparation and one co-author provided one of the subsamples of participants used in the analysis. I was responsible for designing the research question, collecting the data, analyzing and interpreting the data, and manuscript preparation. Data used for this investigation were collected from participants who completed time 1 of a larger study (see study 2).

Study 2 (outlined in Chapter 3) was also conducted at the University of British Columbia. A version of this manuscript will be published in *Psychology of Sport and Exercise* (Available online September 13, 2013; copyright Elsevier). The citation is as follows: [Gunnell, K. E., Crocker, P. R. E., Mack, D. E., Wilson, P. M., & Zumbo, B. D., (in press). Goal contents, motivation, psychological need satisfaction, well-being and physical activity: A test of Self-
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Study 3 (outlined in Chapter 4) was conducted at the University of British Columbia. A version of this manuscript has been submitted for publication. Dr. Peter Crocker, Dr. Diane Mack, and Dr. Bruno Zumbo are co-authors on the manuscript. I was involved in all aspects of this investigation including study design, ethical application, participant recruitment, data collection, analysis and interpretation of the data, and manuscript preparation. Ethical approval was granted by the University of British Columbia Behavioural Research Ethics Board (H12-02445). Data used for this investigation were provided by participants who completed baseline assessments for an intervention investigation (see study 4).

Study 4 (outlined in Chapter 5) was conducted at the University of British Columbia. A version of this manuscript will be submitted for publication. Dr. Peter Crocker, Dr. Diane Mack, and Dr. Bruno Zumbo are co-authors on the manuscript. I was involved in all aspects of this investigation including study design, ethical application, participant recruitment, conducting the intervention, data collection, analysis and interpretation of the data, and manuscript preparation. Ethical approval was granted by the University of British Columbia Behavioural Research Ethics Board (H12-02445).
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CHAPTER 1: Introduction and Literature Review

1.1 Introduction

With 20% of Canadians experiencing mental illness at some point in their lives (Health Canada, 2002) and only 31% of Canadians reporting excellent mental health in 2005 (Canadian Institute for Health Information, 2009), researchers have examined methods for treating psychological ill-being (e.g., depression) and fostering well-being (e.g., satisfaction with life, positive affect). There is now considerable evidence that exercise is effective for treating depression (Craft & Landers, 1998; Penedo & Dahn, 2005; Scully, Kremer, Meade, Rodger, & Dudgeon, 1998), and emerging evidence to suggest that exercise is also associated with psychological well-being (Chodzko-Zajko et al., 2009; Fox, 1999; Netz, Wu, Becker, & Tenenbaum, 2005; Penedo & Dahn, 2005). Attaining a state of psychological well-being is important because well-being is linked with various outcomes such as improved health status, greater longevity, and increased work productivity (Helliwell, Layard, & Sachs, 2012; Ryan, Huta, & Deci, 2013; Ryff & Burton, 2013). Espoused from the positive psychology movement, researchers have begun the scientific pursuit of determining what causes well-being and how it can be changed through intentional activities such as physical activity (Ferguson, Kowalski, Mack, Wilson, & Crocker, 2012; Gunnell, Mack, Wilson, & Adachi, 2011; Mack et al., 2012; Sylvester, Mack, Busseri, Wilson, & Beauchamp, 2012) or through positive psychology interventions (Layous, Nelson, & Lyubomirsky, 2013; Lyubomirsky, Sheldon, & Schkade, 2005; Norrish & Vella-Brodrick, 2008; Ryan & Deci, 2001; Seligman, Steen, Park, & Peterson, 2005; Sheldon & Ryan, 2011).
Self-Determination Theory (SDT; Deci & Ryan, 2002) is one popular theoretical framework that can be integrated into a positive psychology framework (Sheldon & Ryan, 2011). Using SDT, researchers in exercise psychology have examined the psychological outcomes associated with engaging in physical activity behaviour. For example, in exercise contexts, researchers have linked intrinsic goals, autonomous motivation, exercise self-schema, and satisfaction of key psychological needs with both well-being and physical activity behaviour outcomes (Edmunds, Ntoumanis, & Duda, 2006; Kendzierski, 1988; Mack et al., 2012; McDonough & Crocker, 2007; Sebire, Standage, & Vansteenkiste, 2009; Wilson, Longley, Muon, Rodgers, & Murray, 2006). Despite these findings, more research is needed to understand the sequence in which key antecedent variables such as goal contents, motivation, and exercise self-schemas relate to psychological need satisfaction, and in turn, well-being and physical activity behaviour. Moreover, research is needed to understand the role of psychological need satisfaction in more general physical activity contexts rather than limiting results to structured exercise or sport contexts. Understanding the plausible mechanisms responsible for increasing well-being and physical activity behaviour represents an important research agenda that has implications for research, population health, and public policy.

1.1.1 Overall Aim of Research

The overall purpose of this project was to examine the role that psychological need satisfaction plays in predicting well-being and physical activity behaviour. More specifically, 4 investigations were carried out to (1) examine the psychometric characteristics of scores derived from a modified version of an instrument designed to assess perceptions of psychological need satisfaction of competence, autonomy, and relatedness experienced in physical activity, (2) examine if changes in psychological need satisfaction mediated the relationships between
relative intrinsic goal contents, motivation, and well-being/physical activity, (3) examine if psychological need satisfaction has an indirect effect on the relationship between exercise self-schemas and well-being/physical activity, and finally (4) test the effectiveness of a best possible physical activity self-intervention on outcomes such as psychological need satisfaction, exercise self-schemas, well-being, and physical activity. This convergent program of research represents a series of studies that examines the role of psychological need satisfaction in physical activity in a sample of adults drawn from the general population.

1.2 Literature Review

1.2.1 Psychological Well-Being

Historically, psychology has been studied from a negatively biased account of human nature (Sheldon & Ryan, 2011). Researchers investigating psychological health have done so from a negative perspective, focusing on indicators of ill-being rather than well-being (Ryan, Huta, & Deci, 2008). Almost a decade ago, the World Health Organization (World Health Organization, 2004) recognized that mental health is more than the absence of mental illness, disease or infirmary. Accordingly, researchers have begun to focus on positive aspects of psychological functioning, and the field of positive psychology is burgeoning. Positive psychology “is an umbrella term for the study of positive emotions, positive character traits and enabling institutions” (Seligman et al., 2005, p. 410). In other words, positive psychology is a movement wherein researchers aim to study all accounts of human nature, including what features ‘work’, how they work and why they work (Sheldon & Ryan, 2011). The study of psychological well-being falls within the scope of positive psychology.
Psychological well-being is characterized by optimal psychological functioning (Ryan & Deci, 2001). Researchers investigating the antecedents and outcomes associated with well-being have done so under two conceptually related, yet distinct perspectives. The first is referred to as hedonic well-being (HWB; Kahneman, Diener, & Schwarz, 1999) and the second is referred to as eudaimonic well-being (EWB; Waterman, 1993). This differentiated approach to understanding well-being grew out of the recognition that being happy and experiencing pleasure does not necessarily imply that a person is psychologically well (Deci & Ryan, 2008). In light of these assertions, researchers contend that well-being is not exclusively focused on the outcome of happiness per se (as in HWB), but rather, is a process of fulfilling virtues and personal potentials (Deci & Ryan, 2008).

1.2.1 Hedonic and eudaimonic well-being

HWB is characterized by subjective experiences of pleasure and happiness, and results in high positive affect and low negative affect (Ryan & Deci, 2001; Waterman et al., 2010). One way that HWB has been operationalized is through the assessment of subjective well-being (Diener, Suh, Lucas, & Smith, 1999). Subjective well-being is conceptualized as the presence of life satisfaction and positive affect and the absence of negative affect (Ryan & Deci, 2001); however, it has been argued that subjective well-being cannot be directly equated with HWB because it contains a cognitive evaluation of one’s life (Ryan et al., 2008). One criticism of research that examines only HWB is that it does not take into consideration what causes well-being (Waterman, 2007). Therefore, Ryan and colleagues (2008) contend that the investigation of HWB alone cannot fully elucidate well-being. For example, attempts to maximize pleasure and reduce pain or displeasure could lead to a life of selfishness, materialism, and objectified sexuality (Ryan et al., 2008). In other words, while many pursuits can lead to pleasure or
happiness (or HWB), not all pursuits are characterized by living a full and meaningful life (or EWB).

EWB is characterized by living well and actualizing human potentials (Ryan et al., 2008). More formally, EWB has been defined as a “quality of life derived from the development of a person’s best potentials and their application in the fulfillment of personally expressive, self-concordant goals” (Waterman et al., 2010, p. 41). EWB is not necessarily a desired outcome, but rather, it is conceptualized more as a process of living, or fulfilling one’s true daimon (or true self). An individual’s efforts to live in accord with their daimon and to realize human potentials should give rise to EWB (Waterman et al., 2010). In his research on personal expressiveness (a synonym for eudaimonia), Waterman has demonstrated that while personal expressiveness and hedonic enjoyment are related, they are distinguishable concepts that both produce positive affective states; however, they differ in the way in which they relate to activities that further self-realization or best potentials (Waterman, 1993; Waterman et al., 2003). Waterman has also linked personal expressiveness to feelings of intrinsic motivation (Deci & Ryan, 1985), flow (Csikszentmihalyi, 1977; Csikszentmihalyi, 1988), and peak experiences (Maslow, 1964). Activities will foster EWB if they further the development of an individual’s best potentials and advance an individual’s purpose in living.

The differentiated approach to understanding well-being has led to slightly different conceptualizations and operationalizations of EWB (for a review see Huta, 2013a). For example, EWB and HWB have been investigated as both an outcome (Ryan et al., 2013; Waterman et al., 2010) and as a way of living (Huta, 2013a; Huta, 2013b). As a way of living, or as a motive, Huta refers to eudaimonia and hedonia rather than EWB and HWB (Huta, 2013b). In addition,
eudaimonia and hedonia have been studied at both the trait level (examining a person as a whole) or at the state level (examining experiences of eudaimonia and hedonia in a moment or during an activity). The research presented herein will examine EWB and HWB as outcomes associated with engagement in physical activity.

The distinction between EWB and HWB well-being is not without controversy. Kashdan and colleagues (2008) critiqued the usefulness of separating the two conceptualizations of well-being, arguing that EWB is elitist and that distinguishing well-being into different types may confound research efforts. Nevertheless, many researchers have supported the differentiated approach to understanding well-being. Results of confirmatory factor analysis demonstrate that items representing EWB and HWB do indeed load on to separate, yet highly correlated factors (Gallagher, Lopez, & Preacher, 2009; Waterman, Schwartz, & Conti, 2008). Researchers studying the differences between EWB and HWB have found support for the distinction based on biological health outcomes. For instance, researchers have demonstrated that well-being outcomes, particularly EWB, are positively associated with biological markers of health functioning (Ryff & Burton, 2013; Ryff et al., 2006). Higher EWB, as assessed through the Psychological Well-Being Scale (Ryff & Keyes, 1995), has been linked with positive cardiovascular and neuroendocrine factors and immune function, whereas HWB was not (Ryff et al., 2006). Researchers have also found evidence that the absence of EWB may be a risk factor for developing depression later in life (Wood & Joseph, 2010). Finally, intervention research suggests hedonic activities lead to high well-being immediately after an intervention (10-days), whereas eudaimonic activities produced benefits three months later (Huta & Ryan, 2010).
1.2.1.2 Research on eudaimonic and hedonic well-being in physical activity contexts

With the emergence of positive psychology in combination with the evidence supporting the link between physical activity and well-being (Chodzko-Zajko et al., 2009; Fox, 1999; Netz et al., 2005; Penedo & Dahn, 2005), it is not surprising that exercise psychology researchers are examining EWB and HWB outcomes associated with physical activity engagement. Cross-sectional findings indicate that physical activity behaviour is related to EWB in undergraduate students (Mack et al., 2012) and individuals diagnosed with osteoporosis (Gunnell et al., 2011). Prospective research findings indicated that over the course of 6-months, changes in health-enhancing physical activity were associated with changes in EWB and HWB in university students (Mack et al., 2012). Finally, an investigation in individuals diagnosed with osteopenia demonstrated that physical activity was associated with both hedonic and eudaimonic motives (Mack et al., 2011). Contrary to these finding, one investigation found that health-enhancing physical activity was not related to EWB; however, experiencing eudaimonia during health-enhancing physical activity contributed unique variance to EWB above health-enhancing physical activity and experiences of hedonia (Ferguson et al., 2012). Ferguson and colleagues suggested that it is not the quantity of the activity, but rather the quality of the activity that is important. To test this assertion, Ferguson et al. (2012) conducted a qualitative study and found that participants supported the role that health-enhancing physical activity plays in the promotion of EWB (Ferguson et al., 2012). Substantiating these findings, Sylvester and colleagues (2012) found that when health-enhancing physical activity was decomposed into effort, frequency, and duration, only effort during activity was associated with EWB. Taken together, the results from the aforementioned investigations suggest that experiencing eudaimonia during physical activity may be positively associated with EWB.
1.2.1.3 Theoretical frameworks for understanding eudaimonic and hedonic well-being

Various theories and conceptualizations of EWB and HWB well-being have been forwarded (Huta, 2013a). For example, Ryff (1989) conceptualizes EWB as psychological well-being comprised of 6 key dimensions including: personal growth, purpose in life, autonomy, environmental mastery, positive relations with others, and self-acceptance (Ryff & Singer, 2008). Another conceptualization of eudaimonic well-being stems from Waterman’s personal expressiveness research. Waterman attempts to distinguish eudaimonic activity (eudaimonia or personal expressiveness) from eudaimonic outcomes (eudaimonic well-being). Waterman (1993, p. 679) outlined 6 criteria for personal expressiveness that include: an unusually intense involvement in an undertaking, a feeling of a special fit or meshing with an activity that is not characteristic of most daily tasks, a feeling of intensely being alive, a feeling of being complete or fulfilled while engaged in an activity, an impression that this is what the person was meant to do, and a feeling that this is who one really is. Given its broad applicability across cultures, genders, and contextual domains, an increasingly popular framework that has demonstrated empirical evidence for understanding EWB and HWB is Self-Determination Theory (SDT; Deci & Ryan, 2002).

Within SDT, Ryan and colleagues (2008) purport that living well, as characterized by eudaimonia, is achieved through the pursuit of motives, goals, and behaviours that satisfy three fundamental psychological needs (Deci & Ryan, 2008). Individuals are thought to experience greater EWB through the pursuit of intrinsic life goals, through autonomous or self-determined regulation of behaviour or through awareness and mindfulness (Deci & Ryan, 2008). For example, one investigation found that success in an activity under controlling conditions enhanced happiness (HWB) but not vitality (EWB), whereas success in an activity in an
autonomy supportive condition enhanced both happiness and vitality (Nix, Ryan, Manly, & Deci, 1999). Psychological needs represent the fundamental requirements for experiences of EWB (Ryan & Deci, 2000). Basic psychological need satisfaction may be unrelated to hedonic activities, and as a consequence lead to short-term, superficial positive feelings (Vansteenkiste, Niemiec, & Soenen, 2010). On the other hand, pursuit of activities that are characterized by intrinsic goals, autonomous motivation, and psychological need satisfaction are expected to increase EWB. Finally, Ryan and colleagues (Ryan et al., 2013) contend that an individual will only experience EWB insofar as they are living in accord with their self and not enacting externally imposed contingents. The current program of research will use SDT as a guiding theoretical framework. The subsequent sections will outline key tenets outlined by Deci and Ryan within SDT and their relationship to the focal constructs of interest for this dissertation.

1.2.2 Self-Determination Theory

SDT (Deci & Ryan, 2002) serves as a useful theoretical framework for understanding the processes that produce optimal psychological functioning (Sheldon & Ryan, 2011). SDT is an organismic dialectic macro theory of human motivation and personality (Deci & Ryan, 2002). SDT is organismic because Ryan and Deci view humans as “active, growth-oriented organisms that innately seek and engage challenges in their environments, attempting to actualize their potentials, capacities, and sensibilities” (p. 8). While it is understood within SDT that organisms are inherently growth-oriented, the dialectical aspect of the theory stipulates that social environments can either facilitate or hinder a person’s tendency towards growth and internalization (Ryan & Deci, 2002). At the core of SDT lies the concept of basic psychological needs. Ryan and Deci (2002) assert that basic psychological need satisfaction is the facilitating mechanism that determines whether an individual will engage in a particular behaviour and
experience positive outcomes such as EWB and HWB well-being (Deci & Ryan, 2011). Conversely, if psychological needs are thwarted, or actively frustrated, an individual’s motivation to engage in the activity will be diminished and the individual will experience negative outcomes such as decreased well-being or increased ill-being.

SDT is considered a macro theory of motivation because it is comprised of 5 mini-theories linked by the concept of psychological needs that attempt to explain specific phenomena (Ryan & Deci, 2002). The first of the mini-theories is Cognitive Evaluation Theory (CET). Within CET, Deci and Ryan (Deci, 1975; Deci & Ryan, 1980) describe the social environmental factors that facilitate or undermine intrinsic motivation. Organismic Integration Theory (OIT; (Deci & Ryan, 1985; Ryan & Connell, 1989) was developed to understand the continuum of extrinsic motivation and the contextual factors that facilitate the process of internalization and integration of values and regulations. Essentially, OIT concerns the degree to which people experience autonomy while engaging in a particular behaviour (Ryan & Deci, 2002). Causality Orientations Theory (COT; Deci & Ryan, 1985) was developed to understand individual differences in how people orient themselves within their environment. Basic Psychological Needs Theory (BPNT; Deci & Ryan, 2000; Ryan & Deci, 2000) was developed in order to understand how the psychological needs for competence, autonomy, and relatedness relate to health and well-being (Ryan & Deci, 2002). Finally, Goal Content Theory (GCT) was developed to understand the content of goals (intrinsic or extrinsic) people pursue, and their impact on motivation and well-being (Vansteenkiste et al., 2010). The three mini-theories within SDT that are most applicable to this program of research are BPNT, OIT, and GCT.
1.2.2.1 Basic Psychological Needs Theory

At the foundation of SDT lies the hypothesis regarding basic psychological needs. Ryan and Deci (2002) contend that in order for a psychological need to qualify as such, it must be innate, universal, and essential (have a direct relationship with well-being). Basic psychological needs have been described as “nutriments” (Ryan & Deci, 2002, p. 7) necessary for growth and well-being. Furthermore, because basic psychological needs are universal they are assumed to be salient across all ages, genders, and cultures (Ryan & Deci, 2002). Nevertheless, the ways in which needs are satisfied may vary by age, gender, or culture. The three fundamental psychological needs proposed within BPNT and more generally, SDT are competence, autonomy, and relatedness. Competence is the need to feel effective within the social environment (White, 1959). An opportunity to fulfill the need for competence leads people to engage in activities that are optimally challenging to them. Autonomy is a sense of perceiving to be the origin of one’s own behaviours (deCharms, 1968). Autonomy is felt through acting from interest and integrated values (Ryan & Deci, 2002). Relatedness represents a feeling of connection or belonging with important others (Baumeister & Leary, 1995). Relatedness is not associated with a particular title such as “spouse”, but rather represents a feeling of secure attachments and belonging within a community (Ryan & Deci, 2002).

1.2.2.2 Organismic Integration Theory

Within OIT, Ryan and Deci (2002) speculate that humans are naturally endowed with the capacity to internalize behaviours and become self-determined if their required nutriments (psychological needs) are met. For example, if a person engages in an activity because of
external prompts, such as encouragement from a family member, the motivational regulation underpinning the engagement in that behaviour is likely to be external. Over time however, if psychological needs are satisfied, the individual may begin to internalize the behaviour, begin to self-regulate the behaviour, and integrate it in to their sense of self (Ryan & Deci, 2002). This process is termed internalization and is characterized by a transformation of external regulation to self-regulation, becoming more integrated and autonomous as more internalization occurs (Ryan & Deci, 2002). This characterization of internalization of motivational regulations from external to autonomous regulation stands in contrast to the view espoused by researchers of other behavioural theories such as Bandura in Social Cognitive Theory (Bandura, 1997) who hypothesizes that motivation is characterized by a dichotomy representing intrinsic or extrinsic motivation only. In contrast, Ryan and Deci view motivation ranging along a continuum. The more fully a regulation is internalized, the more it is integrated to part of the self and the more self-determined the behaviour becomes (Ryan & Deci, 2002). The self-determination continuum put forth in OIT ranges from amotivation, extrinsic motivation to intrinsic motivation (see Figure 1.1). Underpinning these forms of motivation are 6 types of regulation; non-regulation, external, introjected, identified, integrated and intrinsic regulation. The types of regulation are further underscored by the degree of self-determination in the quality of behaviour (see Figure 1.1). Amotivation is characterized by a state of lacking intention (Ryan & Deci, 2002). When an individual is amotivated, he/she may not act at all, or if he/she does, it will be by just going through the motion, or acting passively. Extrinsically motivated behaviours are characterized by four types of regulations (external, introjected, identified, and integrated) that range in their degree of self-determination. External regulation, the least self-determined form of extrinsic motivation is characterized by motivation to act for reward or to avoid punishment (Ryan &
Deci, 2002). Next, introjected regulation is an external motivation that has been internalized but still is not a part of the self. Introjected regulation is controlling and is characterized by engaging in behaviour to avoid feelings of guilt, shame, or to enhance feelings of worth (Ryan & Deci, 2002). Introjection is characterized by a sense of contingent self-esteem. Identified regulation is more self-determined and is characterized by a conscious valuing or acceptance of the behaviour as personally important. Identification is an important part of internalization as it represents an important point in which external regulation begins to transform into self-regulation (Ryan & Deci, 2002). Integrated regulation is the most self-determined or autonomous form of extrinsic motivation. It is characterized by congruence with personally endorsed values, psychological needs, and goals that are part of the self (Ryan & Deci, 2002). Lastly, internal regulation, or intrinsic motivation is characterized by motivation for enjoyment or inherent interest. Using the continuum of motivation, Ryan and Deci (2002) describe motivation as autonomous and
Figure 1.1 Motivational Continuum. Adapted from Ryan and Deci (2002).
controlled. *Autonomous motivation* is more self-determined and consists of internal regulation, integrated and identified regulations, whereas *controlled motivation* is less self-determined and consists of introjected regulation and external regulation.

The process of internalization is facilitated by psychological need satisfaction (Ryan & Deci, 2002). Within SDT, it is acknowledged that many activities are not inherently interesting and therefore many individuals will only engage in a particular behaviour at the request of a significant other or social network. That is, individuals typically engage in externally motivated behaviours to fulfill the psychological need for relatedness (Ryan & Deci, 2002). Indeed, research has demonstrated the important role relatedness plays for internalizing extrinsically motivated behaviour (Ryan & Deci, 2002). Yet relatedness alone is not enough to promote full integration, perceptions of competence is thus viewed as a catalyst to the internalization process. For example, if an individual engages in an externally regulated behaviour to increase relatedness satisfaction, it is unlikely that they will internalize the behaviour if they do not feel competent. Autonomy is the crucial factor in determining how much internalization will occur (Ryan & Deci, 2002). Full internalization requires autonomy because an individual must grasp the meaning of the behaviour for themselves and integrate that meaning with aspects of their self (Ryan & Deci, 2002). Therefore, all three psychological needs are thought to play an independent and important role to the internalization of behavioural regulation.

**1.2.2.3 Goal Contents Theory**

Motivational regulations identify the reason *why* an individual will pursue a particular behaviour. GCT was created in an attempt to clearly differentiate the goal from the *reason* why an individual pursues the goal (Deci & Ryan, 2000; Vansteenkiste et al., 2010). Accordingly, the
goal of behaviour represents the ‘what’ (e.g., I exercise to lose weight) and the motivational regulation represents the ‘why’ of behaviour (e.g., I exercise because my wife wants me to lose weight). Goal contents can be intrinsic or extrinsic in nature. A goal that is intrinsic such as engaging in physical activity for health will lead to increased satisfaction of psychological needs (Deci & Ryan, 2000; Soenens & Vansteenkiste, 2011; Vansteenkiste et al., 2010). Conversely, a goal that is extrinsic such as engaging in physical activity for image will lead to psychological need thwarting or a lack of psychological need satisfaction. As such, according to Deci and Ryan (2000), the contents of a goal (intrinsic or extrinsic) will lead to either psychological need satisfaction or thwarting, and thus differentially predict behavioural and psychological outcomes. Stated differently, the reason why a goal influences well-being and behaviour is because of its direct relationship with psychological need fulfillment (Deci & Ryan, 2000; Vansteenkiste, et al., 2010).

1.2.2.4 Self-Determination Theory and physical activity

Many researchers attempting to understand physical activity behaviour and associated antecedents and/or outcomes have used constructs embedded in SDT (c.f Ng et al., 2012; Wilson, Mack, & Grattan, 2008). Findings from previous research documents support for OIT’s differentiated approach to understanding motivation for physical activity (Wilson, Mack, & Grattan, 2008). Recently, Wilson and colleagues (2012) found that self-determined motivations for physical activity showed more positive links to weekly behavioural engagement; a finding that has been found by previous researchers (Brunet & Sabiston, 2011). Ryan et al. (2008) speculated that exercise behaviour may not be inherently enjoyable, and therefore well-internalized or self-determined forms of regulation such as identified or integrated may be a useful avenue for researchers or applied health specialists to target. Indeed, internalized forms of
regulations, particularly integrated (McLachlan, Spray, & Hagger, 2011) and identified regulations (Daley & Duda, 2006; Sabiston et al., 2010) have been found to predict exercise behaviour. Similarly, more internalized forms of extrinsic motivation have been linked to greater psychological outcomes such as positive affect (Edmunds, Ntoumanis, & Duda, 2007; McDonough & Crocker, 2007; Wilson, Rodgers, Blanchard, & Gessell, 2003).

In addition to supporting Deci and Ryan’s contentions outlined within OIT, emerging research has documented support for GCT theory within exercise contexts. Cross-sectional research has demonstrated that intrinsic goals for exercise are associated with psychological need fulfillment (Sebire, Standage, & Vansteenkiste, 2008; Sebire et al., 2009; Thøgersen-Ntoumani, Ntoumanis, Cumming, Bartholomew, & Pearce, 2011), autonomous regulations (Sebire et al., 2008), well-being (Sebire et al., 2009), and exercise behaviour (Sebire, Standage, & Vansteenkiste, 2011). Goal contents and motivational regulations are moderately correlated ($r$’s = .30 and .44) because of their shared contribution to psychological need satisfaction. Despite their correlation, researchers have demonstrated that goal contents and motivation independently contribute to the prediction of well-being (Sebire et al., 2009; Sheldon, Ryan, Deci, & Kasser, 2004) and behavioural outcomes (Sebire et al., 2011). Researchers have also found support for the mediating role of psychological need satisfaction between the goal contents-well-being relationships (Sebire et al., 2009; Smith, Ntoumanis, Duda, & Vansteenkiste, 2011). Taken together, results presented in research examining GCT generally support Ryan, Williams, and Patrick’s (2008) assertions that pursuing intrinsic goals will lead to greater behavioural persistence and well-being.
A systematic review found support for the nomological network related to psychological need satisfaction put forth within BPNT (Wilson, Mack, Gunnell, Oster, & Gregson, 2008). For example, researchers have demonstrated associations between greater psychological need satisfaction and more self-determined motivations (McDonough & Crocker, 2007; Wilson & Rogers, 2008). In sport contexts psychological need satisfaction has been positively associated with markers of well-being (Reinboth, Duda, & Ntoumanis, 2004; Reinboth & Duda, 2006) and negatively with markers of ill-being (Mack et al., 2011). Longitudinal research has mirrored cross-sectional findings and theoretical assertions. For example, Adie and colleagues (2012) found that psychological need satisfaction of competence and relatedness explained within person changes in EWB (subjective vitality) over two seasons of elite adolescent soccer. Together, these results support contentions outlined in BPNT.

Researchers have also supported the contention that psychological needs serve as mediators between social environments and psychological outcomes in sport settings (Adie, Duda, & Ntoumanis, 2012; Reinboth & Duda, 2006). In more general physical activity contexts, the satisfaction of all three psychological needs have been found to mediate the relationship between physical activity and psychological well-being in university students (Mack et al., 2012; Wilson & Bengoechea, 2010) and individuals diagnosed with osteoporosis (Gunnell et al., 2011) and osteopenia (Mack et al., 2011). Despite these findings, researchers have noted that when specific indirect effects are considered, different psychological needs emerge as more or less salient (Gunnell et al., 2011; Mack et al., 2012). With accumulating evidence that overall satisfaction of psychological needs represents an important mechanism that directly influences well-being, more research is needed to understand the antecedents of psychological need
satisfaction, the unique contribution of each psychological need, and how to enhance
psychological need satisfaction and promote well-being through physical activity contexts.

Another important antecedent associated with psychological need fulfillment is the role
Although in its original conception, SDT was focused more on the influence of the social
environment and natural growth tendencies, the theory grew to include the concept of identity
formation (Soenens & Vansteenkiste, 2011). Within SDT, identity formation is thought to be a
natural process in which individuals grow and seek to align their identities with their sense of
self, a process facilitated by psychological need satisfaction within given contexts (Ryan & Deci,
2011; Soenens & Vansteenkiste, 2011). The remaining sections of this chapter will provide a
review of the literature regarding the constructs of self-schemas and possible selves and how
they can be fruitfully studied using concepts within SDT’s nomological network.

1.2.3 Self-Determination Theory and the Self

A precise definition of the self has been contested and conceptualizations of the self
differ based on theoretical frameworks (Leary & Tangney, 2003). Within SDT, Ryan and Deci
(2000) view the self as “an innate and natural process that guides one towards more integrated
and optimal functioning” (Soenens & Vansteenkiste, 2011, p. 3). Within this conceptualization
individuals are thought to have multiple identities that are more or less integrated into their sense
of self (Ryan & Deci, 2011). In an effort to explain why some identities are adopted and
developed and others are not, Ryan and Deci contend that identities will develop as a direct
result of psychological need satisfaction. As such, from the SDT perspective, the identities that
people assume can be more or less integrated towards the self; however, not all aspects of one’s
psychological makeup become integrated into the self. In other words, identities can be externally imposed as in the case of the child gymnast whose parents are pressuring her to compete. Conversely, identities can be fully integrated as in the case of the gymnast who finds the activity inherently interesting or enjoyable. Psychological needs facilitate internalization which gradually refines cognitive, affective, and behavioural tendencies (Deci & Ryan, 2000). Furthermore, the self is not derived solely from social factors, but rather the self has intrinsic growth processes that foster integration towards one’s own actions or relations to others (Deci & Ryan, 1990). In summary, SDT does not view the self as one holistic self, but rather a dynamic combination of various identities that vary in their degree of integration into the self (Ryan & Deci, 2011). One construct that is closely aligned and similar to identity is self-schema (Berry, Strachan, & Verkooijen, 2013; Strachan & Whaley, 2013).

1.2.3.1 Self-schemas

Self-schemas represent generally stable structures that direct our understanding of how or why things are, in relation to us (Markus, 1977). Self-schemas are formally defined as “cognitive generalizations about the self, derived from past experience that organize and guide the processing of self-related information contained in the individual’s social experiences” (Markus, 1977, p. 64). Therefore, self-schemas are domain specific and can be brought about by specific events, or based on general representations from repeated events (Markus, 1977). Once a self-schema has been established, it will function to serve as a determinant of the importance attached to it, what becomes of it, and how information is processed and structured (Markus, 1977). If repeated experiences solidify the self-schema, that self-schema will become more resistant to contradictory information. Self-schemas are characterized by domain specific attributes or abilities and experiences in that domain (Cross & Markus, 1994). Having a self-schema in a
particular domain is thought to predict future behaviour in that domain. As a consequence, self-schemas may serve as a foundation for the development of future oriented selves, or possible selves (Cross & Markus, 1994).

1.2.3.2 Possible selves

Possible selves are defined as the self-knowledge an individual possesses about their potential and future selves and are developed from representations of the self in the past and what it could be in the future (Markus & Nurius, 1986). They do not represent any image; but rather, consist of specific, individualized, and significant hoped for or feared for selves that are considered to be part of the self (Erikson, 2007; Markus & Nurius, 1986). Possible selves are thought to enhance our understanding of motivation and affective states (Markus & Nurius, 1986). When an individual considers what is possible for them, the cognition can become a possible self and serve as a motivational force that produces affective states. Possible selves are important to motivation because they serve as incentives to approach or avoid future behaviour.

1.2.4 Linking Self-Determination Theory, Self-Schemas, and Possible Selves

Recently, Sabiston, Whitehead, and Eklund (2012) and Strachan and Whaley (2013) called for researchers using self-schema and possible selves constructs to do so under a larger theoretical framework such as SDT. One advantage to subsuming self-schemas and possible selves under the SDT umbrella is that SDT accounts for the degree of integration towards the self; a process facilitated through the satisfaction of basic psychological needs (Ryan, 1995). The characterization of identity and schemas used in cognitive approaches often neglects the nature of growth and the impact of integration and internalization (Ryan, 1995). Moreover, Ryan (1995) has argued that many cognitive theories have moved away from a self-unifying system to
describe many independent selves that occur in many different contexts (e.g., possible selves). As conceptualized in the cognitive approach, he described people as having a “handbag...for various identity schemas that are cued up by differing social contexts” (p. 398). In other words, self-schema theories do not account for the degree of integration of a particular schema into the self, but rather view schemas as being independent entities cued by social contexts or external prompts. By ignoring the variation in integration towards the self, researchers who conduct psychological interventions will be doing so under the assumption that they are “training, shaping, directing, programing and controlling” (Ryan, 1995, p. 399). That is, in using the cognitive approach of self-schemas researchers will work towards controlling participants by imposing external pressures. Conversely, if the SDT perspective is used, the researcher who conducts a psychological intervention, while attempting to support psychological needs, will be doing so under the assumption that the intervention is “facilitating, conducing, supporting, or nurturing” tendencies to facilitating self-determination (Ryan, 1995, p. 399). Therefore, using the SDT approach to understanding self-schemas and possible selves holds considerable appeal in terms of understanding the mechanisms through which behaviour change or psychological outcomes can be achieved.

Researchers have supported the utility of examining self-schema constructs under the SDT framework. For example, based on SDT, Bober and Grolnick (1995) argued that there could be qualitative differences in how people ascribe to self-schemas based on autonomous or controlled orientation. Corroborating their hypothesis, Bober and Grolnick found that participants with higher autonomous orientations changed less when they were given counter-schematic information whereas those with more controlled orientations changed more in the direction of the counter-schematic information. In discussing these results, Bober and Grolnick
suggested that individuals who were more autonomous were able to be more flexible and self-aware than their non-autonomous counterparts because they were not undergoing an intrapsychic conflict around how they should be and how they are seen. Furthermore, Bober and Grolnick’s results support Deci and Ryan’s contentions that individuals with an autonomous orientation and self-schema are more self-aware. Bober and Grolnick’s (1995) demonstrated the combining cognitive theories of self-schema and motivational theories of SDT provided additional information about how individuals process information about themselves. In another example, Lynch and colleagues (2009) combined Self-Discrepancy Theory (another cognitive approach similar to schema theory; Higgins, 1987) with SDT and found that the more autonomy support an individual received, the less discrepancy there was between ideal and actual selves, and this predicted well-being (Lynch, La Guardia, & Ryan, 2009). Most recently, Brunet and colleagues (2012) integrated OIT and Self-Discrepancy Theory (Higgins, 1987) and found that consistency between actual and ideal physical self-perceptions were related to physical activity behaviours, and this relationship was mediated by motivational regulations. Greater agreement between actual and self-guide states was associated with greater intrinsic motivation and physical activity, whereas more discrepancy between actual and self-guide states was associated with introjected and external regulation (Brunet, Sabiston, Castonguay, Ferguson, & Bessette, 2012).

Taken together, researchers suggest that self constructs can be studied under a larger theoretical framework such as SDT. SDT is a macro-theory of motivation, and concepts within the theory could help to explain the role of self in motivation. SDT can complement the study of cognitive approaches such as self-schema and possible selves through a more articulated understanding of the self through constructs such as motivational regulations, and basic
psychological needs. The following sections will outline points of convergence and divergence between SDT and cognitive approaches such as self-schemas and possible selves.

1.2.4.1 Motivation

A salient link between self-schemas, possible selves and SDT is the focus on motivation. Because motivation is at the forefront of both theories, self-schemas and possible selves can be understood using the SDT framework (Sabiston, et al., 2012). More specifically, self-schemas and possible selves can be integrated with motivational tenets outlined in OIT (Deci & Ryan, 2002). Self-schemas are related to motivation because they influence the way in which people process information and how they process information about current and future behaviour (Markus, 1977; Kendzierski, 1988). Possible selves are thought to motivate behaviour because they provide a cognitive representation to end states (Markus & Nurius, 1986), and as a result, they have been described as a “bridge” between the now and then (Markus & Ruvolo, 1989, p. 211). The concept of possible selves includes the notion that possibilities of the self provide incentive for action/behaviour or incentive to avoid action or behaviour.

Adopting SDT as a theoretical framework, the self-schema/possible selves-behaviour link can be explained by motivational regulations and the continuum of internalization towards the self for a particular behaviour. For example, in line with predictions within SDT, if a person has a self-schema or possible self that is externally regulated, the person may be less likely to engage in the behaviour. Conversely, if a person has a self-schema or possible self that is regulated by self-determination, the person may be more likely to engage in the activity for enjoyment (e.g., intrinsic regulation) or because they value the activity (e.g., identified regulation). More simply stated, two people may possess the same possible self (e.g., fitness; Markus & Nurius, 1986);
however, the content (e.g., intrinsic vs. extrinsic goal) and origin (e.g., autonomous or controlled) of the possible self will impact the course of action to realize this possible self. Opportunities to fulfil psychological needs may facilitate integration of the possible self or self-schema and help researchers elucidate the link between self-schemas/possible selves and psychological well-being and behaviour.

1.2.4.2 Psychological need satisfaction

Self-schemas and possible selves provide specific cognitions for concepts similar to basic psychological needs such as mastery, affiliation, and agency (Markus & Nurius, 1986). Within SDT, Ryan and Deci (2011) contend that individuals will develop identities (or schemas) in order to facilitate satisfaction of psychological needs. That is, an individual is more likely to engage in a particular behaviour if that behaviour provides opportunities for competence, autonomy, and relatedness. Similarly, possible selves will be created based on cognitions about competence, relatedness, and agency (Markus & Nurius, 1986). Therefore, self-schemas and possible selves may serve as important antecedents to psychological need satisfaction.

1.2.4.2.1 Competence, self-schemas, and possible selves. Self-schemas and possible selves are thought to require a sense of self-efficacy (Markus & Nurius, 1986) or competence (Cross & Markus, 1994). Self-efficacy is “concerned with judgements of personal capability” (Bandura, 1997, p. 11). Self-efficacy is similar to competence because they are both domain specific cognitions about abilities. Self-efficacy is more concerned with outcomes, whereas it is the need for competence in and of itself that contributes to well-being (Bandura, 1997; Deci & Ryan, 2000). In order to develop a possible self, an individual will use self-knowledge from previous experiences and self-schemas to determine what is possible for him or her to achieve.
Within SDT, the need for competence is thought to give people the propensity to seek challenges that are optimal for their capacities (Ryan & Deci, 2002). Beliefs about competence should influence self-schemas because an individual who experiences incompetence in a particular domain is unlikely to continue engagement in that behaviour, thereby reducing the likelihood that they will become schematic in that domain (Cross & Markus, 1994). That is, people will gravitate towards identity development for a particular domain when they feel effective in it (Ryan & Deci, 2011). Beliefs about competence should influence possible selves because a person would only possess a possible self that he or she believes he or she has the capacity to enact.

1.2.4.2.2 Autonomy, self-schemas, and possible selves. Within SDT, individuals are hypothesized to engage in and develop schemas or possible selves that are regulated by a sense of autonomy or self-determination. To the degree that individuals fully accept, value, and integrate a self-schema, they will experience greater autonomy satisfaction. Yet autonomy represents a unique niche in the identity-SDT framework because some identities will not be fully integrated, and as a consequence, may not engender greater autonomy satisfaction (Ryan & Deci, 2011). Based on SDT, self-schemas and possible selves that are well integrated into the self, and that foster a sense of psychological need satisfaction are more likely to be realized, or activate behaviour, than those self-schemas or possible selves that are externally regulated. Indeed, using the concept of autonomy when examining self-schemas and possible selves contributes novel information about the degree of integration towards the self.

1.2.4.2.3 Relatedness, self-schemas, and possible selves. Ryan and Deci (2011) assert that schemas are created first and foremost to satisfy perceptions of relatedness in order to find
secure attachments and feelings of belonging. Using this line of reasoning, it is possible that an individual develops a particular self-schema in order to experience relatedness with important others. The creation of a possible self will provide specific cognitions about affiliation and is influenced by the social environment (Markus & Nurius, 1986). Therefore, the psychological need for relatedness may play an important role in how self-schemas and possible selves are created and lead to increased affective or behavioural outcomes.

Being able to articulate a best possible self involves goal focused visions which should theoretically be linked to greater psychological need satisfaction (Layous et al., 2013). Layous and colleagues (2013) suggested that individuals can increase need satisfaction through intentional activities like a best possible selves writing intervention. This hypothesis is based on previous work that suggests people can enhance their need satisfaction through goal pursuits (Niemiec, Ryan, & Deci, 2009; Sheldon & Elliot, 1999). To this end, Layous et al., (2013) found that a best possible self intervention created greater perceptions of relatedness, but not competence or autonomy. Finally, after conducting a qualitative study examining motivational aspects of musical possible selves, Schnare, MacIntyre, and Doucette (2012) coded four main themes consistent with each of the three psychological needs (i.e., improvement, social connection, success, and enjoyment). Results from these investigations suggest that psychological needs may play an important role in the creation of possible selves, and how possible selves influence behaviour and well-being. Based on the results from these investigations, it seems plausible that articulating a possible self could lead to greater perceptions of psychological need satisfaction.
1.2.5 Self-Schemas and Possible Selves in Physical Activity

1.2.5.1 Self-schema and exercise

Self-schema theory has been used in exercise contexts in an attempt to understand behavioural outcomes such as engagement in exercise (Kendzierski, 1988). Based on Markus’ (1977) work, Kendzierski (1988) hypothesized that having an exercise schema would lead individuals to engage in more exercise behaviour compared to not having an exercise schema. Moreover, Kendzierski (1988) hypothesized that exercise schematics would have greater exercise related cognitions (e.g., intentions, commitment, interest) compared to non-exercise schematics. In order to examine her hypotheses, Kendzierski developed an instrument that can be used to classify individuals into one of three schema types. Exercise schematics are individuals that consider exercise to be highly self-descriptive and highly important to their self (Kendzierski, 1988). Conversely, non-exercise schematics are individuals who consider exercise to be highly non-descriptive or not important to their self (Kendzierski, 1988). Finally, as schematics consider exercise to be moderately self-descriptive and do not consider exercise to be important to their self (Kendzierski, 1988).

Results of Kendzierski’s (1988; 1990) investigations found support for theoretical assertions (Markus, 1977). Participants who were classified as exercise schematics reported engaging in exercise on more days of the week and doing more activities for exercise than either aschematics or non-exercise schematics (Kendzierski, 1988; Kendzierski, 1990). Researchers have supported the contention that exercisers schematics exercise more than non-exercise schematics (Banting, Dimmock, & Lay, 2009; Estabrooks & Courneya, 1997). Exercise self-schema was found to moderate the intention-exercise behaviour link (Estabrooks & Courneya,
and exercise schematics were found to have more plans and intentions to exercise in the future (Kendzierski, 1988; Sheeran & Orbell, 2000), a finding that may be particularly relevant to the creation of possible selves.

1.2.5.2 Possible selves and exercise

Researchers have examined variables that are associated with exercise possible selves (Harju & Reed, 2003; Whaley, 2003). For example, Harju and Reed (2003) found that college students who described themselves as having achieved their exercise possible selves were likely to feel capable, to exercise, work out, and were more fit. In another example, Whaley (2003) found that the possible selves individuals listed were able to distinguish levels of exercise behaviours. For example, possible selves associated with extrinsic goals such as image, weight, and attractiveness differentiated non-exercisers from exercisers. Moreover, long-term exercisers were more likely to report greater hoped for and feared for selves related to health and physical activity. Collectively, the results from these two investigations indicate that investigating possible selves in exercise contexts may help understand exercise motivation.

Researchers employing intervention investigations have found evidence to suggest that generating exercise possible selves can lead to increased exercise behaviour. In one of the first intervention investigations using a possible selves manipulation Ouellette and colleagues (2005) found that participants who were future oriented and who were exposed to an exercise possible self manipulation increased their exercise participation at follow-up. Recently, Murru and Martin Ginis (2010) conducted a possible selves intervention to examine the role of self-regulation (scheduling, planning, barrier and goal-setting self-efficacy) as mediating variables in the promotion of exercise engagement. The intervention was a randomized controlled experiment.
with three conditions. The first condition was a hoped for possible self where participants were told to generate images of themselves in the future as an exerciser. The second condition was a feared possible self where participants were asked to generate images of themselves as someone who does not exercise. Finally, the third condition was a control group where participants completed a physical activity quiz. The image generation task was based on Ouellette et al.’s (2005) study. Results indicated that participants who completed the feared for and hoped for possible selves intervention (collapsed together) reported engaging in more minutes of exercise over 4 and 8 weeks than those in the control group (Murru & Martin Ginis, 2010). Furthermore, the results of the intervention were partially mediated by planning self-efficacy. Taken together, the effects of the two intervention studies (Murru & Martin Ginis, 2007; Ouellette et al., 2005) demonstrated that a possible selves manipulation was associated with greater exercise engagement. However, these two interventions did not examine the effect of the possible selves manipulation on well-being.

1.2.5.3 Self-schemas, possible selves, and psychological well-being

Articulating a possible self may bring about a positive affective state that is energizing and promotes action (Cross & Markus, 1994). The discrepancy between a current self-concept or self-schema and a future possible self should create affective consequences (Higgins, 1987; Markus & Nurius, 1986). Experiences of affect that are brought about by engaging in an activity related to the self is thought to lead to greater satisfaction than experiencing affect from an activity that is not related to the self (Rejeski & Mihalko, 2001). Realizing a possible self may therefore create a positive emotional state and a desire to maintain this state (Cross & Markus, 1994). Indeed, Markus and Nurius (1986) found that possible selves were related to positive affect. In another example, in older adults, a health specific possible self leads to increased
activities related to the possible self and subsequent affective experiences (Hopman, Gerstorf, Smith, & Glumb, 2007). Self-schemas are thought to influence affect regulation because in order to be consistent with one’s previous views of the self, an individual will work to enhance and promote that self whenever possible (Markus & Wurf, 1987). This effort to enhance the possible self should solidify it, and lead to positive outcomes such as well-being.

Intervention work on possible selves from the positive psychology literature supports theoretical hypotheses and demonstrates that writing about one’s best possible self can lead to greater well-being (King, 2001; Layous et al., 2013; Lyubomirsky, Dickerhoof, Boehm, & Sheldon, 2011; Sheldon & Lyubomirsky, 2006). For example, Sheldon and Lyubomirsky (2006) found that compared to expressing gratitude, a best possible selves writing task group demonstrated the largest increase in positive affect immediately following the intervention. Moreover, the best possible selves group had the highest degree of self-concordant motivation (or inherent interest). In other words, participants in the best possible selves group demonstrated the greatest amount of identification and interest in continuing the task compared to control and expressing gratitude groups (Sheldon & Lyubomirsky, 2006). More recently, Layous and colleagues (2013) found that a 4-week best possible selves writing intervention increased well-being and perceptions of relatedness. This was the first investigation to examine perceptions of psychological need satisfaction and possible selves. Therefore, based on results from the possible selves-behaviour literature (Murru & Martin Ginis, 2010; Ouellette et al., 2005) and results from the possible selves-well-being literature (Layous et al., 2013; Sheldon & Lyubomirsky, 2006), possible selves manipulations have the ability to increase behavioural engagement in physical activity and enhance psychological well-being.
1.2.6 Measurement, Score Reliability and Validity

With the increased interest in the role of psychological need satisfaction in exercise contexts and in the best possible selves intervention (Layous et al., 2013), researchers have highlighted the importance of developing context specific instruments to assess psychological need satisfaction (Wilson, Rogers, et al., 2006). Two context specific instruments have been designed to assess perceptions of competence, autonomy, and relatedness within exercise contexts specifically. The Psychological Needs Satisfaction in Exercise Questionnaire (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) and the Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006) were developed to assess perceptions of competence, autonomy, and relatedness experienced during exercise. Wilson, Mack, Gunnell, Oster, and Gregson (2008) conducted a review on the measurement properties associated with scores from the PNSE and BPNES. Their results indicated that scores associated with both instruments (the PNSE and BPNES) demonstrated good psychometric properties and that scores could be interpreted meaningfully. While these findings are promising for researchers interested in structured exercise, little information is available about the utility of the only English instrument\(^1\) designed to assess psychological need satisfaction in exercise (i.e., the PNSE) when modified to global physical activity contexts. Structured exercise is defined as “a form of leisure-time physical activity that is usually performed repeatedly over an extended period of time (exercise training) with a specific external objective such as improvement of fitness, physical performance, or health” (Bouchard, Blair, & Haskell, 2012, p. 12). Whereas physical activity is

\(^1\) At the time of this research, the PNSE was the only English measure of psychological need satisfaction in exercise contexts. Recently, Vlachopoulos, Ntoumanis, and Smith (2010) have translated the BPNES into English and provided preliminary evidence of score validity and reliability.
defined as “any bodily movement produced by skeletal muscles that results in an increase in metabolic rate over resting energy expenditure” (Bouchard et al., 2012, p. 12). Querying physical activity as the context of interest allows researchers to use participants engaged in exercise, sport, commuting activities, work activity (e.g., heavy lifting), and leisure time physical activity, while not limiting their results to only participants engaged in exercise.

With an increased interest in more global markers of physical activity such as health-enhancing physical activity and leisure time physical activity, researchers have begun to modify the PNSE from exercise to physical activity contexts (e.g., Gunnell et al., 2011; Mack et al., 2012); however, little effort has been made to examine the merit of modifying the instrument beyond reporting coefficient alpha (e.g., Gunnell et al., 2011; Mack et al., 2012). With researchers questioning the utility of a modified version of the PNSE (e.g., McDonough & Crocker, 2007; Peddle, Plotnikoff, Wild, Au, & Courneya, 2008), research is need to begin the examination of score validity and reliability of the modified PNSE. Because this program of research is based on the key role of psychological need satisfaction in physical activity contexts, the first study in this dissertation will examine evidence of score validity and reliability for the modified PNSE (the PNSE-PA). As such, a brief review of validity theory and the process of measurement validation is necessary.

At the heart of any research endeavour lays the critical role of measurement (Gunnell, Schellenberg, et al., forthcoming; Hubley & Zumbo, 1996; Zumbo, 2009). Measurement is used for the purpose of research, feedback, and/or interventions (Zumbo, 2009). Without evidence of score validity, the interpretations or inferences made from any instrument are meaningless, inappropriate, and of limited use (Zumbo, 2007). Consequently, instruments used to assess key
constructs such as psychological need satisfaction should demonstrate evidence of score validity and reliability such that any inferences made from the scores are both meaningful and inform the evidence base concerning the construct. Validity is defined by the *Standards for Educational and Psychological Testing* (the *Standards*) as “the degree to which evidence and theory support the interpretation of test scores entailed by proposed uses of tests” (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999, p. 9). Reliability is defined as “the consistency of such measurement when the testing procedure is repeated on a population of individuals or groups” (AERA et al. 1999, p. 25). More simply stated, validity refers to the meaningfulness of the scores and inferences, whereas reliability concerns the amount of error present within the scores. As such, when a researcher validates a score, they are also evaluating the credibility or quality of the claims that can be made from that test score (Kane, 2013). Therefore, demonstrating evidence of score reliability and validity for instruments used in research represents a crucial prerequisite for interpreting research results (Gunnell, Schellenberg, et al., forthcoming).

Recently, researchers have argued for the inclusion of validation efforts in research in sport and exercise psychology that are based on validity theory (Gunnell, Schellenberg, et al., forthcoming; Gunnell, Wilson et al., forthcoming). The *Standards* represents one framework developed by prominent psychometricians and validity theorists such as Messick (1995), and Cronbach and Meehl (1955) that can be used as a guiding framework for evaluating psychometric properties of scores from instruments. Consequently, this program of research will adopt the *Standards* framework for psychometric evaluation of instrument scores. Within the *Standards*, validity is conceptualized as a unified theory, meaning that all validity evidence bears on score meaning (AERA et al., 1999). Of critical importance, scores and inferences derived
from the instruments are validated, not the instruments themselves per se (AERA et al., 1999). Validating the scores of the instruments emphasizes that score validity is dynamic rather than static, and bound by place, time, context, sample, and score use (Zumbo, 2007). Finally, validation is an ongoing process (Hubley & Zumbo, 2013; Messick, 1995), and as such, each investigation in this study will provide evidence of score reliability and validity where possible. Notwithstanding, Kane (2013) recently argued that researchers should report validity and reliability evidence that is meaningful to the research question(s). Consequently, because psychological need satisfaction is the key variable of interest in this program of research, and because the purpose of this research is to examine the more global context of physical activity rather than structured exercise an important first step to this program of research was to examine evidence of score validity and reliability for the modified instrument designed to assess psychological need satisfaction in the general population engaged in physical activity.

1.2.7 Overall Research Questions

The overall purpose of the 4 studies presented herein was to examine the role of psychological need satisfaction in physical activity contexts. Key antecedent variables of interest include: the role of goal contents, motivational regulations, exercise self-schemas and possible selves. Key outcome variables include: EWB and HWB, and physical activity behaviour. In total, 4 studies were conducted to address the overarching research question about the role of psychological need satisfaction in predicting well-being and physical activity behaviour outcomes. This program of research was not conducted sequentially, but rather, represents a convergent program of research addressing research questions pertaining to the antecedents and outcomes associated with psychological need satisfaction in physical activity contexts and the mediational role that psychological need satisfaction may play.
A preliminary step necessary for this program of research was to examine evidence of score validity and reliability of an instrument modified to assess psychological need satisfaction in global physical activity contexts and in a general population. The purpose of study 1 (outlined in Chapter 2) was to examine measurement properties of scores from the Psychological Need Satisfaction In Exercise Scale (PNSE; Wilson et al., 2006), including the merit of item modification to general physical activity contexts (PNSE-PA), evidence of internal structure, measurement invariance between populations and instrument formats, and score reliability. The psychometric investigation of scores from the PNSE-PA was based on validity theory and represents an important step to ensuring that inferences made from the scores obtained in each investigation were meaningful. Study 1 was conducted using participants who completed time 1 of the Study 2 questionnaire package, along with two data sets obtained from previous research.

The purpose of study 2 (outlined in Chapter 3) was to examine if changes in psychological need satisfaction mediated the relationship between changes in relative intrinsic goal contents → motivation → changes in well-being/physical activity behaviour. Study two was addressed using 2 time points separated by 6 months. Although there is data supporting the use of SDT’s mini-theories for explaining physical activity and well-being outcomes (Ng et al., 2012) our current understanding of how the mini-theories fit together is limited. Moreover, this micro-level examination of SDT’s mini-theories impedes our ability to understand the overall underlying psychological processes involved in predicting well-being and physical activity behavior. Therefore, study 2 examined select antecedents posited by Deci and Ryan (Deci & Ryan, 2011; Deci & Ryan, 2000) to directly predict psychological need satisfaction and in turn, well-being and physical activity behaviour.
Study 3 (outlined in Chapter 4) examined if exercise self-schemas were related to well-being and physical activity behaviour because of opportunities to satisfy basic psychological needs. Study 3 built on the findings from study 2 because it examined a construct related to goals and motivation (i.e., self-schemas). Furthermore, Deci and Ryan (2000) contend that self-schemas could vary in their degree of integration towards the self, and that individuals are more likely to integrate a self-schema into their self if the schema provides satisfaction of competence, autonomy, and relatedness. Study 3 was conducted using a cross-sectional design and using participants who completed the baseline assessment for study 4 (outlined in Chapter 5).

Finally, study 4 (outlined in Chapter 5) examined if a best possible physical activity self intervention over 4 weeks would increase exercise self-schemas, psychological need satisfaction, well-being, and physical activity behaviour. Study 4 was an extension of study 2 because best possible selves are thought to reflect personal goals and motives individuals possess for themselves (Markus & Nurius, 1986). Study 2 explored the relationships between goals, motivation and psychological needs. Furthermore, study 4 provided converging evidence for study 3 because possible selves are created based upon self-schemas. Study 4 was conducted using a randomized controlled design. The intervention lasted 4 weeks, with assessments at baseline, post-test, and 1 month follow-up. Finally, one treatment group in study 4 received psychological need satisfaction primers (Sheldon & Filak, 2008) such that we could directly test the effects of manipulating perceptions of psychological need satisfaction. Consequently, this intervention will serve as an important contribution to the literature because it will directly test the effect of using psychological need satisfaction primers (Sheldon & Filak, 2008) to attempt to directly manipulate perceptions of psychological need satisfaction.
Collectively this research will provide insight into the antecedents and consequences associated with psychological need satisfaction in physical activity contexts. Although numerous investigators have supported theoretical tenets that psychological need satisfaction is related to well-being outcomes in exercise and sport contexts (Adie et al., 2012; Reinboth & Duda, 2006; Sebire et al., 2009; Sylvester et al., 2012; Teixeira, Carraca, Markland, Silva, & Ryan, 2012; Wilson, Mack, Gunnell et al., 2008) research results have been limited. In addition to the individual contribution of each study discussed above, there are at least 5 general novel contributions this program of research will make to the extant SDT literature base. These contributions span sample characteristics, operationalization of measured variables, and theoretical advancement.

First, although investigators have found evidence to support psychological need satisfaction as predictors of well-being, the evidence regarding their differential role in predicting EWB and HWB is limited (Wilson, Mack, & Grattan, 2008). Examining EWB and HWB represents an important research agenda because researchers have argued that HWB may not be as enduring and EWB (Huta & Ryan, 2010), and that EWB may be more strongly related to physical health outcomes (Ryff & Burton, 2013). Furthermore, investigators have suggested that satisfaction of individual psychological needs may differentially predict EWB and HWB (Mack et al., 2012; Sylvester et al., 2012). Indeed, several researchers have called for the examination of independent psychological need satisfaction variables because creating average need satisfaction scores may mask novel findings about the contribution of each need (Deci & Ryan, 2000; Sheldon, Elliot, Kim, & Kasser, 2001; Sheldon, Zhaoyang, & Williams, 2013). As such, the results presented herein will inform researchers on the unique role of satisfying each psychological need and their relationship with EWB and HWB outcomes.
A second contribution this program of research will make to the literature is that each investigation will examine psychological need satisfaction as predictors of physical activity behaviour. Although Deci and Ryan (2011) contend that psychological need satisfaction provides energy and direction to engage in behaviour, with a few exceptions (e.g., Edmunds et al., 2006; McDonough & Crocker, 2007), researchers have been slow to directly test theoretical hypothesis of the direct role of psychological need satisfaction in predicting physical activity behaviour. Two systematic reviews demonstrated small positive bivariate associations between psychological need satisfaction and exercise behaviour (Teixeira et al., 2012; Wilson, Mack, Gunnell et al., 2008). If psychological need satisfaction is found to predict physical activity behaviour, the results of this investigation will support the hypothesized key role of psychological need satisfaction in predicting both well-being and behavioural outcomes.

A third important contribution of this research is that indirect effects produced by satisfying each psychological need between antecedent variables such as relative intrinsic goals, motivation, and exercise self-schemas and consequence variables such as EWB, HWB, and physical activity will be examined. Theorists have hypothesized that satisfaction of psychological needs may serve as mediators (e.g., Deci & Ryan, 2011; Ryan, Patrick, Deci, & Williams, 2008; Vallerand, 1997). Indeed, several researchers working within more global physical activity contexts such as exercise and sport have found support for the mediational role that psychological need satisfaction plays between relationships such as physical activity and well-being (Gunnell et al., 2011; Mack et al., 2012; Sylvester et al., 2012), between the motivational climate and well-being (Reinboth & Duda, 2006), and between autonomy support and well-being (Adie, Duda, & Ntoumanis, 2008). Despite the importance of previous research findings, few attempts have been made to understand the mediational role between goal contents,
motivation, self-schemas, well-being, and physical activity behavior. As such, this program of research will contribute to the extant literature examining the mediational role of psychological need satisfaction between proposed relationships forwarded within SDT.

Fourth, although investigators using SDT have extended research findings beyond the use of university undergraduate students (e.g., Edmunds et al., 2007; Gunnell et al., 2011; Sebire et al., 2009), researchers examining self-schema and possible selves constructs have generally relied on samples of individuals drawn from university populations (e.g., Kendzierski, 1988; Layous et al., 2013; Murru & Martin Ginis, 2010; Sheldon & Lyubomirsky, 2006). While examining theoretical assertions in a sample of university students is an important step in testing theory, the results from the investigations may lack external validity. Indeed, Henrich and colleagues (2012) have argued that because college students differ on so many motivational and psychological variables compared to individuals not in college, research based on college students may simply reflect and examination of outliers and therefore will not generalize to the rest of the population. Consequently, this research program will examine participants drawn from the general population to enhance the generalizability of the study findings.

Finally, researchers have begun to recognize the important role of examining more general physical activity contexts rather than restricting results to individuals engaged in structured exercise. When researchers examine exercise contexts, they are limiting their results to individuals who engage in repetitive, goal oriented physical activity (Bouchard et al., 2012). Conversely, if researchers query physical activity, their results apply to anyone who engages in physical activity, including but not limited to exercise, sport, commuting activity, and leisure activity (Bouchard et al., 2012). In the current research, participants will be asked to respond to
each questionnaire regarding their physical activity, therefore making the results more global and inclusive to individuals who do not necessarily engage in structured exercise yet still accrue the health benefits of other forms of physical activity such as gardening.

In summary, understanding the factors that influence psychological need satisfaction within physical activity contexts is an important avenue for research since psychological need satisfaction has been suggested as a vehicle for promoting well-being and physical activity (Edmunds et al., 2006; Gunnell et al., 2011; Mack et al., 2012). The results of this program of research are anticipated to contribute to the SDT literature and potentially provide guidance for health professionals seeking to improve well-being and physical activity.

2.1 Introduction

Despite the compelling evidence that physical activity can improve both mental and physical health (Bouchard, Blair, & Haskell, 2007), 85% of Canadian adults are not sufficiently active to meet physical activity guidelines (based on accelerometer data; Colley et al., 2011). Various psychological constructs and theories have been proposed to explain the relationship between physical activity and health outcomes (e.g., self-efficacy, self-esteem; Fox, 1999). One psychological theory that has gained widespread popularity given its range and utility in understanding the complexities of human behavior is Self-Determination Theory (SDT; Deci & Ryan, 2002).

2.1.1 Self-Determination Theory: A Brief Overview

SDT is a macro-level theory of human motivation and behavior that is comprised of five mini-theories each of which address different aspects of human functioning and personal development. The central assumption embedded within SDT is that humans are naturally endowed with the capacity for growth, development, and assimilation with the social world (Deci & Ryan, 2002). Such development is largely determined by the extent to which social environments provide opportunities to satisfy basic psychological needs (Deci & Ryan, 2002).

Ryan and Deci (2002) advanced Basic Psychological Needs Theory (BPNT), which identifies the existence of at least three psychological needs. Competence involves feeling effective while completing optimally challenging tasks (White, 1959). Autonomy refers to feeling volitional, agentic, and self-governing such that a person perceives his/her behavior as
emanating from within themselves and not controlled by external sources or agenda (deCharms, 1968). Finally, relatedness pertains to a feeling of connection or belonging with important others or within one’s social milieu (Baumeister & Leary, 1995). According to Deci and Ryan (2002), the psychological needs central to BPNT are innate and when satisfied authentically, within or across contexts, promote optimal well-being.

2.1.2 SDT and Exercise: Evidence and Caveats

BPNT has become popular amongst physical activity researchers (Wilson, Mack, Gunnell et al., 2008). Early work in the area focused largely on perceptions of competence and autonomy in terms of their association with intrinsic motivation and adherence behaviors (Markland, 1999). Subsequently, researchers have provided mixed support for the link between fulfilling competence, autonomy, and relatedness needs within exercise contexts and (a) more internalized exercise motives, and (b) higher indices of well-being measured at either the global or domain-specific levels (see Wilson & Rodgers, 2007 for a review). One systematic review reported small-to-moderate associations between fulfillment of each psychological need proposed by Deci and Ryan (2002) within BPNT and various markers of well-being in adult populations (Wilson, Mack, Gunnell et al., 2008).

One criticism of early research using BPNT concerned the lack of suitable instrumentation designed to assess perceived psychological need satisfaction within exercise (Wilson, Mack, Gunnell et al., 2008). Researchers relied on either single-item indicators of psychological need satisfaction (e.g., Wilson, Rodgers, & Fraser, 2002) or modified instruments originally designed to measure components of BPNT experienced in other contexts (e.g., Kowal & Fortier, 1999). Measurement experts (Crocker & Algina, 1986) have lamented that the use of such instruments
is likely to obfuscate the development of knowledge in a given area because of threats to item content relevance and representation that ultimately confound appraisals of construct validity.

Scrutiny of previous research in early applications of BPNT to the study of exercise-related issues illustrates concerns regarding both the item content relevance and representation of instruments chosen to measure perceived competence, autonomy, and relatedness amongst exercisers (Wilson & Rodgers, 2007). Item content relevance is concerned with the degree to which a manifest item is relevant to the target construct of interest for a sample within a given domain of inquiry (Messick, 1995). On the contrary, item content representation concerns the extent to which a set of content relevant items ‘cover’ the full conceptual bandwidth for the construct of interest as defined by underlying theory (Messick, 1995). Concerns around content representation and relevance have led to the development of two instruments designed specifically to measure the constructs embedded within BPNT in the context of exercise.

2.1.3 BPNT and Instrument Development in Exercise Psychology Research

The Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, et al., 2006) was created using a construct validation approach to instrument development adopted by Messick (1995)². The PNSE was designed to measure feelings of competence, autonomy, and relatedness typically experienced by adults while engaged in structured exercise (Wilson, Rogers et al., 2006). In their initial development and validation article, Wilson, Rogers et al. (2006) provided structural evidence of score validity and internal consistency reliability of scores

2 The Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos & Michailidou, 2006) was also created using the construct validation approach advocated by Messick (1995). The BPNES was developed in Greek-speaking samples of exercisers and has yet to undergo extensive validation in English speaking cultures of samples.
derived from the PNSE. Subsequent investigations have linked greater scores on PNSE subscales with more internalized forms of exercise motivation (Wilson & Rogers, 2008) and positive changes in more self-determined motives for exercise across time reflecting greater internalization (Wilson & Rogers, 2008). Finally, links between psychological need satisfaction assessed with the PNSE have been made to well-being measured with global indices (Wilson et al., 2006) and context-specific markers (Wilson, Mack, Blanchard, & Gray, 2009). Evidence for score reliability using Cronbach’s (1951) coefficient of internal consistency were found (α’s > 0.89) across two samples of young adult exercisers (Wilson, Rogers, et al., 2006). Furthermore, researchers found stability coefficients, assessed with intraclass correlations, ranging from 0.52 to 0.69 across two test administrations separated by a 10-week interval (Wilson & Rogers, 2008). These findings are consistent with the fundamental tenets of BPNT (Deci & Ryan, 2002). Collectively, results specifically drawn from exercise contexts support the inferences made from scores derived from the PNSE.

With initial validation studies conducted in exercise contexts, the PNSE has been adapted to assess basic psychological needs experienced via participation in broader physical activity contexts (dragon boating; McDonough & Crocker, 2007) and used with samples of older adults (PNSE modified to physical activity (PNSE-PA; Gunnell et al., 2011). Structured exercise refers to activity that is engaged in repeatedly and usually with a specific objective or target endpoint (e.g., improved fitness; Bouchard et al., 2007). Conversely, physical activity is any bodily movement that increases energy expenditure (Bouchard et al., 2007). The evidence-base informing appraisals of construct validity with reference to the PNSE’s use beyond the confines of structured exercise are not devoid of criticism. McDonough and Crocker (2007) noted that the PNSE-Autonomy subscale may be too narrowly focused on decisional-autonomy rather than...
adequately capturing the affective component of this construct. This indirectly calls into question the degree of content representation inherent in the PNSE-Autonomy items when used to assess constructs central to BPNT in broader physical activity settings beyond merely exercise participation. In addition, one investigation provided mixed support for the criterion validity of the original PNSE scores in adult cancer survivors (Peddle et al., 2008). Peddle and colleagues found that external and intrinsic motives for exercise were not predicted by any of the subscale scores derived from the PNSE, a finding that was inconsistent with other studies of asymptomatic samples (e.g., Wilson & Rogers, 2008). Given that the PNSE is a relatively new instrument in the SDT literature, a number of construct validity issues warrant more careful attention prior to adopting (or revising) this instrument for use in additional studies using BPNT in the domain of exercise or physical activity.

2.2 Overview and Justification for the Present Study

The overall purpose of this study was to examine the measurement properties of the PNSE-PA including invariance of test scores across instrument format (PNSE-PA compared to PNSE). Three samples were drawn ostensibly from three different populations to determine the utility of the instrument for measuring constructs embedded within BPNT in diverse groups. It is important to examine measurement invariance across samples derived from diverse populations (e.g., age groups) because it is naïve to assume that different groups are the same (Wu, Li, & Zumbo, 2007). Messick (1995) has presented a cogent argument concerning the ongoing nature of construct validation that recommends the collection and appraisal of evidence from multiple sources to inform the test user of the utility of an instrument. Presently, the evidence base informing the construct validity of scores from the PNSE and the PNSE-PA is limited in depth and scope based on the instrument’s relative infancy and use in the literature. Two specific issues
pertaining to score invariance were examined in this study. The first issue concerned testing the invariance of scores from the PNSE-PA against the scores derived from the PNSE in different groups of respondents. The second issue examined in this study tested the invariance of PNSE-PA scores across two subgroups comprised of a sample of adults from the general population and a sample living with osteoporosis.

Measurement experts have extolled the importance of examining score invariance for different assessment tools during instrument development (Cheung & Rensvold, 2002) because it cannot be assumed that constructs measured with the same instrument across different subgroups retain their meaning (Wu et al., 2007). Measurement invariance is concerned with the extent to which scores from an instrument (e.g., the PNSE) retain their meaning across different subgroups (e.g., males and females) such that any comparative analysis between the subgroups is not confounded by artifacts stemming directly from construct measurement (e.g., item response formats; Wu et al., 2007). In other words, measurement invariance determines if items comprising an instrument are interpreted with the same meaning across distinct groups of interest (Cheung & Rensvold, 2002).

Another use of measurement invariance is to examine whether modifications to instruments (e.g., adaptations or translations) can underpin changes across groups in the psychometric properties of the instrument (Cheung & Rensvold, 2002). For example, in cross-cultural investigations, researchers often investigate score invariance across translated instruments for evidence of problematic adaptations to ensure that cross-group comparisons are meaningful (Sireci, Patsula, & Hambleton, 2005). In another example, Hong (1995) conducted measurement invariance testing between state and trait self-regulation instruments. Assessing
score invariance across different forms of the same instrument can provide useful information for
the test user (Cheung & Rensvold, 2002; Hong, 1995). In brief, such examinations provide
information pertaining to the versatility of instruments beyond a single form to identify the
breadth of test situations where a user may deploy versions of the same instrument. It is
appropriate to use measurement invariance techniques to examine differences between
instrument versions (e.g., languages or contexts) because measurement invariance is conducted
by examining the measurement model which consists of observed scores (or items) to latent
factors (Lubke, Dolan, & Neale, 2003). Therefore, if the adapted instrument contains the same
items that are intended to load on to identical latent factors, measurement invariance can be
examined.

The first purpose of this study therefore, concerns the degree of malleability inherent in the
item content expressed within the original version of the PNSE (Wilson, Rogers, et al., 2006).
Measurement invariance between scores from the original PNSE and PNSE-PA was examined to
determine the degree of equality between two different forms of the instrument. At present, the
extent to which items embedded within the PNSE can (or should) be modified for use in more
global physical activity contexts rather than structured exercise per se has received scant
attention. A few investigators have indirectly examined this issue to date in samples of dragon
boat racers (McDonough & Crocker, 2007) and people living with osteoporosis (Gunnell et al.,
2011). Both investigations report minimal evidence of distortion attributable to measurement
error stemming from the modifications used with the original PNSE items (PNSE-PA;
Cronbach’s α’s > 0.87 across samples). In contrast, both investigations identify concerns in
correlational analyses with indices of motivation (McDonough & Crocker, 2007) and well-being
(Gunnell et al., 2011). Given that generic forms of physical activity may be of greater interest for
health promotion (Bouchard et al., 2007; Colley et al., 2011) and that researchers have begun to examine constructs in relation to leisure time physical activity rather than solely assessing structured exercise (Gunnell et al., 2011; McDonough & Crocker, 2007; Wilson, Mack, Blanchard et al., 2009), further scrutiny of this issue is warranted at this early stage of research concerning the PNSE-PA.

A second issue concerns the degree to which PNSE-PA scores demonstrate evidence of measurement invariance across subgroups of interest. Without establishing measurement invariance, it is difficult to ascertain if differences between groups are ‘true’ differences, or are caused by different psychometric responses to items on the instrument (Cheung & Rensvold, 2002). Examining measurement invariance of scores between subgroups of interest on the PNSE-PA may contribute further evidence for (or against) score validity, particularly when comparisons across subgroups of interest is of particular interest in research agendas. It appears that only Wilson, Rogers, et al. (2006) have examined the issue of measurement invariance with reference to original PNSE scores. Their findings provide support for partial invariance across young male and female adult exercisers ($M_{age} = 22.03$ years, $SD = 4.16$). Given that the PNSE and PNSE-PA are being used increasingly in more diverse samples (e.g., cancer survivors; Peddle et al., 2008) and in more general physical activity contexts (Gunnell et al., 2011), further evidence attesting to the degree of measurement invariance attributable to PNSE-PA scores is warranted to justify the use of this instrument.
2.3 Methods

2.3.1 Participants

The overall sample was comprised of three subsamples: (a) university students/staff, (b) a sample of the general population and (c) individuals living with osteoporosis.

Sample a: Participants enrolled in university-based exercise classes ($N = 21$) provided data. This subsample was comprised of 30 male exercisers ($M_{\text{age}} = 32.03$ years; $SD_{\text{age}} = 12.32$ years; $Range = 20-71$ years) and 253 female exercisers ($M_{\text{age}} = 26.13$ years; $SD_{\text{age}} = 8.56$ years; $Range = 18-74$ years). Self-reported estimates of height and weight were converted to Body Mass Index (BMI) values indicating that the majority of male ($M_{\text{BMI}} = 24.70$ kg/m$^2$; $SD_{\text{BMI}} = 2.09$ kg/m$^2$; $Range = 20.09-27.62$ kg/m$^2$) and female ($M_{\text{BMI}} = 23.04$ kg/m$^2$; $SD_{\text{BMI}} = 3.13$ kg/m$^2$; $Range = 17.71-35.90$ kg/m$^2$) participants were classified as ‘normal’ based on Health Canada’s (2010) risk stratification guidelines. Both males ($M_{\text{METS}} = 41.00$; $SD_{\text{METS}} = 19.41$; $Range_{\text{METS}} = 0.00-92.00$) and females ($M_{\text{METS}} = 47.55$; $SD_{\text{METS}} = 34.20$; $Range_{\text{METS}} = 0.00-295.00$) reported being physically active during a typical week prior to data collection$^4$.

Sample b: This subsample was comprised of 67 males ($M_{\text{age}} = 40.27$ years; $SD_{\text{age}} = 21.01$ years; $Range = 18-97$ years) and 146 females ($M_{\text{age}} = 34.07$ years; $SD_{\text{age}} = 18.34$ years; $Range = 17-90$ years) from the general population who completed an online questionnaire. One participant did not report his/her gender. Self-reported height and weight were converted to BMI and indicated that that on average, males ($M_{\text{BMI}} = 25.23$ kg/m$^2$; $SD_{\text{BMI}} = 3.27$ kg/m$^2$; $Range =$

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$^3$ A data entry error was noted for one individual’s BMI value. As such, that case was deleted prior to calculating descriptive statistics for BMI ($n = 252$).

$^4$ These scores are based on summary composite values derived from the Godin Leisure Time Exercise Questionnaire (Godin & Shephard, 1985).
18.09-38.52 kg/m²) were classified as “overweight” whereas the females ($M_{BMI} = 23.40$ kg/m²; $SD_{BMI} = 3.54$ kg/m²; $Range = 14.40-36.40$ kg/m²) were classified as ‘normal’ based on Health Canada’s (2010) guidelines. On average, most males ($M_{METS} = 59.63$; $SD_{METS} = 46.00$; $Range_{METS} = 0.00-278.00$) and females ($M_{METS} = 56.54$; $SD_{METS} = 32.51$; $Range_{METS} = 0.00-193.00$)⁵ reported being physically active during a typical week³.

Sample c: Individuals who reported they had been diagnosed with osteoporosis by a physician provided data for this subgroup. This subsample was comprised of 28 males ($M_{age} = 62.89$ years; $SD_{age} = 14.68$ years; $Range = 39-86$ years) and 192 females ($M_{age} = 67.92$ years; $SD_{age} = 11.11$ years; $Range = 22-89$ years). Self-report estimates of height and weight were converted to BMI and revealed that the majority of male ($M_{BMI} = 24.08$ kg/m²; $SD_{BMI} = 5.44$ kg/m²; $Range = 14.06-43.16$ kg/m²) and female ($M_{BMI} = 23.64$ kg/m²; $SD_{BMI} = 3.81$ kg/m²; $Range = 16.59-43.16$ kg/m²) participants were classified as ‘normal’ based on Health Canada’s (2010) guidelines. On average, most males ($M_{METS} = 37.52$; $SD_{METS} = 24.68$; $Range_{METS} = 0.00-102.00$) and females ($M_{METS} = 29.15$; $SD_{METS} = 22.61$; $Range_{METS} = 0.00-109.00$) reported being physically active during a typical week³.

2.3.2 Measures

2.3.2.1 Demographics

Self-reported estimates of demographic variables such as age (or date of birth) height, weight, and gender were obtained from all subsamples (please see Appendix A-2).

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⁵ Two individuals reported engaging in 100 and 240 bouts of mild, moderate and vigorous activity during a typical week. As such, these two cases were identified as extreme outliers ($z > 6.00$) and deleted prior to calculating descriptive statistics for LTPA ($n = 212$).
2.3.2.2 Leisure-time physical activity (LTPA)

LTPA was assessed with the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985; please see Appendix A-4) in all subsamples. The GLTEQ is a 3-item measure of LTPA engaged in for over 15 min in a typical week. Respondents were asked to indicate how many times they engaged in mild (e.g., minimal effort), moderate (e.g., not exhausting) and strenuous (e.g., heart beats rapidly) activity. An overall score is calculated in metabolic equivalent units (METS) based on the formula \( \sum [(9 \times \text{strenuous}) + (5 \times \text{moderate}) + (3 \times \text{mild})] \). The GLTEQ has demonstrated evidence of construct validity based on score interpretations in university populations (Wilson et al., 2010) and a sample of individuals with osteoporosis (Wilson, Mack, Gunnell, Grattan, & Oster, 2009).

2.3.2.3 Psychological needs

Satisfaction of competence, autonomy and relatedness needs were assessed with the PNSE (PNSE; Wilson, Rogers, et al., 2006) and the PNSE-PA. The original version of the PNSE was used in sample a. The modified version of the PNSE (PNSE-PA; please see Appendix A-7) was used in sample b and c. The modification consisted of a replacement of the word “exercise” with “physical activity”. The original stem statement anchors each item in terms of how participants usually felt while exercising (i.e., “The following statements represent different feelings people have when they exercise. Please answer the following questions by considering how you typically feel while you are exercising”). The modified stem used in the samples b and c assessed how participants felt while engaging in physical activity (i.e., “The following statements represent different feelings people have when they engage in physical activity”). Sample original and modified items, respectively, characterizing each construct included: (a) “I
feel good about the way I am able to complete challenging exercises” and “I feel good about the way I am able to complete challenging physical activities” (Perceived Competence; 6 items), (b) “I feel free to participate in exercise in my own way” and “I feel free to participate in physical activity in my own way” (Perceived Autonomy; 6 items) and (c) “I feel connected to the people who I interact with while we are exercising together” and “I feel connected to the people who I interact with while we are physically active together” (Perceived Relatedness; 6 items). The PNSE and the PNSE-PA are both 18-item instruments that use a 6-point Likert scale response format per item anchored by 1 (False) and 6 (True). Higher scores per PNSE and PNSE-PA subscale reflect greater perceptions of psychological need fulfillment.

2.3.3 Data Collection Procedures

After obtaining ethical approval at respective institutions, participant recruitment began. Subsample a was recruited at a large university in central Canada (see Wilson & Rogers, 2008 for additional details). Participants were asked to complete a questionnaire package on two occasions. Only the data collected at time 1 were used for the present investigation. These participants were students and staff who were enrolled in aerobic exercise classes at the university. The second subsample consisting of participants from the general population was recruited using various strategies (e.g., announcements on relevant websites, word of mouth and announcements in university class rooms; please see Appendix B-1-B-3). Those who were interested in participating were invited to complete an online questionnaire. This sample was drawn from a larger prospective study. Only data from time 1 were used. Sample c consisted of individuals who self-reported a physician diagnosis of osteoporosis and were recruited through various methods (e.g., announcements on osteoporosis websites and through a bone-health
specialist clinic). Regardless of recruitment strategy, all participants in this group were given identical informed consents, study information, and questionnaire packages.

2.3.4 Data Analysis

Data analysis proceeded in sequential stages. First, data were screened for data entry errors and missing data. In the case that more than 50.00% of the data were missing for any one subscale (e.g., competence, autonomy or relatedness), that case was deleted from further analysis (Tabachnick & Fidell, 2007). If there was \( \leq 50.00\% \) missing data for any subscale, missing values were replaced using a within person median substitution imputation protocol (Tabachnick & Fidell, 2007). Next, descriptive statistics were calculated in order to describe all subsamples of people. Fourth, estimates of indicator reliability for each latent variable were calculated using the formula \( \rho_c = (\sum \lambda^2) / [(\sum \lambda^2 + \sum (\theta))] \) (composite reliability; Diamantopoulos & Siguaw, 2000, p. 90). In addition, average variance extracted was calculated using the formula \( \rho_v = (\sum \lambda^2) / [\sum \lambda^2 + \sum (\theta)] \) to examine the amount of variance accounted for by the latent variable versus that accounted for by measurement error (Diamantopoulos & Siguaw, 2000, p. 91). Fifth, confirmatory factor analyses (CFA) were calculated on each subsample to examine the internal structure of scores derived from the PNSE and PNSE-PA. Sixth, two multi-group confirmatory factor analyses (MG-CFA; Wu et al., 2007) were tested to assess measurement invariance of scores derived from the 3-factor, correlated latent variable measurement model proposed originally by Wilson, Rogers, et al. (2006) for the PNSE. The first MG-CFA tested the effect of instrument modification on score invariance between the PNSE and the PNSE-PA. Subsequently, the second MG-CFA examined the issue of score invariance for the PNSE-PA across groups sampled ostensibly from two distinct populations.
Measurement invariance was tested using recommendations advocated by Wu et al., (2007) who identified the importance of examining means and covariance structures (MACS) over the commonly used covariance structure (CS) technique. MACS offer greater utility because it models covariances and variances along with the means of the observed variables. In so doing, intercepts are incorporated into the model. Testing measurement invariance involves examining four nested models with increased equality constraints. The four models included; configural invariance, weak invariance, strong invariance and strict invariance (Meredith, 1993). In the configural model, there were no constraints across subsamples and therefore this model assumed that the same factor model specification holds across the two subsamples. In the weak invariance model, the factor loadings were constrained to be equal; however, the intercepts and error variances were allowed to be free. The strong invariance model constrained the factor loadings and intercepts to be constant while the strict invariance model constrained the factor loadings, intercepts and error variances to be equivalent. Although researchers (Wu et al., 2007) have debated the necessary levels of constraints required for measurement invariance, Wu et al. (2007) assert that cross group equality in all four measurement models is necessary for measurement invariance because strong invariance is a necessary prerequisite for comparing the means of the factors across subsamples.

Given the ordered nature of the response scale in the PNSE, Jöreskog’s (Jöreskog & Moustaki, 2001; Jöreskog, 2004) approach to CFA and MG-CFA was employed. Polychoric correlation matrices and asymptotic covariance matrices were estimated, setting the underlying thresholds to be constant across subsamples. These matrices are needed for robust maximum likelihood estimation, and also to produce a vector of item means, enabling the use of CFA and MG-CFA and MACS models similar to how continuous observed variables are treated in a CFA
or MG-CFA. Each model was tested using LISREL 8.80 (Jöreskog & Sörbom, 2006). To identify the model, the factor variances were set to 1 for all models. Support for the previous less constrained models was assumed at each step of the model testing hierarchy.

### 2.3.4.1 Assessing model fit

Because the data were considered ordered categorical in nature in this analysis, the scale corrected Satorra-Bentler $\chi^2$ (S-B$\chi^2$) test statistic was interpreted (Satorra & Bentler, 1994). As with the $\chi^2$ a significant S-B$\chi^2$ implies that the data are not a good fit to the model; however, it has been demonstrated that the $\chi^2$ is over-powered and sensitive to sample size and as such, other goodness of fit statistics were considered when evaluating global model fit (Brown, 2006). In line with Hu and Bentler’s (1999) recommendations, Comparative Fit Index (CFI) values close to or above 0.95 were considered acceptable. Root Mean Square Error of Approximation (RMSEA) values close to or below 0.06 were used to assume reasonable good fit (Brown, 2006).

### 2.3.4.2 Assessing invariance

To test for measurement invariance in the MG-CFA, we employed a number of recommendations advocated by Cheung and Rensvold (2002) and Wu et al. (2007). That is, a nonsignificant S-B $\chi^2$ difference between nested models and a CFI difference of $\leq |0.01|$ from the less constrained model were used as guidelines for determining invariance. It should be noted that Corten and colleagues (2002) recommend that the $\chi^2$ difference test not be used in isolation from other evidence because this index is overly sensitive to sample size and model complexity. The $\chi^2$ difference represents the difference between the $\chi^2$ values from the two nested models. Significance is evaluated using the difference between degrees of freedom of the nested models.
(Cheung & Rensvold, 2002). When examining the $\chi^2$ difference, the premise concerns the degree of improvement (or lack thereof) associated with the additional constraints imposed on the model being tested, and as such, the $\chi^2$ difference should not be statistically significant if no real improvement has been observed when comparing nested models to one another.

2.4 Results

2.4.1 Preliminary Data Analysis

Overall, 20, 3, and 33 cases were deleted in sample a, b, and c, respectively, because there were $\geq 50.00\%$ of missing data on a particular subscale. There was no discernible pattern in missing data in sample a; however, in sample b all three cases deleted were due to missing data on the relatedness subscale. Similarly, in sample c, 42.42% of the deleted cases were due to missing data on the relatedness subscale only (6.06% did not complete the competence subscale; 3.03% did not complete the autonomy subscale). The remaining missing cases were deleted due to missing data on 2 or 3 of the subscales. Missing values analyses were conducted on the reduced samples and it was determined that missing data were not problematic ($< 5.00\%$ on each subscale; Tabachnick & Fidell, 2007) and therefore a within person median substitution imputation protocol was employed to replace the missing data.

2.4.2 Descriptive Statistics and Reliability Estimates

Descriptive statistics are reported in Table 2.1. Each sample examined in this study reported scores for perceived competence, autonomy, and relatedness towards the upper end of
the response options used with the PNSE (i.e., > 3.0; See Table 2.1). Observed values of composite reliability ($\rho_c$) and average variance extracted ($\rho_v$) for each PNSE subscale were $\rho_c \geq 0.94$ and $\rho_v \geq 0.72$ for sample a, $\rho_c \geq 0.95$ and $\rho_v \geq 0.77$ for sample b and $\rho_c \geq 0.95$ and $\rho_v \geq 0.75$ for sample c (see Table 2.1 for specific values).

### 2.4.3 Confirmatory Factor Analysis

CFA analyses were conducted on scores from the PNSE and PNSE-PA for each subsample to examine structural evidence of score validity prior to invariance testing. For the sample that completed the original version of the PNSE (sample a), results revealed a good fit of the measurement model to the observed data ($S-B\chi^2 = 270.72, p < .001; \text{CFI} = 0.99; \text{RMSEA} = 0.06, 90\% \text{CI} = 0.05-0.07$). In the subsample of the general population who completed the modified PNSE-PA (sample b), the data fit the measurement model reasonably well ($S-B\chi^2 = 343.58, p < .001; \text{CFI} = 0.98; \text{RMSEA} = 0.08, 90\% \text{CI} = 0.08-0.10$). The measurement model of the individuals with osteoporosis who completed the PNSE-PA (sample c) was also deemed to offer a good fit to the sample data ($S-B\chi^2 = 262.48 p < .001; \text{CFI} = 0.99; \text{RMSEA} = 0.07, 90\% \text{CI} = 0.06-0.08$).

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\(^{6}\) Subscale scores were created using the mean of the 6 items designed to measure each psychological need. Although the data were treated as ordinal in the multi-group CFA analysis, mean subscale scores were generated for descriptive purposes only.
2.4.4 Cross-Group Invariance Test

MG-CFA analyses were conducted to test measurement invariance of the PNSE and PNSE-PA across subsamples. Results of each model and difference tests can be found in Tables 2.2 and 2.3.

Sample a (PNSE) vs. b (PNSE-PA): In model 1, the configural model, no constraints were specified. Although the S-B $\chi^2$ was significant, the CFI (0.98) and RMSEA (0.07, 90% CI = 0.07-0.08) indicated a good fit to the model. Model 2, or weak invariance had constrained factor loadings and results indicated that the data fit the model reasonably well (S-B$\chi^2 = 707.97, p < .001; \text{CFI} = 0.98; \text{RMSEA} = 0.08, 90\% \text{ CI} = 0.07-0.09). Adding the constraints in model 2 did not result in a $\Delta$ CFI that exceeded $|0.01|$ and as such, weak invariance was supported. In model 3, the factor loadings and intercepts were constrained and the model fit was significantly worse than the weak model (S-B$\chi^2$ difference = 563.59, $p < .001; \Delta \text{CFI} = |0.02|). As such, strong invariance was not supported and therefore, strict invariance was not examined (Wu et al., 2007).

Sample b (PNSE-PA) vs. Sample c (PNSE-PA): With no constraints specified, the configural model revealed a good fit (S-B $\chi^2 = 607.82, p < .001), \text{CFI} = 0.98, \text{RMSEA} = 0.08, 90\% \text{ CI} = 0.07-0.09). In the second model (weak invariance), the factor loadings were held constant and results indicated a good fit (S-B $\chi^2 = 697.55, p < .001, \text{CFI} = 0.98, \text{RMSEA} = 0.08, 90\% \text{ CI} = 0.08-0.09). Although the S-B $\chi^2$ difference was significant, the $\Delta$ CFI was less than $|0.01|$ providing support for weak invariance. When constraints were placed on the factor

After running the multi-group CFA analysis, LISREL applied a ridge function to the matrix being analyzed. The data were checked and it was confirmed that the data were read into the program properly. Although this occurs frequently with polychoric or asymptotic matrices, LISREL’s ridge function is an acceptable solution. One limitation is that it decreases accuracy of the robust maximum likelihood estimates.
loadings and intercepts, the more constrained strong invariance model was not supported (S-B\(\chi^2\) difference = 583.28, \(\Delta\) CFI = 0.03). Given that strong invariance was not supported, strict invariance was not examined.

2.5 Discussion

The aim of this paper was to investigate (a) the merit of modifying items embedded within the PNSE for use in more global physical activity contexts than just structured exercise, and (b) the degree of cross-group equivalence of PNSE-PA scores between two diverse samples engaged in physical activity. Reliability estimates across subsamples implied minimal evidence of measurement error across PNSE and PNSE-PA scores. Results of the CFA revealed that the data fit the 3-factor correlated measurement model of the PNSE and PNSEA-PA reasonably well across all subsamples. Results of measurement invariance testing supported weak invariance but not strong invariance for investigations of both instrument modification and cross-group invariance. Overall, these findings suggested that the PNSE-PA has merit in terms of assessing the constructs embedded in BPNT within physically active samples; however, findings of this investigation revealed that scores from the PNSE-PA have unequal intercepts compared to the original PNSE and across two groups that warrants some caution when conducting comparative analysis across instrument forms.

Results of the statistical analysis of invariance between the PNSE and the PNSE-PA scores revealed that the first level of invariance, namely configural, was supported. Therefore, individuals in both subsamples conceptualized the constructs in the same manner (Cheung & Rensvold, 2002). Stated differently, despite the contextual change, the data provided by the university students/staff and the sample drawn from the general population manifest into the
same number of factors, with the same items being associated with the same factors in both subsamples (Cheung & Rensvold, 2002; Gregorich, 2006; Meredith, 1993). These results are promising because it provides evidence that the modifications embedded in the PNSE-PA did not influence which factor each item was purported to load upon in the measurement model. When configural invariance was assessed between the two subsamples that completed the PNSE-PA, the model was also supported. As such, in this investigation, the items within the PNSE-PA were associated with the proposed latent first-order factors of the original PNSE, and across two groups.

Invariance testing provided evidence for the tenability of weak invariance attributable to PNSE and PNSE-PA scores across three subsamples in this study. Weak invariance tests if the strength of the relationships between specific items and factors differ between groups or that one unit change in the item score is scaled to be an equal unit change in the factor score (Cheung & Rensvold, 2002; Wu et al., 2007). Since this test of invariance was supported, we can assume that the scale of the factors is invariant across versions of the PNSE and across two subsamples that completed the PNSE-PA. As such, resulting variances across samples are on the same metric (Wu et al., 2007). Weak invariance also tests if the common factors have identical meaning across subsamples (Gregorich, 2006). Since weak invariance was tenable, it seems reasonable to conclude that all three subsamples construed perceived competence, autonomy and relatedness in the same manner. This finding is in line with BPNT, and holds credence in the samples reported within this investigation regardless of which form of the instrument participants completed. These results highlight another potential strength of the PNSE scores in that the satisfaction of the basic psychological needs extend to broader physical activity contexts. Furthermore, when
the modified PNSE-PA is used, the concept of basic psychological need satisfaction extends across subsamples from the general population and individuals living with osteoporosis.

Raising concerns over additive response bias, the data provided no support for strong invariance between groups who completed the PNSE and PNSE-PA or across the two samples that completed the PNSE-PA. Beyond weak invariance, a common threat to measurement invariance across subsamples is differential additive response bias (Gregorich, 2006). These are forces that are unrelated to the factors (e.g., age) that cause systematic deviations, higher or lower, to item responses in one subsample but not the other (Gregorich, 2006). When these additive response influences are not equivalent between subsamples, it holds the potential to taint estimates of group mean differences (Gregorich, 2006). In other words, subsample means cannot be compared without concern for bias. Given that strong invariance was not supported in this investigation, comparisons between the factor (scale) means in these samples would be ambiguous because there are apparent differences between subsamples in the scale and origin of the factor (Cheung & Rensvold, 2002). Stated differently, comparisons of mean values derived from the PNSE and PNSE-PA should be avoided. In addition, comparisons of means from the PNSE-PA across diverse subgroups may also warrant caution in future research that does not account the observed lack of strong invariance found in this investigation.

Strong invariance between groups completing the PNSE and PNSE-PA was not supported in this study. This indicates that although factor loadings were similar, the scores derived from the PNSE of PNSE-PA are consistently biased for one group (Wu et al., 2007). Since the PNSE-PA was modified to measure perceptions of psychological need satisfaction experienced via more general physical activity contexts, it seems reasonable that the two
versions of the instrument are not invariant. It is difficult to determine if the bias is caused by group membership or between the versions of the instrument. For example, it is possible that the salience of the items differs by age or cultural norms. It is also conceivable that the modification from exercise to physical activity introduced additive response bias (i.e., differences caused by forces unrelated to the common factors such as cultural norms; Gregorich, 2006). In this case, although the latent variables have the same meaning across groups (weak invariance), differences in the interpretation of the definitions of physical activity and exercise may have confounded the responses; however, differential additive response bias is not easily interpretable, even after evidence of equivalent factor meanings has been found (i.e., weak invariance; Gregorich, 2006).

Since strong invariance was not found between the sample drawn from the general population and individuals living with osteoporosis, it could indicate that the bias is reflective of differences in the relative salience of the items with the factor (Chan, 2002). For example, those with osteoporosis may have construed autonomy differently than the sample from the general population. Autonomy consists of both affective autonomy (i.e., absence of feelings of pressure and tension) and decisional autonomy (i.e., feeling of choice; Houlfort, Koestner, Joussemet, Nantel-Vivier, & Lekes, 2002). The PNSE may capture only decisional autonomy (Wilson, Rogers, et al., 2006) and may therefore not be as applicable to people with osteoporosis that may hold different reasons (e.g., bone health) or values for engaging in exercise (Rejeski & Mihalko, 2001). Ultimately, the underlying mechanisms precluding support for strong invariance in this study with reference to the PNSE-PA scores remains unclear and a topic ripe for further inquiry with this instrument.
Following Messick’s (1995) assertion regarding the ongoing nature of construct validation, the results reported in this study extend the available evidence pertaining to the validity of inferences to be derived from scores generated by the PNSE-PA in diverse samples engaged in physical activity. It has been suggested that testing Deci and Ryan’s (2002) claims regarding the universal affects attributable to competence, autonomy, and relatedness needs requires careful attention to the measurement of these constructs in the domain of physical activity including exercise (Wilson, Mack, Gunnell et al., 2008; Wilson & Rodgers, 2007). Observations from this study suggest that modifying and using the PNSE beyond the confines of structured exercise contexts with young adults may require careful forethought given the possibility of response bias evident in the PNSE-PA scores that could cloud subsequent interpretations. Gregorich (2006) pointed out that additive response bias could be caused by a variety of influences unrelated to the common factors (e.g., age, gender, cultural norms etc.). It remains to be seen if any of these influences are acting to create response bias within these subsamples. A recent investigation examining the universality hypothesis in exercise settings using cross culture subsamples noted mixed support for Ryan and Deci’s (2002) contentions (Edmunds, Duda, & Ntoumanis, 2010). Further investigation into the universality hypothesis proposed by Ryan and Deci (2002) seems warranted at this juncture.

Two important contributions of this investigation lie within the specification and testing of measurement models positing different forms of test score invariance models. First, in using a MACS approach, and investigating intercepts and means, no evidence could be found to support the strong invariance model with reference to PNSE-PA scores in the samples investigated. It is relevant to note that if the testing of MG-CFA had relied on the popular approach of covariance structures only, differences in the factor comparisons across subsamples caused by unequal
calibration would not have been found (Wu et al., 2007). The second contribution stems from the method of analysis used. Given that researchers who are testing MG-CFA using the PNSE treated the Likert data as continuous (Wilson, Rogers, et al., 2006) the results of their analyses may be misleading. Lubke and Muthen (2004) have shown that treating ordinal data as continuous in MG-CFA may lead to inflated chi-squared values and lower parameter coverage for factor loadings. The present investigation tested measurement invariance using a MG-CFA that treats the data as ordered categorical using polychoric correlation matrices and asymptotic covariance matrices to avoid this troubling issue. While researchers have shown that certain estimation procedures such as weighted least squares requires large sample sizes (Flora & Curran, 2004; Olsson, Fross, Troye, & Howell, 2000), Flora and Curran (2004) demonstrated that small to moderate sample sizes are appropriate when analyzing the polychoric correlation matrix with robust estimation procedures. It is recommended that future studies consider this issue of estimation procedures carefully in their analyses.

2.5.1 Study Limitations and Future Directions

While this study provides insight into invariance of PNSE and PNSE-PA scores across distinct samples of interest, there are some limitations that should be considered when interpreting the data. First, the test of measurement invariance of scores derived from the PNSE and PNSE-PA could have been confounded by the modification. Although testing measurement invariance in instruments that have been adapted is appropriate if the underlying structure remains constant (Sireci et al., 2005), the extent to which the observed differences in the invariance analyses stemming directly from this change in item wording in the PNSE remains unclear and worthy of further scrutiny. As such, it is difficult to determine if strong invariance
between scores of the PNSE and PNS-PA was not supported due to cross-group differences or the wording of the PNSE.

A second limitation concerned the disproportionate composition of the subsamples used in this study with reference to participant gender. More females than males comprised all three cohorts. Future inquiry into the utility of the PNSE-PA may wish to include equal numbers of males and females to offset any gender-based effect that could distort interpretations. Three additional limitations warrant careful note based on study conclusions, namely the small sample size used in the measurement model analyses and the limited number of cohorts examined in the investigation. Small samples can distort parameter estimates in applications of structural equation modeling to test of issues such as score invariance using CFA. As such, it is recommended that future studies include larger samples that preclude question marks pertaining to parameter stability based on low statistical power evident in smaller samples. It also seems prudent to recommend that future studies employ more diverse cohorts to determine the utility of the PNSE and PNSE-PA for assessing the constructs embedded in BPNT (Deci & Ryan, 2002) beyond the confines of structured exercise in young, relatively healthy cohorts of adults and individuals with osteoporosis. Finally, according to Cheung and Rensvold (2002), a change in CFI greater than or equal to |0.01| between nested models represents a significant and important difference. However, researchers have noted that more research is needed to validate this decision rule (Wu et al., 2007). In addition, Wu and colleagues (2007) pointed out that no guidelines have been created for assessing fit based on polychoric correlation matrices.
2.6 Summary

Grounded in BPNT (Ryan & Deci, 2002), the purpose of this study was to examine properties of score invariance between the original PNSE and a modified from structured exercise to physical activity contexts version (PNSE-PA). A secondary aim was to examine select properties of measurement invariance within scores derived from the PNSE-PA across subsamples. Using techniques advocated by Jöreskog (Jöreskog, 2004; Jöreskog & Moustaki, 2001), configural and weak invariance were supported for both investigations of score invariance. On the basis of these findings, it seems reasonable to suggest that the constructs of perceived competence, autonomy and relatedness experienced in physical activity were construed in a similar fashion across the subsamples using the PNSE and PNSE-PA. Support was not found, however, for strong invariance, precluding direct and unambiguous comparisons of scores across each subgroup with the versions of the PNSE-PA employed in this study or between samples that completed the different versions of the instrument. Overall, the results of this study highlight the strengths and potential weaknesses of the PNSE and justify additional inquiry into the psychometric properties of scores derived from this instrument in future investigation of BPNT within exercise and physical activity context.
Table 2.1 Descriptive Statistics and Internal Consistency Reliability Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample a: PNSE</th>
<th></th>
<th></th>
<th>Sample b: PNSE-PA</th>
<th></th>
<th></th>
<th>Sample c: PNSE-PA</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$\rho_c$</td>
<td>$\rho_v$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$\rho_c$</td>
<td>$\rho_v$</td>
<td>$M$</td>
</tr>
<tr>
<td>Age</td>
<td>26.76</td>
<td>9.19</td>
<td>-</td>
<td>-</td>
<td>36.01</td>
<td>19.34</td>
<td>-</td>
<td>-</td>
<td>67.24</td>
</tr>
<tr>
<td>BMI</td>
<td>23.15</td>
<td>3.30</td>
<td>-</td>
<td>-</td>
<td>23.97</td>
<td>3.55</td>
<td>-</td>
<td>-</td>
<td>23.69</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>47.24</td>
<td>32.81</td>
<td>-</td>
<td>-</td>
<td>57.33</td>
<td>37.26</td>
<td>-</td>
<td>-</td>
<td>30.16</td>
</tr>
<tr>
<td>Perceived Competence</td>
<td>5.12</td>
<td>0.79</td>
<td>0.95</td>
<td>0.76</td>
<td>4.73</td>
<td>1.00</td>
<td>0.95</td>
<td>0.77</td>
<td>3.62</td>
</tr>
<tr>
<td>Perceived Autonomy</td>
<td>5.39</td>
<td>0.71</td>
<td>0.95</td>
<td>0.78</td>
<td>5.28</td>
<td>0.84</td>
<td>0.97</td>
<td>0.83</td>
<td>5.16</td>
</tr>
<tr>
<td>Perceived Relatedness</td>
<td>4.31</td>
<td>1.15</td>
<td>0.94</td>
<td>0.72</td>
<td>4.56</td>
<td>1.14</td>
<td>0.96</td>
<td>0.79</td>
<td>4.72</td>
</tr>
</tbody>
</table>

Note. Sample a = University staff/students, Sample b = Sample from the general population, Sample c = Participants with osteoporosis; PNSE = Psychological Need Satisfaction in Exercise Scale (Wilson, Rodgers, et al., 2006); PNSE-PA = Modified PNSE specific to physical activity; Age = Number of years; BMI = ratio of kg/m$^2$; Physical Activity = Summary responses to GLTEQ in form of METS; $\rho_c$ = composite reliability; $\rho_v$ = average variance extracted, $M$ = Mean, $SD$ = Standard Deviation.
Table 2.2 Goodness-of-fit Indices for MG-CFA: Sample a (PNSE) vs. Sample b (PNSE-PA)

<table>
<thead>
<tr>
<th>Multi-Group CFA Models</th>
<th>S-B$\chi^2$</th>
<th>$df$</th>
<th>S-B $\chi^2$ diff.</th>
<th>$\Delta df$</th>
<th>CFI</th>
<th>$\Delta$ CFI</th>
<th>RMSEA</th>
<th>90% CI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configural Model</td>
<td>620.26***</td>
<td>264</td>
<td>--</td>
<td>--</td>
<td>0.98</td>
<td>--</td>
<td>0.07</td>
<td>0.07-0.08</td>
<td></td>
</tr>
<tr>
<td>Weak Model</td>
<td>707.97***</td>
<td>282</td>
<td>87.71***</td>
<td>18</td>
<td>0.98</td>
<td>0.00</td>
<td>0.08</td>
<td>0.07-0.09</td>
<td></td>
</tr>
<tr>
<td>Strong Model</td>
<td>1271.56***</td>
<td>300</td>
<td>563.59***</td>
<td>18</td>
<td>0.96</td>
<td>0.02</td>
<td>0.11</td>
<td>0.11-0.12</td>
<td></td>
</tr>
<tr>
<td>Strict Model</td>
<td>1301.52***</td>
<td>318</td>
<td>29.96*</td>
<td>18</td>
<td>0.96</td>
<td>0.00</td>
<td>0.11</td>
<td>0.11-0.12</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Sample a = University staff/students, Sample b = Sample from the general population; PNSE = Psychological Need Satisfaction in Exercise Scale (Wilson, Rogers, et al., 2006); PNSE-PA = Modified PNSE specific to physical activity; $df$ = Degrees of freedom, S-B$\chi^2$ = Satorra-Bentler Chi-Square, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval; Configural Model = Parameter loadings, intercepts and error variances free, Weak Model = Parameter loadings constrained, Strong Model = Parameter loadings and intercepts constrained, Strict Model = Parameter loadings, intercepts and error variances constrained. "*** p < .001, "* p < .05
Table 2.3 Goodness-of-fit Indices for MG-CFA: Sample b (PNSE-PA) vs. Sample c (PNSE-PA)

<table>
<thead>
<tr>
<th>Multi-Group CFA Models</th>
<th>S-B(\chi^2)</th>
<th>df</th>
<th>S-B</th>
<th>(\Delta df)</th>
<th>CFI</th>
<th>(\Delta CFI)</th>
<th>RMSEA</th>
<th>90% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configural Model</td>
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<td>264</td>
<td>--</td>
<td>--</td>
<td>0.98</td>
<td>--</td>
<td>0.08</td>
<td>0.07-0.09</td>
</tr>
<tr>
<td>Weak Model</td>
<td>697.55***</td>
<td>282</td>
<td>89.73***</td>
<td>18</td>
<td>0.98</td>
<td>0.00</td>
<td>0.08</td>
<td>0.08-0.09</td>
</tr>
<tr>
<td>Strong Model</td>
<td>1280.83***</td>
<td>300</td>
<td>583.28***</td>
<td>18</td>
<td>0.95</td>
<td>0.03</td>
<td>0.12</td>
<td>0.12-0.13</td>
</tr>
<tr>
<td>Strict Model</td>
<td>1247.49****</td>
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<td>33.34†</td>
<td>18</td>
<td>0.96</td>
<td>0.01</td>
<td>0.12</td>
<td>0.11-0.12</td>
</tr>
</tbody>
</table>

*Note.* Sample b = Sample from the general population, Sample c = Participants with osteoporosis; PNSE = Psychological Need Satisfaction in Exercise Scale (Wilson, Rodgers, et al., 2006); PNSE-PA = Modified PNSE specific to physical activity; df = Degrees of freedom, S-B\(\chi^2\) = Satorra-Bentler Chi-Square, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval; Configural Model = Parameter loadings, intercepts and error variances free, Weak Model = Parameter loadings constrained, Strong Model = Parameter loadings and intercepts constrained, Strict Model = Parameter loadings, intercepts and error variances are constrained. *** \(p < .001\), * \(p < .05\), † S-B\(\chi^2\) value in the strict model should not be interpreted because it decreased with additional constraints. The authors attempted to increase the precision of estimation; however, the S-B\(\chi^2\) remained the same. Although not reported here, the conventional chi-square does increase with the additional constraints from strong to strict models.
2.7 Bridging Summary

With researchers speculating on the merit and consequences associated with modifying items on the original PNSE (McDonough & Crocker, 2007; Wilson & Bengochea, 2010), an important preliminary step to this program of research was to examine score reliability and validity of the modified to physical activity contexts Psychological Need Satisfaction in Exercise Scale (PNSE; Wilson, Rogers, et al., 2006). Results from study 1 provided preliminary evidence for score reliability and validity of the modified PNSE-PA in individuals from the general population. Specifically, scores from the PNSE-PA were found to have good internal structure and low error variance. Scores from the PNSE-PA demonstrated weak invariance across instrument formats (PNSE vs. PNSE-PA) and across populations (general population vs. individuals with osteoporosis), indicating that the original items designed to tap the satisfaction of each psychological need still loaded in a similar fashion onto their respective latent factors (competence, autonomy, and relatedness) in the modified format. Moreover, individuals interpreted the items of the PNSE-PA in a similar fashion to individual who interpreted items of the original PNSE.

Having provided preliminary reliability and validity evidence for scores of the PNSE-PA, Study 2 proceeded to examine antecedents and consequences associated with psychological need satisfaction. Study 2 examined two theoretically plausible models based on 3 mini-theories of SDT. The first model examined if changes in goal contents predicted changes in motivation which in turn predicted changes in psychological need satisfaction. Changes in psychological need satisfaction then predicted changes in well-being and physical activity behaviour. The second model tested was based on previous research (McDonough & Crocker, 2007; Ng et al.,
and examined changes in psychological need satisfaction as the antecedent to motivation. Finally, the indirect effects produced by psychological need satisfaction were examined.
CHAPTER 3: Goal Contents, Motivation, Psychological Need Satisfaction, Well-Being and Physical Activity: A Test of Self-Determination Theory Over 6 Months

3.1 Introduction

With mounting evidence supporting the link between physical activity and well-being (Fox, 1999; Penedo & Dahn, 2005), researchers have now turned their attention towards understanding the mechanisms that facilitate participation in physical activity and increased well-being (e.g., Sebire et al., 2011; Sebire et al., 2009). Based on results of their meta-analysis, Ng and colleagues (2012) suggest that Self-Determination Theory (SDT; Ryan & Deci, 2002) holds promise for understanding health behaviors and motivational processes related to well-being and health outcomes. SDT is a macro-level framework consisting of 5 mini theories that explain select aspects of human motivation, behavior, and personal well-being (Ryan & Deci, 2002; Vansteenkiste, Niemiec, Soenens, 2010). While the majority of researchers using SDT to study physical activity have focused almost exclusively on Organismic Integration Theory (OIT) and/or Basic Psychological Needs Theory (BPNT), emerging research has examined the utility of a third mini-theory in physical activity settings, namely Goal Contents Theory (GCT; Sebire et al., 2011; Sebire et al., 2009). The purpose of this investigation is to test a model using 3 of SDT’s mini-theories. More specifically, GCT, OIT, and BPNT were used to understand a hypothesized model whereby changes in relative intrinsic goals predict changes in motivation which in turn predict changes in psychological need satisfaction and in turn predict well-being and physical activity behavior (please see Figure 3.1). Indirect effects through motivation and psychological need satisfaction were also examined.
3.1.1 Basic Psychological Needs Theory

Within BPNT, Ryan and Deci (2002) postulate that humans have three fundamental psychological needs for competence, autonomy, and relatedness that when fulfilled, lead to increased well-being. Competence is characterized by feelings of effectiveness while engaging in optimally challenging tasks (Ryan & Deci). Autonomy is characterized by feelings of personal agency and volition (or self-governance), and relatedness is characterized by feelings of a meaningful connection or belonging with important others (Ryan & Deci). Finally, Deci and Ryan (2011) hypothesize that psychological need satisfaction predicts behavioural engagement because their satisfaction provides energy and direction to continue engaging in the behaviour. Using BPNT, researchers (Adie et al., 2012; Gunnell et al., 2011; Mack et al., 2012; Reinboth & Duda, 2006; Sylvester et al., 2012) have demonstrated that psychological need satisfaction links with well-being outcomes in physical activity contexts in a manner largely consistent with Deci and Ryan’s (2002) contentions.

3.1.2 Organismic Integration Theory

Ryan and Deci (2002) theorize that motivation ranges along a continuum from extrinsic to intrinsic motivation. Motivation can be classified as autonomous or controlled based on the degree of self-determination that is present. Controlled motivation reflects motivation that is less self-determined in nature and consists of External regulation (i.e., activities controlled by external prompts or cues to action) and Introjected regulation (i.e., activities controlled by self-imposed contingencies or intrapsychic pressure). Autonomous motivation is more self-determined than controlled motivation and is comprised of the following regulations: (a) Identified (i.e., activity is personally valued), (b) Integrated (i.e., activities assimilated with self), and (c) Intrinsic (i.e., activity that is engaged in for no separable consequences other than
behavioral engagement itself). To the extent that the behavior is regulated by autonomous motivation, the individual will experience optimal outcomes such as persistent behavior, health, and well-being (Deci & Ryan, 2000). Psychological needs are differentiated from motivational regulations because they represent a universal and innate requirement, rather than a desire or underlying reason why an individual will engage in a behaviour (Ryan & Deci, 2002). Researchers using OIT have demonstrated that more self-determined motivational regulations are positively associated with physical activity (McDonough & Crocker, 2007; Wilson, Rodgers, Fraser, & Murray, 2004; Wilson et al., 2012), well-being (McDonough & Crocker, 2007), and psychological need satisfaction (McDonough & Crocker, 2007; Wilson & Rogers, 2008).

3.1.3 Goal Contents Theory

GCT was developed to understand how the content of a goal can lead to differential outcomes affecting well-being and behavior (Deci & Ryan, 2000). In an effort to differentiate goal contents from motivational regulations proposed within OIT, Deci and Ryan (2000) proposed that a goal focuses on ‘what’ a person is expecting to obtain as a function of behavioral participation (e.g., I exercise to improve my health) whereas a motivational regulation focuses on the reason ‘why’ a person undertakes the behavior (e.g., because my doctor told me to). Intrinsic goal contents such as for health and personal growth are more likely to lead an individual to satisfy psychological needs (Deci & Ryan, 2000; Vansteenkiste et al., 2010). Conversely, extrinsic goal contents such as image and recognition are pursued for external contingencies such as self-worth, and are less likely to lead to psychological need fulfilment (Deci & Ryan, 2000). The content of goals is also important for predicting behavior and well-being; with intrinsic goal contents being associated with positive outcomes such as self-determined motivation (Gillison, Standage, & Skevington, 2006; Ingledew & Markland, 2009; Sebire et al., 2011), psychological
need fulfillment (Sebire et al., 2009; Thøgersen-Ntoumani, Ntoumanis, & Nikitaras, 2010), well-being (Gillison et al., 2006; Sebire, et al., 2009), and exercise (Sebire et al., 2011).

3.1.4 Putting the Mini-Theories Together: Justification for the Research

Although support for SDT’s mini-theories has been found in physical activity contexts, evidence is limited based on the use of only 1 or 2 mini-theories being considered simultaneously (Gillison et al., 2006; Sebire et al., 2011). Examining each mini-theory independently precludes conclusions regarding how all variables combine together to produce effects on well-being and behaviour. Therefore, the justification for this research is threefold. First, Ingledew and Markland (2008) articulated an argument for the role that goal contents have on facilitating either autonomous or controlled motivation, and in turn, the differential impact these constructs have on behaviour and cognitive outcomes. With the accumulation of evidence supporting the sequence of goal contents predicting motivation, and in turn, predicting well-being and behaviour (Gillison et al., 2006; Ingledew & Markland, 2009; Sebire et al., 2009), Sebire and colleagues (2011) called for researchers to directly examine psychological need satisfaction within the complex model of SDT rather than assume their role (Ingledew & Markland, 2009). Although Sebire and colleagues (2009) found that psychological need satisfaction serves as a mediator between relative intrinsic goals and well-being outcomes, motivation was not included in the model. Moreover, Sebire and colleague’s (2009) examined a composite need satisfaction variable despite the hypothesized unique contribution of each psychological need (Deci & Ryan, 2000). The current investigation extends previous research because it will systematically examine where psychological need satisfaction fits as an explanatory process within the framework offered by SDT.
A second justification for the study is that researchers examining BPNT and OIT have typically examined a sequence in which psychological need satisfaction predicts motivation. Yet, to date, we are unaware of published research that has examined motivation as a potential antecedent to psychological need satisfaction. Using SDT (Deci & Ryan, 2002), and based on contentions outlined by Vallerand (1997) in the Hierarchical Model of Intrinsic and Extrinsic Motivation, several investigators have tested a model whereby motivational regulations mediate the relationship between psychological needs and behavioural or affective outcomes (Edmunds et al., 2006; McDonough & Crocker, 2007; Milyavskaya & Koestner, 2011; Ng et al., 2012). Across multiple domains, Milyavskaya and Koestner, (2011) found only partial support for the mediating role of motivational regulations and these authors acknowledged that psychological need satisfaction may not require a mechanism to increase well-being. This speculation was consistent with assertions made by Deci and Ryan (2000) who stated that “fluctuations in need fulfillment will directly predict fluctuations in well-being” (p. 243). Specifying psychological needs as an antecedent of motivational regulations (e.g., Ng et al., 2012) implies that psychological needs have an indirect relationship with well-being outcomes, a hypothesis that is consistent with the internalization component of OIT, yet not wholly consistent with BPNT. As such, the current investigation will test a model wherein motivation precedes psychological need satisfaction.

A third justification for the present research is that the bulk of SDT based investigations have been cross-sectional in design (Teixeira et al., 2012). Although cross-sectional research is important, it represents at best a snap shot of the hypothesized dynamic processes linking various constructs embedded in SDT’s nomological network (Deci & Ryan, 2002). A central tenet of SDT is that humans are active and growth oriented, with integration representing a dynamic
process facilitated or forestalled by psychological need satisfaction or thwarting (Ryan & Deci, 2002). Because goals and motivation are hypothesized to change based on opportunities for psychological need satisfaction (or thwarting), an important avenue for research is to examine the impact of change in constructs embedded within SDT. Examining patterns of change contributes to the extant SDT literature because it will provide evidence of how changes in certain variables (e.g., psychological need satisfaction) effect changes in other variables (e.g., well-being). If evidence is found to support the sequence of SDT based on the 3 mini-theories tested herein, then researchers will gain insight into how changing one variable may precipitate changes in another key set of processes (or variables) set forth by Deci and Ryan (2002) within the SDT framework.

3.2 Research Question and Hypotheses

The purpose of this study was to examine a model based on SDT as outlined in Figure 3.1. Second, indirect effects through motivation and psychological need satisfaction were examined. Based on SDT (Deci & Ryan, 2000) and previous research (Ingledew & Markland, 2009; Sebire et al., 2011; Sebire et al., 2009), the following 5 hypotheses were forwarded:

H1: Increases in relative intrinsic goal contents will positively predict changes in autonomous motivation and negatively predict changes in controlled motivation (see Figure 3.1).

H2: Increases in autonomous motivation will positively predict changes in psychological need satisfaction, whereas increases in controlled motivation will negatively predict changes in psychological need satisfaction (see Figure 3.1).

H3: Increases in psychological need fulfillment will predict increases well-being and physical activity (see Figure 3.1).
H4: Increases in psychological need fulfillment will (a) positively mediate the relationship between changes in autonomous motivation and well-being/physical activity, and (b) positively mediate the relationships between changes in relative intrinsic goal contents and well-being/physical activity through autonomous motivation.

H5: Decreases in psychological need fulfillment will (a) negatively mediate the relationship between changes in controlled motivation and well-being/physical activity, and (b) negatively mediate the relationships between changes in relative intrinsic goal contents and well-being/physical activity through controlled motivation.

Finally, because psychological need satisfaction fosters internalization (Deci & Ryan, 2000), and researchers have modeled and found support for satisfying psychological needs as antecedents to motivational regulations (McDonough & Crocker, 2007; Wilson & Rogers, 2008), an alternative model was tested whereby psychological need satisfaction preceded motivation (see Figure 3.2). The purpose of testing an alternative model was twofold: first, alternative model testing is an important step in theory testing (Kline, 2010) that helps circumvent confirmation bias (MacCallum & Austin, 2000). Second, as both models are theoretically plausible (Deci & Ryan, 2000; Vallerand, 1997) it is important to test which model provides the best account of the data.

3.3 Methods

3.3.1 Procedures

After obtaining ethical approval for the study, participants from the general population were recruited using a multifocal strategy that included internet-based announcements on
websites, email, and poster boards. The only inclusion criteria were that the participants were 17 years and older. Willing participants were sent an email with a link to the online questionnaire. Participants provided informed consent and then completed the first questionnaire. Six months later, participants received an email containing a link to the second identical online questionnaire.

3.3.2 Participants

Participants \((N = 203; 68.00\% \text{ female})\) ranged in age from 17 to 65 \((M_{\text{age}} = 32.57 \text{ years, } SD = 15.73)\) with an average body mass index of 23.50 kg/m\(^2\) \((SD = 3.52)\). Marital status was as follows: single/never married \((58.60\%)\), married/common law \((35.50\%)\), separated divorced \((5\%)\), or widowed \((1\%)\). Most of the participants identified as white \((84.70\%)\). Educational attainment varied across participants: 43.30\% held a university degree, 37.40\% held a high school diploma and 18.70\% had a graduate degree. Finally, most participants identified as being regularly engaged in physical activity for more than 6 months \((86.20\%)\) at time 1.

3.3.3 Measures

3.3.3.1 Demographics

Age, self-reported height, weight, education, marital status, ethnicity, and stage of change for physical activity were queried (Mullan & Markland, 1997).\(^8\)

\(^8\) Data obtained for this investigation were part of a larger study. [Information withheld for peer review process]. For this investigation, participants over the age of 65 were not included in the analysis.

\(^9\) One participant was removed because he/she indicated he/she reported 240 bouts of strenuous and moderate physical activity.

\(^{10}\) After completing the demographic information, participants read the following definition of physical activity: “The following statements pertain to your participation in physical activity. For the purposes of these statements, physical activity is defined as... (1) Any bodily movement produced by the skeletal muscles that results in a substantial increase over the body’s energy expenditure, (2) Physical activity can include planned or structured exercise, sports, commuting activities by foot or bicycle, household chores (e.g., vacuuming), work activity (e.g.,
3.3.3.2 Goal contents

Goal contents were assessed with the 20-item Goal Contents in Exercise Questionnaire (GCEQ; Sebire et al., 2008). The GCEQ was developed using SDT to assess intrinsic (health, social affiliation and skill development) and extrinsic goal contents (image and social recognition). This instrument was modified to physical activity contexts by replacing any instances of the word “exercise” with “physical activity”. Following the stem: “please indicate on the scale provided how important each goal is for you with reference to your physical activity” participants were asked to rate each item on a Likert scale from 1 (not at all important) to 7 (extremely important). An example of an original item read “to develop my exercise skills”. The modified item read: “to develop my physical activity skills”. Based on previous research (Sebire et al., 2011; Sebire et al., 2009) a relative intrinsic goal content variable was created by subtracting the average of extrinsic subscales [social recognition (α<sub>time 1</sub> = .91, H<sub>time1</sub> = .92; α<sub>time 2</sub> = .90, H<sub>time2</sub> = .93) and image (α<sub>time 1</sub> = .91, H<sub>time1</sub> = .95; α<sub>time 2</sub> = .88, H<sub>time2</sub> = .94)] from the average of intrinsic subscales [health (α<sub>time 1</sub> = .84, H<sub>time1</sub> = .85; α<sub>time 2</sub> = .78, H<sub>time2</sub> = .81), skill development (α<sub>time 1</sub> = .91, H<sub>time1</sub> = .91; α<sub>time 2</sub> = .92, H<sub>time2</sub> = .91) and social affiliation (α<sub>time 1</sub> = .91, H<sub>time1</sub> = .95; α<sub>time 2</sub> = .91, H<sub>time2</sub> = .95)]. Scores from the GCEQ have demonstrated initial reliability and validity evidence (Sebire et al., 2008; Sebire et al., 2009).

3.3.3.3 Motivation

Motivation for physical activity was assessed with the Behavioral Regulations in Exercise Questionnaire (BREQ; Mullan, Markland, & Ingledew, 1997). The BREQ is a 15-item instrument developed using SDT to assess extrinsic (4 items), introjected (3 items), identified (4 lifting heavy boxes) and leisure time hobbies (e.g., gardening). Please keep this definition of physical activity in mind as you respond to the following questions".
items), and intrinsic (4 items) regulations. Integrated regulation was assessed with items developed to fit within the BREQ (BREQ-2R; Wilson, Rogers, Loitz, & Scime, 2006). This instrument was modified to physical activity contexts by replacing all instances of the word “exercise” with “physical activity”. Following the stem: “Please indicate on the scale provided how true each statement is for you” participants were asked to rate each item on a scale of 1 (not true for me) to 5 (very true for me). An example original item is: “I engage in exercise because it’s fun”. The modified item read: “I engage in physical activity because it’s fun”. Based on previous research (Sebire et al., 2011; Wilson et al., 2012) scores from the BREQ were used to create composite variables representing controlled motivation and autonomous motivation.

Controlled motivation was calculated by obtaining the average from external (α_time1 = .91, H_time1 = .92, α_time2 = .91, H_time2 = .92) and introjected regulation (α_time1 = .74, H_time1 = .76, α_time2 = .74, H_time2 = .76) at each time point. Autonomous motivation was calculated by obtaining the average from identified (α_time1 = .78, H_time1 = .86; α_time2 = .84, H_time2 = .93), integrated (α_time1 = .87, H_time1 = .92; α_time2 = .91; H_time2 = .93) and intrinsic regulation (α_time1 = .92, H_time1 = .93; α_time2 = .93, H_time2 = .94) items. Scores from the BREQ-2R (cf. Wilson et al., 2012) and from the modified to physical activity version (Verloigne et al., 2011) have demonstrated reliability and validity across investigations.

### 3.3.3.4 Psychological need fulfillment

Perceptions of psychological need fulfillment were assessed with the Psychological Need Satisfaction in Exercise Questionnaire (PNSE; Wilson et al., 2006). The PNSE is an 18-item measure developed using SDT to assess perceptions of competence (6 items), autonomy (6 items) and relatedness (6 items) experienced in exercise contexts. The modified to physical activity version of this instrument was used (PNSE-PA; Gunnell, Wilson, Zumbo, Mack, &
Crocker, 2012). Following the stem: “please answer the following questions by considering how you typically feel when you engage in physical activity” participants responded to items on a Likert scale from 1 (false) to 6 (true). Score validity and reliability for the PNSE-PA has been demonstrated (Gunnell et al., 2012).

3.3.3.5 Well-being

In recognition of the differentiated approach to understanding well-being as comprised of eudaimonic and hedonic well-being (Ryan et al., 2013), two instruments were adopted as indicators of well-being. The Subjective Vitality Scale (SVS; Ryan & Frederick, 1997) is a 7-item scale that assesses a participant’s aliveness and energy experienced in physical activity contexts and thought to reflect eudaimonic well-being (Ryan et al., 2013). Following the stem: “please respond to each of the following statements by indicating the degree to which the statement is true for you when engaged in physical activity” participants responded to each item on a Likert scale ranging from 1 (not at all true) to 7 (very true). Hedonic well-being was assessed with the short 10-item Positive and Negative Affect Schedule (PANAS; Mackinnon et al., 1999; Watson, Clark, & Tellegen, 1988). Following the stem: “indicate to what extent you generally feel this way when you engage in physical activity” participants were asked to rate each item on a scale of 1 (very slightly or not at all) to 5 (extremely). Scores from the PANAS and SVS have demonstrated good psychometric properties in exercise psychology research (e.g., Sebire et al., 2009; Wilson et al., 2006).

3.3.3.6 Physical activity

Physical activity was assessed with the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985). The LTEQ assesses the number of times participants engage in physical activity for over 15 minutes. Participants are asked to indicate the number of bouts of
light, moderate and strenuous activity engaged in over a typical week. A composite physical activity score is then creating using the formula: $\sum [(\text{Strenuous} \times 9) + (\text{Moderate} \times 5) + (\text{Mild} \times 3)]$. Score reliability and validity have been documented for this instrument (Godin & Shephard, 1985; Jacobs, Ainsworth, Hartman, & Leon, 1993).

### 3.3.4 Data Analysis

First, data were matched at time 1 and time 2 through email addresses. Out of the original 203 participants, 149 participants completed the time 2 questionnaire (27% attrition). For participants who completed both questionnaires, ≤ 4% missing data was present. In order to retain the sample size, and assuming that the data were missing at random, an expectation maximum algorithm (EM) was used in SPSS to impute missing data per subscale at each time point independently. Data analysis was conducted on 203 participants. Independent $t$-tests, chi-square difference tests, and Cohen’s $d$ effect sizes were calculated to examine mean differences between individuals that provided data at two time points vs. one. Descriptive statistics were calculated on time 1 and time 2 subscale scores. Next, confirmatory factor analyses (CFA) using the first indicator approach to set the metric with robust maximum likelihood estimation were calculated in MPlus to examine the factor structure of the modified instruments at time 1 and time 2 separately (Brown, 2006). Score reliability of each subscale was examined with coefficient alpha and coefficient H (Hancock & Mueller, 2001). Coefficient H is a measure of construct reliability calculated using the results of the CFA’s.
Next, residualized change scores were calculated in SPSS by regressing time 2 observed variables on time 1 observed variables\textsuperscript{11}, saving the unstandardized residual values (Zumbo, 1999). The residualized change scores were then used as observed variables in path analysis using MPlus. Preacher and Hayes (2008) bootstrapping method for examining multiple mediation was used because it reduces type I error rates, increases statistical power, allows for the covariation of mediators, and does not assume a normal sampling distribution. The covariance matrix was analyzed specifying a bootstrap sample of 5000. Unstandardized values and the bias corrected 95\% confidence intervals (BcCI) were used to interpret results (Preacher & Hayes, 2008). Goodness of fit statistics for the CFA’s and path analyses were assessed by obtaining a Comparative Fit Index (CFI) of .90 or above and Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) of .08 and .06 or below, respectively (Brown, 2006).

3.4 Results

3.4.1 Preliminary Analysis

Participants who provided data at two time points had significantly lower physical activity ($t(201) = 2.00, p = .047, d = .30$), and controlled motivation ($t(201) = 2.18, p = .031, d = .34$) than participants who did not provide data at two time points. Descriptive statistics are presented in Table 3.1. Skewness and kurtosis values for the residualized change scores ranged from $[0.00$ to $2.41]$ and $[0.02$ to $12.39]$, respectively. Bivariate correlations between residualized change scores along with coefficient alpha and H are presented in Table 3.1.

\textsuperscript{11} For relative intrinsic goals the residualized change score was obtained by first calculating change in the average intrinsic subscales and change in the extrinsic subscales separately. Next, change in extrinsic subscales was subtracted from change in intrinsic subscales.
3.4.2 Score Validity and Reliability

Generally, scores from each instrument demonstrated validity evidence of internal structure (see Table 3.2); however, the scores for the PNSE-PA at time 1 and 2 demonstrated evidence of model misspecification. Modification indices suggested the presence of correlated errors within subscale items, and the presence of high item correlations. Given that composite observed variables rather than latent variables were used for the main analyses, these modifications were not pursued.

3.4.3 Main Analysis

The main analyses mirrored those of Sebire and colleagues (2009). First, a structural path model was specified and tested to examine the first three hypotheses (see Figure 3.3). Taking into account model complexity and despite the elevated RMSEA, this model revealed an adequate fit to the data $\chi^2 (16) = 53.50, p < .0001, CFI = .90, RMSEA = .11 (90\% CI = .08-.14), SRMR = .06. H_1$ was supported; changes in relative intrinsic goal contents positively predicted changes in autonomous motivation and negatively predicted changes in controlled motivation (see Figure 3.3). $H_2$ was partially supported; changes in autonomous motivation positively predicted changes in satisfaction of each psychological need; however changes in controlled motivation were not significantly related to changes in psychological need satisfaction. $H_3$ was partially supported with changes in competence and relatedness predicting increases in vitality and positive affect. Changes in autonomy satisfaction negatively predicted negative affect. Finally, changes in competence satisfaction positively predicted physical activity behavior.

To examine the mediation hypotheses, a second model was specified with direct paths from relative intrinsic goal contents and from motivation to well-being and physical activity (see Figure 3.4 and Table 3.3). The addition of direct paths allows for the complete examination of
how the independent variables affect the dependent variables through total effects, direct effects, and total indirect effects (Preacher & Hayes, 2008). Mediation occurs when the confidence intervals of the total indirect effect or specific indirect effects do not cross 0 (Preacher & Hayes, 2008). This model displayed a superior fit to the data: $\chi^2 (4) = 8.68$, $p = 0.07$ CFI = .99, RMSEA = .08 (90% CI = .00-.15), SRMR = .02. H4 (a) was partially supported; changes in all three psychological needs mediated the relationship between changes in autonomous motivation and increases in vitality (specific indirect effects through competence and relatedness) and positive affect (specific indirect effects through competence and relatedness), and decreases in negative affect (specific indirect effects through autonomy). Although there was no total indirect effect, positive changes in competence emerged as a specific mediator between changes in autonomous motivation and physical activity. H4 (b) was partially supported; there was a total indirect effect of changes in psychological need satisfaction and motivation in the relationship between relative intrinsic goals and vitality, with specific indirect effects of changes in autonomous motivation through competence satisfaction and autonomous motivation through relatedness satisfaction. Although no total indirect effect was detected, similar results were found for the relationship between changes in relative intrinsic goals and positive affect, with specific indirect effects of changes in autonomous motivation, autonomous motivation through competence satisfaction, and autonomous motivation through relatedness satisfaction. Finally, changes in autonomous motivation through competence emerged as a specific indirect effect between relative intrinsic goals and physical activity. H5 was partially supported; decreases in psychological need satisfaction did not produce any overall indirect effects; however, a specific indirect effect emerged for autonomous motivation through autonomy satisfaction in the relationship between relative intrinsic goals and negative affect.
3.4.4 Alternative Hypothesized Model

The alternative model produced a poor fit to the data $\chi^2 (19) = 95.43, p = .00$, CFI = .79, RMSEA = .14 (90% CI = .11-.17), SRMR = .10. The Akaike information criterion (AIC) is a parsimonious fit index used to compare non-nested models (Kline, 2010). Model 1 was more parsimonious (AIC = 4484.68) than the alternative model (AIC = 4541.44), and therefore more likely to replicate. Based on the goodness of fit statistics and the AIC, the alternative model was deemed to be unacceptable and was not further explored.

3.5 Discussion

We examined and found support for a sequence drawn from SDT as depicted in Figure 3.1 (Deci & Ryan, 2002) whereby changes in relative intrinsic goals predicted changes in motivation which predicted changes in psychological need satisfaction, which in turn predicted changes in well-being and physical activity. Results of the mediation analysis revealed a pattern indicating that changes in satisfying each psychological need housed within BPNT (Deci & Ryan) produced indirect effects between changes in autonomous motivation and well-being/physical activity behaviour. Moreover, changes in autonomous motivation through the fulfillment of specific psychological needs proposed by Deci and Ryan produced indirect effects between relative intrinsic goals and well-being/physical activity.

3.5.1 Antecedents of Motivation and Basic Psychological Need Satisfaction

Consistent with previous research (Gillison et al., 2006; Ingledew & Markland, 2008; Sebire et al., 2011), results of the current investigation revealed that changes in relative intrinsic goal contents positively predicted autonomous motivation and negatively predicted controlled motivation across 6 months. Results also indicated that experiencing increases in autonomous
motivation for physical activity was associated with increased psychological need satisfaction. Although investigators have presented results of bivariate relationships between psychological need satisfaction and motivational regulations (e.g., McDonough & Crocker, 2007; Wilson & Rogers, 2008), this investigation represents a first attempt to test and find support for the contention that changes in motivation could engender greater psychological need satisfaction.

Contrary to our study hypothesis, changes in controlled motivation did not negatively predict changes in psychological need fulfillment. However, the finding supports an emerging line of research differentiating a lack of psychological need fulfillment from psychological need thwarting (Vansteenkiste & Ryan, in press). In this investigation, we assessed a lack of need fulfillment (i.e., low scores items of the PNSE-PA) rather than active need thwarting. Bartholomew and colleagues (2011) assert that a lack of need fulfillment and active need thwarting cannot be equated, and in fact, could produce differential outcomes. Future research is needed to directly test these assertions on the basis of SDT and examine how (or if) controlled motives are related to active psychological need thwarting.

3.5.2 Psychological Need Satisfaction Predicting Well-being and Physical Activity

Research in exercise and physical activity contexts consistently demonstrates that competence is a particularly salient psychological need contributing to optimized well-being (Gunnell et al., 2011; Mack et al., 2012; Wilson, Longley, et al., 2006; Wilson & Bengoechea, 2010) and physical activity behavior (Edmunds et al., 2006). In the present investigation, as perceptions of competence and relatedness increased, so too did well-being. Previous investigators examining structured exercise have questioned the salience of relatedness satisfaction in relation to well-being outcomes (e.g., Wilson, Longley, et al., 2006). The finding that relatedness emerged as a significant predictor of well-being in the presence of competence
and autonomy supports an emerging line of research in the context of more general physical activity contexts such as health-enhancing physical activity (Mack et al., 2012; Sylvester et al., 2012). Together, results suggest that although perceptions of relatedness may have a more distal relationship with well-being in structured exercise contexts (Wilson, Longley, et al., 2006), sharing a meaningful connection may have a more proximal relationship with well-being for individuals engaged in more general physical activity (Mack et al., 2012; Sylvester et al., 2012).

The finding that changes in autonomy did not emerge as a predictor of changes in well-being is inconsistent with theory, yet consistent with a previous longitudinal study in sport contexts over time (Adie et al., 2012) and studies in physical activity contexts (Mack et al., 2012; Wilson & Bengoechea, 2010). Corroborating those results, this study suggests that changes in autonomy may not be as salient for predicting well-being as the other psychological needs in physical activity contexts. Changes in autonomy satisfaction did negatively predict negative affect, indicating that the satisfaction of autonomy may have had a protective effect against negative affect. Sheldon and colleagues (2001) suggested that while perceptions of competence are likely to increase positive emotion, feelings of agency are likely to counteract negative affect. Our findings support Sheldon’s contentions, especially given the finding that increases in perceived autonomy were associated with decreases in negative affect.

In terms of physical activity engagement, fulfilment of psychological needs is thought to provide individuals with the energy and direction needed to engage in, and sustain, behaviour (Deci & Ryan, 2011). Consistent with previous investigations (Edmunds et al., 2006), only changes in competence satisfaction predicted increases in physical activity behaviour. Given the central role competence plays in predicting physical activity and well-being, health practitioners may wish to strive towards increasing individual’s perceptions of competence.
3.5.3 Indirect Effects through Psychological Need Satisfaction and Motivation

Ingledew and Markland (2008) asserted that the effect of goal contents on motivation could differentially predict affective and behavioural outcomes, and that this sequence is facilitated by psychological need satisfaction (Ingledew & Markland, 2009). To the best of our knowledge, this is the first investigation to test whether satisfying each psychological need within BPNT (Deci & Ryan, 2002) serves as a mediator in the relationship between changes in motivation and well-being/physical activity and whether satisfying psychological needs through motivation is a mediator between relative intrinsic goals and well-being/physical activity.

3.5.3.1 Well-being outcomes

Results revealed that changes in the satisfaction of all three psychological needs had a positive total indirect effect on the relationship between autonomous motivation and well-being. Consistent with previous research using well-being as the outcome (Mack et al., 2012; Sylvester et al., 2012), changes in perceptions of competence and relatedness emerged as significant independent mediators and again highlights the importance of feeling effective and as though you have meaningful connections with others during physical activity. Also corroborating previous research (Mack et al., 2012; Wilson & Bengoechea, 2010) and contentions regarding the role of autonomy satisfaction (Sheldon, Elliot, Kim, & Kasser, 2001), decreases in autonomy satisfaction served as a specific mediator in the relationship between autonomous motivation and negative affect.

When considering the relative intrinsic goal predicting vitality relationship, results revealed that relative intrinsic goals predicted changes in vitality because of changes in autonomous motivation through competence and relatedness satisfaction. This finding is not surprising given that researchers have demonstrated intrinsic goals to be related to well-being
through psychological need satisfaction (Sebire et al., 2009) and research demonstrating that self-determined motivation mediated the link between goal contents and quality of life (Gillison et al., 2006). Unique to the current findings however, we found that autonomous motivation and satisfaction of competence and relatedness needs simultaneously produced the indirect effect between relative intrinsic goals and vitality. This finding underscores the importance of examining psychological need satisfaction in relation to goal contents and motivation.

Shrout and Bolger (2002) contend that an overall indirect effect is not needed to examine specific indirect effects, especially when *a priori* hypotheses are forwarded. In some cases, when a specific indirect effect emerges in the absence of an overall indirect effect, the results could indicate inconsistent mediation or suppression. Inconsistent mediation occurs in multiple mediator models when two mediators have opposite signs. In our analyses autonomous motivation was hypothesized to have a positive indirect effect whereas controlled motivation was hypothesized to have a negative indirect effect. As such, several of our mediation effects occurred in the absence of a direct effect and an overall indirect effect. For example, although no total indirect effect was found between relative intrinsic goals and positive affect, specific indirect effects emerged such that changes in relative intrinsic goals were associated with positive affect through changes in autonomous motivation, and through changes in autonomous motivation and competence and relatedness satisfaction. Similarly, no total indirect effect was found between relative intrinsic goals and negative affect yet specific indirect effects emerged. Inconsistent with our hypotheses however, changes in autonomous motivation served as a positive indirect effect between relative intrinsic goals and negative affect. Although the direct effect between autonomous motivation and negative affect was also positive (see Figure 3.2), the bivariate relationship was non-significant. These results indicate that suppression or multi-
collinearity within the multivariate model may have produced this aberrant finding. Future research should examine the relationship between autonomous motivation and negative affect.

3.5.3.2 Physical activity outcomes.

Results from a systematic review revealed that self-determined or autonomous motivation was consistently associated with exercise related outcomes (Teixeira et al., 2012). In the current investigation and contrary to previous research, at the bivariate level of analysis, autonomous motivation was not significantly related to physical activity behaviour. This finding could be attributable to the use of residualized change scores to calculate the bivariate correlations or simply reflect a spurious effect. At the multivariate level of analysis, autonomous motivation did not directly predict physical activity yet when indirect effects were considered, changes in autonomous motivation predicted physical activity through competence satisfaction. We suspect that the lack of total indirect effect and direct effect reflects inconsistent mediation caused by the opposite signs of autonomous motivation and controlled motivation as noted in previous research testing complex models grounded in SDT (Sebire et al., 2011). The finding that competence emerged as a significant mediator is not surprising and supports the longstanding observation that competence satisfaction is associated with physical activity (Teixeira et al., 2012).

Elucidating the importance of goal contents for exercise, researchers have speculated that goal content may be related to behavioural outcomes through motivational regulations (Ingledew & Markland, 2009; Sebire et al., 2011). Our findings support previous research (Sebire et al., 2009) demonstrating no direct effect between relative intrinsic goals and physical activity in the presence of motivation; however, changes in relative intrinsic goals positively predicted physical activity behaviour through the specific indirect effect of autonomous motivation through competence satisfaction. Contrary to previous findings (Sebire et al., 2011) autonomous
motivation alone did not mediate the link between relative intrinsic goal content and physical activity behaviour. This finding could indicate that when psychological need satisfaction was in the model in the presence of motivation and goals, autonomous motivation is only important when it is associated with competence satisfaction. Alternatively, this aberrant finding could be attributable to the different instruments used to assess physical activity across studies (e.g., accelerometry vs. self-report; Sebire et al., 2011). Nevertheless, few investigators have examined how GCT, OIT, and BPNT fit together and research is needed to cross-validate these findings.

One final observation worthy of consideration was the finding that controlled motivation had little effect on variables within the hypothesized model. For example, aside from predicting negative affect, controlled motivation did not negatively predict physical activity or well-being, nor did it produce an indirect effect in the mediation model. Our hypothesis was based on theory regarding the negative impact of controlled motivation (Deci & Ryan, 2000) and a few investigations that have found negative associations between controlled motivation and behaviour (Brunet & Sabiston, 2011; Wilson, et al., 2004) and well-being (McDonough & Crocker, 2007). Nevertheless, a recent publication reviewing the SDT-based evidence in exercise contexts has indicated that controlled motivation often displays only a small negative relationship with exercise behaviour or no relationship at all (Teixeira et al., 2012). Results from Teixeira and colleagues (2012) review combined with earlier studies by Wilson et al. (2004) and Brunet and Sabiston (2011) suggest a possible sex and age effect on the relationship between controlled motivation and exercise. Research examining age and sex effects on the relationships between controlled motivation and well-being is needed.
3.5.4 Limitations and Future Directions

Although this investigation contributes novel information to the growing literature on SDT, limitations should be acknowledged. The data were collected using a relatively small convenience sample. Researchers may wish to examine more purposive samples such as members of physical activity programs, or exercise initiates. Furthermore, researchers may wish to examine how (or if) the constructs examined herein differ across age groups (Brunet & Sabiston, 2011). Second, the type of analysis that could be conducted was limited by the 2 time point design over a relatively short duration (6 months). Moreover, although based on residualized change scores, the point estimates of the indirect effects were small. Longitudinal investigations over multiple time points could be conducted in order to determine how trajectories of change influence well-being or physical activity behaviour. Such designs would allow for the use of multilevel modelling and the potential to examine the possible reciprocal relationship between psychological need satisfaction and motivation. Third, the instruments used in this investigation were all modified to physical activity. While previous research has supported this modification with respect to the PNSE-PA and BREQ (Gunnell et al., 2012; Verloigne et al., 2011) and we examined the internal structure of each instruments’ scores, continued inquiry into the construct validity of scores from the modified instruments is warranted. Notably, it would be worthwhile to examine validity evidence of content given that the majority of these instruments were developed using exercisers. It is possible that exercisers have different goals and motivation than individuals who engage in physical activity.

3.6 Conclusion

This study examined a sequence of SDT in which changes in relative intrinsic goals predicted changes in motivation which predicted changes in psychological need satisfaction and
in turn, predicted changes well-being and physical activity (see Figure 3.1). Furthermore, a number of specific indirect effects were uncovered between changes in relative intrinsic goals and well-being and physical activity and between changes in autonomous motivation and well-being and physical activity. Taken together, results from this investigation point to various components of the SDT sequence that could be targeted in an effort to increase well-being and physical activity behaviour. Health specialists attempting to increase physical activity should encourage intrinsic relative to extrinsic physical activity goals, encourage autonomous motivation, and encourage individuals to engage in activity that makes them feel optimally challenged.
Table 3.1 Bivariate Correlations Between Residualized Change Scores

<table>
<thead>
<tr>
<th>Time 1</th>
<th>Time 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>1. Physical Activity</td>
<td>60.20</td>
</tr>
<tr>
<td>2. Subjective Vitality</td>
<td>5.35</td>
</tr>
<tr>
<td>3. Positive Affect</td>
<td>3.79</td>
</tr>
<tr>
<td>4. Negative Affect</td>
<td>1.33</td>
</tr>
<tr>
<td>5. Competence</td>
<td>4.77</td>
</tr>
<tr>
<td>6. Autonomy</td>
<td>5.27</td>
</tr>
<tr>
<td>7. Relatedness</td>
<td>4.59</td>
</tr>
<tr>
<td>8. Controlled Motivation</td>
<td>2.65</td>
</tr>
<tr>
<td>9. Autonomous Motivation</td>
<td>4.26</td>
</tr>
<tr>
<td>10. Relative Intrinsic Goal</td>
<td>0.56</td>
</tr>
</tbody>
</table>

*Note.* *p* < .05. H = coefficient H, α = coefficient alpha; M = mean, SD = Standard Deviation.
Table 3.2 Results of Confirmatory Factor Analysis

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$ (df)</th>
<th>CFI</th>
<th>RMSEA (90%CI)</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SVS_time1</td>
<td>43.55 (14)*</td>
<td>.95</td>
<td>.10 (.07-.14)</td>
<td>.03</td>
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<td>SVS_time2</td>
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<td>.96</td>
<td>.06 (.02-.10)</td>
<td>.04</td>
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<tr>
<td>PANAS_time1</td>
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<td>.97</td>
<td>.06 (.03-.08)</td>
<td>.05</td>
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<td>PANAS_time2</td>
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<td>.05 (.01-.08)</td>
<td>.06</td>
</tr>
<tr>
<td>PNSE_time1</td>
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<td>.86</td>
<td>.10 (.09-.11)</td>
<td>.07</td>
</tr>
<tr>
<td>PNSE_time2</td>
<td>352.24 (132)*</td>
<td>.87</td>
<td>.09 (.08-.10)</td>
<td>.07</td>
</tr>
<tr>
<td>BREQ_time1</td>
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<td>.93</td>
<td>.07 (.05-.08)</td>
<td>.06</td>
</tr>
<tr>
<td>BREQ_time2</td>
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<td>.94</td>
<td>.06 (.05-.07)</td>
<td>.06</td>
</tr>
<tr>
<td>GCEQ_time1</td>
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<td>.91</td>
<td>.08 (.07-.09)</td>
<td>.07</td>
</tr>
<tr>
<td>GCEQ_time2</td>
<td>326.81 (160)*</td>
<td>.91</td>
<td>.07 (.06-.08)</td>
<td>.08</td>
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</table>

*Note. $p < .05$; SVS = Subjective Vitality Scale in physical activity contexts; PANAS = Positive and Negative Affect Schedule in physical activity contexts; PNSE: Psychological Need Fulfillment in Exercise Scale; BREQ = Behavioral Regulation in Exercise Questionnaire, GCEQ = Goal Contents in Exercise Questionnaire. $\chi^2$ = Chi Square; df= degrees of freedom, CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation and 90% Confidence Interval; SRMR = Standardized Root Mean Square Residual.
<table>
<thead>
<tr>
<th>Motivation  ➔ Outcomes</th>
<th>Total Indirect estimate</th>
<th>95% BcCI</th>
<th>Specific indirect estimate</th>
<th>95% BcCI</th>
</tr>
</thead>
<tbody>
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<td>-2.08-14.87</td>
<td>7.34*</td>
<td>2.13-16.24</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Autonomy</td>
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<td>-13.03-2.11</td>
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<td>-5.88-6.71</td>
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<td></td>
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<td>-2.16-4.63</td>
<td>-0.32</td>
<td>-3.22-2.49</td>
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<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Autonomy</td>
<td>1.22</td>
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<td>-0.47-1.49</td>
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<tr>
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<td>0.10*</td>
<td>0.02-0.25</td>
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<td>0.06-0.33</td>
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<td>-0.02-0.06</td>
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<tr>
<td>Autonomy</td>
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<td>-0.03-0.06</td>
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<tr>
<td>Relatedness</td>
<td>0.01</td>
<td>-0.03-0.06</td>
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<td></td>
</tr>
<tr>
<td><strong>Autonomous Motivation ➔ Positive Affect</strong></td>
<td>0.14*</td>
<td>0.06-0.25</td>
<td>0.09*</td>
<td>0.03-0.19</td>
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<td><strong>Autonomous Motivation ➔ Negative Affect</strong></td>
<td>-0.11*</td>
<td>-0.25--0.02</td>
<td>-0.03</td>
<td>-0.11-0.04</td>
</tr>
<tr>
<td>Competence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autonomy</td>
<td>-0.05*</td>
<td>-0.15--0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relatedness</td>
<td>-0.03</td>
<td>-0.12-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Controlled Motivation ➔ Negative Affect</strong></td>
<td>0.02</td>
<td>-0.02-0.08</td>
<td>0.00</td>
<td>-0.01-0.03</td>
</tr>
<tr>
<td>Competence</td>
<td>-0.00</td>
<td>-0.00-0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autonomy</td>
<td>0.02</td>
<td>-0.03-0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relatedness</td>
<td>-0.00</td>
<td>-0.03-0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Relative Goal Content ➔ Outcomes**

| Relative Intrinsic Goals ➔ Physical activity | -0.46 | -2.39-1.49 | -0.32 | -2.16-1.21 |
| Controlled motivation                      |       |           |       |           |
| Autonomous motivation                      | -0.70 | -2.49-0.67 |       |           |
| **Controlled Motivation ➔ Competence**     | 0.06  | -0.46-0.63 |       |           |
| Autonomous Motivation ➔ Competence         | 0.85* | 0.19-2.48  |       |           |
| **Controlled Motivation ➔ Autonomy**       | -0.22 | -1.47-0.15 |       |           |
| Autonomous Motivation ➔ Autonomy           | -0.30 | -1.77-0.22 |       |           |
Table 3.3 Continued. Total and Specific Indirect Effects of the Hypothesized Model

<table>
<thead>
<tr>
<th>Path</th>
<th>Effect Size</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Motivation --&gt; Relatedness</td>
<td>-0.01</td>
<td>-0.27-0.08</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Relatedness</td>
<td>0.17</td>
<td>-0.66-1.00</td>
</tr>
<tr>
<td>Relative Intrinsic Goals --&gt; Vitality</td>
<td>0.05*</td>
<td>0.01-0.12</td>
</tr>
<tr>
<td>Controlled motivation</td>
<td>-0.00</td>
<td>-0.03-0.04</td>
</tr>
<tr>
<td>Autonomous motivation</td>
<td>0.02</td>
<td>-0.01-0.07</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Competence</td>
<td>0.00</td>
<td>-0.01-0.01</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Competence</td>
<td>0.01*</td>
<td>0.00-0.04</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Autonomy</td>
<td>0.00</td>
<td>-0.01-0.00</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Autonomy</td>
<td>0.00</td>
<td>-0.01-0.01</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Relatedness</td>
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<td>-0.01-0.01</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Relatedness</td>
<td>0.02*</td>
<td>0.01-0.05</td>
</tr>
<tr>
<td>Relative Intrinsic Goals --&gt; Positive Affect</td>
<td>0.03</td>
<td>-0.01-0.07</td>
</tr>
<tr>
<td>Controlled motivation</td>
<td>-0.01</td>
<td>-0.03-0.02</td>
</tr>
<tr>
<td>Autonomous motivation</td>
<td>0.02*</td>
<td>0.00-0.05</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Competence</td>
<td>0.00</td>
<td>-0.01-0.01</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Competence</td>
<td>0.01*</td>
<td>0.00-0.03</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Autonomy</td>
<td>0.00</td>
<td>-0.01-0.01</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Autonomy</td>
<td>0.00</td>
<td>-0.01-0.00</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Relatedness</td>
<td>0.00</td>
<td>-0.01-0.00</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Relatedness</td>
<td>0.01*</td>
<td>0.00-0.03</td>
</tr>
<tr>
<td>Relative Intrinsic Goals --&gt; Negative Affect</td>
<td>-0.03</td>
<td>-0.06-0.00</td>
</tr>
<tr>
<td>Controlled motivation</td>
<td>-0.04*</td>
<td>-0.07-0.01</td>
</tr>
<tr>
<td>Autonomous motivation</td>
<td>0.03*</td>
<td>0.01-0.06</td>
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<tr>
<td>Controlled Motivation --&gt; Competence</td>
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<td>-0.01-0.002</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Competence</td>
<td>-0.003</td>
<td>-0.02-0.004</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Autonomy</td>
<td>-0.004</td>
<td>-0.02-0.00</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Autonomy</td>
<td>-0.006*</td>
<td>-0.02-0.001</td>
</tr>
<tr>
<td>Controlled Motivation --&gt; Relatedness</td>
<td>0.00</td>
<td>-0.001-0.005</td>
</tr>
<tr>
<td>Autonomous Motivation --&gt; Relatedness</td>
<td>0.00</td>
<td>-0.02-0.005</td>
</tr>
</tbody>
</table>

Note. * were used to denote significant effects based on the 95% Bias Corrected Confidence Intervals. All values are unstandardized.
Figure 3. 1 Hypothesized Model.

*Note.* + indicates hypothesized positive relationships, - indicates hypothesized negative relationships.
Figure 3. 2 Hypothesized Alternative Model.

Note. + indicates hypothesized positive relationships, - indicates hypothesized negative relationships.
Figure 3. 3 Unstandardized Values for Structural Model

*Note.* Preliminary structural model showing changes in motivation and goal contents predicting changes in psychological needs, well-being and physical activity. Values are unstandardized changes scores, brackets contain 95% BcCI. Only statistically significant paths are shown. Psychological need satisfaction variables were correlated via disturbance terms (Preacher & Hayes, 2008).
Figure 3. 4 Unstandardized Values for the Multiple Mediation Model

Note. Revised structural model with direct and indirect relationships between motivations and goal contents, psychological needs and outcomes. Values are unstandardized changes scores, brackets contain 95% BC CI. Only statistically significant paths are shown. Psychological need satisfaction variables were correlated via disturbance terms (Preacher & Hayes, 2008).
3.7 Bridging Summary

Study 2 provided evidence for the role of psychological need satisfaction between antecedents such as relative intrinsic goals and autonomous motivation and outcomes such as well-being and physical activity behaviour. Another important variable hypothesized to be an antecedent to psychological need satisfaction and implicated in the prediction of well-being and physical activity behaviour is the role of identity and the self. Ryan and Deci (2011) speculate that individuals have multiple identities that are more or less assimilated with their overall self. The congruence between self and identity is thought to depend on motives, goals, and basic psychological need satisfaction (Soenens & Vansteenkiste, 2011). Humans are thought to have a natural tendency to grow towards integration and organization and this process is facilitated (or thwarted) by fulfillment of basic psychological need satisfaction (or thwarting; Deci & Ryan, 2012; Soenens & Vansteenkiste, 2011). When an identity is associated with increased psychological need satisfaction, it is thought to be more internalized and congruent with the self (Soenens & Vansteenkiste, 2011). Therefore, well integrated identities are characterized by greater psychological need satisfaction, autonomous motivation, and intrinsic goals, all variables that are hypothesized to lead to greater well-being and behavioural engagement (Ryan & Deci, 2012).

Researchers examining identity within an SDT framework have found associations between exercise identity and basic psychological need satisfaction (Vlachopoulos et al., 2011; Wilson & Muon, 2008) and behavioural regulations (Strachan, Fortier, Perras, & Lugg, 2012; Vlachopoulos et al., 2011). Another important self variable that has been identified as having utility for intervention work is possible selves. A possible self is the self-knowledge an individual possesses about themselves in the future, and is based on current and past self-
schemas (Markus & Nurius, 1986). Having found support in study 2 that changes in relative intrinsic goals and autonomous motivation predicted changes in psychological need satisfaction and in turn, changes in well-being and physical activity behaviour, an important next step was to determine if a best possible self intervention could increase exercise self-schema, psychological need satisfaction, well-being and physical activity behaviour.

To examine these tenets, a best possible physical activity intervention was conducted (see study 4). Prior to examining the results of the intervention, baseline data was used to answer relevant research questions about the role of psychological need satisfaction in the relationship between exercise self-schema and well-being and physical activity behaviour. In combination with the results of study 2, if psychological need satisfaction is found to be a key mechanism translating the effect between exercise self-schema and well-being/physical activity behaviours, interventionist will know that facilitating psychological need satisfaction could be the key ingredient for a myriad of positive outcomes. For example, if self-schema is not an integrative process facilitated by psychological need satisfaction, interventions would work towards “training, shaping, directing, programing and controlling” (Ryan, 1995, p. 399). Conversely, and as hypothesized, if psychological needs facilitate the relationship between identity integration, intrinsic goals and motivation then interventionists would work towards “facilitating, conducing, supporting, and nurturing such tendencies” (Ryan, 1995, p. 399). Therefore, understanding how psychological needs relate to self-schema and how they transmit effects to well-being and behaviour is critical to understanding how individuals internalize behaviour and align their identities with their self. Study 3 sought to build on previous research (Vlachopoulos et al., 2011; Wilson & Muon, 2008) and test a mediational model whereby psychological need satisfaction
mediates the relationship between exercise self-schema and well-being/physical activity behaviour.
CHAPTER 4: The Role of Psychological Need Satisfaction in the Relationship Between Exercise Self-Schema and Well-Being and Physical Activity Behaviour

4.1 Introduction

The World Health Organization (WHO) has recognized physical inactivity as the fourth leading risk factor for mortality around the world (World Health Organization, 2011). Physical activity plays a critical role in health including reducing the risk of diabetes, cardiovascular disease, and obesity (World Health Organization, 2011). Despite the benefits of physical activity, in 2008 the WHO estimated that 31% of adults (aged 15 and above) were insufficiently active. Psychological well-being has also been implicated as a protective buffer against chronic health conditions (Helliwell et al., 2012) and increased longevity (Diener & Chan, 2011). Given the importance of physical activity and well-being to health, it is not surprising that researchers have extended this line of inquiry to include the myriad of psychological variables that could influence physical activity behaviour and well-being outcomes. One psychological construct that holds considerable appeal for understanding exercise behaviour and well-being is exercise self-schemas (Kendzierski, 1988).

4.1.1 Exercise Self-Schema

In her seminal article, Markus (1977) defined self-schemas as domain specific cognitive generalizations about the self that are based on previous experience and serve as powerful self-regulators of behaviour (Markus, 1977). Self-schemas are thought to assist individuals in processing information about themselves, and also to serve as a motivational force to engage in behaviour (Markus, 1977). An individual who holds an exercise self-schema would consider exercise as both self-descriptive and important to their self-image (Kendzierski, 1988).
Researchers have linked self-schemas to behavioural and psychological outcomes such as frequency for exercise (Kendzierski, 1988), commitment (Kendzierski, 1988), intention (Estabrooks & Courneya, 1997; Sheeran & Orbell, 2000), self-efficacy (Yin & Boyd, 2000), and sport enjoyment (Boyd & Yin, 1999). Results from these investigations reveal that possessing an exercise self-schema correlates with motivation and self-regulation required for physical activity engagement and may facilitate well-being outcomes. Some researchers have recently argued, however that self-schemas may be better understood using a larger motivational framework such as Self-Determination Theory (SDT; Deci & Ryan, 2000; Sabiston et al., 2012; Strachan & Whaley, 2013).

4.1.2 Self-Determination Theory

SDT is a macro-theory of human motivation and personality (Ryan & Deci, 2002). At the heart of SDT lies Ryan and Deci’s hypothesis that humans have innate psychological needs for competence, autonomy, and relatedness. Competence occurs when individuals feel effective and as though they can express their capabilities in their environment (Ryan & Deci). Autonomy occurs when an individual feels as though they are the source of their own behaviour (Ryan & Deci) whereas relatedness occurs when an individual feels as though they have meaningful connections with important others (Ryan & Deci). Ryan and Deci describe psychological needs as “nutriments” (p. 7) that are universal and essential for growth and well-being. Moreover, when fulfilled, psychological needs provide the impetus for energy and direction towards future behaviours (Deci & Ryan, 2000). Numerous investigators using BPNT have found support for Deci and Ryan’s contentions as increased psychological need satisfaction in physical activity contexts has been positively associated with well-being and physical activity behaviour.
(Edmunds et al., 2006; Edmunds et al., 2007; Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013; Gunnell et al., 2011; Mack et al., 2012; Sylvester et al., 2012; Wilson, Longley, et al., 2006).

4.1.3 Self-Determination Theory and Identity

A central tenet of SDT is that identities vary in their degree of integration towards the self, and that understanding this variation can help us understand human functioning (Ryan & Deci, 2003). The degree of integration towards the self varies as a direct consequence of opportunities to satisfy basic psychological needs (Ryan & Deci, 2003; Ryan & Deci, 2011; Ryan, 1995). More specifically, identities are developed and maintained to help individuals support perceptions of competence, provide the opportunity to develop and express personal interests consistent with personal values and to establish authentic connections to important others (Ryan & Deci, 2011). Therefore, psychological needs are thought to be the mechanism (i.e., mediator) responsible for the relationship between identity and well-being/behaviour (Ryan & Deci, 2003). Researchers using identity theory and SDT have found positive associations between exercise identity and exercise behaviour (Wilson & Muon, 2008), and basic psychological need satisfaction (Vlachopoulos et al., 2011; Wilson & Muon, 2008). Outside of the SDT context, exercise identity has been linked with life satisfaction (Strachan et al., 2012). Consequently, it is argued that the reasons individuals form identities is to fulfill basic psychological needs (Ryan & Deci, 2011) and that the fulfillment of competence, autonomy and relatedness is associated with well-being and physical activity outcomes. However, to the best of our knowledge, these tenants have not been tested within the context of physical activity.
4.2 Purpose and Justification

The primary purpose of this investigation is to examine the role of psychological need satisfaction in the relationship between exercise self-schema and well-being/physical activity behaviour. Based on SDT (Ryan & Deci, 2003) it was hypothesized that exercise self-schema would be positively associated with well-being/physical activity behaviour through the indirect effect of psychological need satisfaction. The secondary purpose of this investigation was to examine the factor structure of the Exercise Self-Schema Scale (ESS; Kendzierski, 1988). Based on previous research (Berry et al., 2013; Wilson & Muon, 2008) using the Exercise Identity Scale (Anderson & Cychosz, 1994), it was hypothesized that a 2-factor structure of the ESS would fit the data better than a 1-factor structure. The overall justification for this research is threefold.

First, while research using the construct of self-schemas within the Theory of Planned Behaviour is plentiful (Banting et al., 2009; Estabrooks & Courneya, 1997; Sheeran & Orbell, 2000), Sabiston, and colleagues (2012) called for researchers studying self-schema constructs to do so under larger motivational theories such as SDT in order to advance our understanding of self constructs. Although a few investigators have examined identity constructs within an SDT framework (Vlachopoulos et al., 2011; Wilson & Muon, 2008), few have examined self-schemas using SDT (e.g., Saebu & Sørensen, 2011). To this end, Berry and colleagues, (2013) argued for the examination of self-schema (similar to identity) given its focus on one’s own view of the self and of the image one has of oneself. Furthermore, little research has examined the link between self-schema and well-being within exercise contexts. This investigation represents an attempt to examine self-schemas using constructs embedded within SDT (i.e., psychological need satisfaction).
satisfaction). Consequently, this investigation will contribute novel information to the literature on self-schemas through a SDT perspective.

Second, Deci and Ryan (2000) argued that self-schemas could vary in the degree of integration and assimilation towards the self. Since psychological need satisfaction is thought to be the key mechanism that facilitates integration and self-regulation of externally regulated behaviours (Deci & Ryan, 2000), it is theoretically important to examine if having an exercise self-schema is associated with psychological need fulfillment. If psychological need satisfaction is found to be a key mechanism translating the effect between exercise self-schema and well-being/physical activity behaviours, then interventionists would be working towards “facilitating, conducing, supporting, and nurturing such tendencies” (Ryan, 1995, p. 399) in an effort to promote self-regulation and optimal motivation to engage in exercise. Conversely, if self-schema is not found to be an integrative process facilitated by psychological need satisfaction, interventionists would work towards “training, shaping, directing, proograming and controlling” (Ryan, 1995, p. 399). Therefore, understanding the relationships among psychological need satisfaction, self-schema, well-being and behaviour can facilitate understanding how individuals internalize behaviour and align their self-schemas with their self.

Finally, the measurement of the ESS has been questioned by researchers because of concern with the categorization of individuals into exercise types (i.e., exercise schematic, non-schematic, or aschematic (Berry et al., 2013; Sabiston et al., 2012). Using the scoring protocol outlined by Markus (1977) and Kendzierski (1988) has led to up to 45% of individuals as being ‘unclassified’ (Sabiston et al., 2012). Based on Sheeran and Orbell’s (2000) contention that exercise self-schema may be best viewed as person characteristics rather than as a type, the ESS has recently been examined as a continuous variable (e.g., Banting et al., 2009; Berry et al.,
2013; Sheeran & Orbell, 2000). Researchers have used both a 1 factor structure (Banting et al., 2009) and a two factor structure with the descriptive and importance component separated (Berry et al., 2013; Sheeran & Orbell, 2000). Consistent with procedures advocated by The Standards for Educational and Psychological Testing (AERA et al., 1999) we will examine the factor structure for ESS responses.

4.3 Methods

4.3.1 Procedure
After obtaining approval from a University ethical review board, participants aged 25 to 65 were recruited using online announcements, emails, and through recruitment posters displayed at various university sites (please see Appendix E-1-E-3). Recruitment material advertised a ‘self’ intervention. Participants were provided with a link to an online questionnaire (please see Appendix E-3).

4.3.2 Participants
Participants (N = 153; 55.6% female, 91.4% White) were on average 41 years old (SD = 12.59, Range = 25-65 years). The average body mass index of participants was 26.21 kg/m² (SD = 6.14). Marital status was as follows: 65.4% were married or in a common law relationship, 23.5% were single never married, 9.8% were separated or divorced, and 1.3% was widowed. Educational status was as follows: 53.6% attained a university or college degree, 32.7% attained a graduate degree, 13.1% attained a high school degree and 0.7% completed some high school.

12 Participants in this investigation were part of a larger intervention study. Only participants who completed the baseline assessment for the intervention were used.
4.3.3 Measures

4.3.3.1 Exercise self-schema

Exercise self-schema was assessed using Kendzierski’s 6-item scale (ESS; 1988; please see Appendix C-3). Three key phrases were presented to participants (“someone who exercises regularly”, “someone who keeps in shape”, and “physically active”) and participants were asked to rate how self-descriptive each phrase was on a Likert scale of 1 (does not describe me) to 11 (describes me). Second, participants were asked to rate how important the trait was, regardless of whether the trait described them, on a scale of 1 (not at all important) to 11 (very important). Researchers have used the ESS as a continuous variable representing one descriptive component and one importance component (Berry et al., 2013).

4.3.3.2 Psychological need satisfaction

Psychological need satisfaction was measured with the 18-item Psychological Need Satisfaction in Exercise Scale (Wilson, Rogers, et al., 2006; please see Appendix C-7), modified to physical activity contexts (PNSE-PA; Gunnell et al., 2012). This instrument was developed using SDT to determine the degree to which participants experience competence (6 items), autonomy (6 items) and relatedness (6 items) in exercise contexts. Participants were asked to rate their responses from 1 (false) to 6 (true). Previous research using the modified PNSE-PA demonstrated score reliability and validity (Gunnell et al., 2012; Mack et al., 2012)

4.3.3.3 Well-being

Psychological well-being was assessed with a combination of instruments to reflect the distinction between eudaimonic and hedonic well-being (Ryan et al., 2008). All well-being instruments directed participants to rate how they felt when engaged in physical activity. Vitality was assessed with the 7-item Subjective Vitality Scale (SVS; Ryan & Frederick, 1997); please
see Appendix C-5). Participants were asked to respond to each item on a scale of 1 (*not at all true*) to 7 (*very true*). Meaning was assessed using 4 items from the Meaning Scale (MS; Huta & Ryan, 2010; please see Appendix C-4). Following the stem “to what degree do you typically feel that your physical activity and physical activity experiences are”, participants were asked to rate the items: “valuable”, “full of significance”, “meaningful”, and “dear to me” on a scale of 1 (*not at all*) to 7 (*very much*). Affect was assessed using the short, 10-item Positive and Negative Affect Schedule (Mackinnon et al., 1999; Watson et al., 1988; please see Appendix C-6). Participants were asked to rate 5 positive affect and negative affect (each) items on a scale of 1 (*very slightly or not at all*) to 5 (*extremely*).

**4.3.3.4 Physical activity**

Physical activity was assessed using the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985; please see Appendix C-8). Participants were asked to provide the number of times they engaged in strenuous, moderate, and mild physical activity for over 15 minutes in a typical week. A total physical activity score was calculated using the formula 

\[
[(9\times \text{strenuous}) + (5\times \text{moderate}) + (3\times \text{mild})].
\]

The LTEQ is a widely used instrument for self-reported physical activity behaviour and scores from the LTEQ have demonstrated score validity and reliability (Godin & Shephard, 1985; Jacobs et al., 1993).

**4.3.4 Data Analysis**

In total, 155 participants provided responses on ≥ 50% of items for each subscale. Assuming the data were missing at random (< 2% missing), missing data were imputed using an expectation maximization algorithm in SPSS. Two participants were removed because their LTEQ values were deemed to be extreme outliers (\(z = 4.34\) and 11.45) leaving a final sample size of 153. Next, descriptive statistics were calculated along with Pearson bivariate correlations.
and estimates of internal consistency. To examine the factor structure of scores from each instrument, Confirmatory Factor Analyses (CFA’s) were estimated using Mplus. Robust Maximum Likelihood estimation was used, setting the variance of the latent variables to one. A combination of goodness-of-fit statistics were interpreted (Brown, 2006) with a comparative fit index (CFI) close to or above .90, a standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) close to or below .08 and .06 deemed acceptable (Brown, 2006). Based on the results of the CFA analyses, coefficient H (Hancock & Mueller, 2001), an estimate of score reliability was calculated.

The main analysis used observed variables for path analysis. First, a structural model was specified wherein exercise self-schema predicted psychological need satisfaction and psychological need satisfaction predicted well-being and physical activity behaviour. Next, to examine mediation effects, direct paths were added from exercise self-schema to well-being and physical activity behaviour. Preacher and Hayes’ (2008) bootstrapping procedure to test for multiple mediation was used. We request 5,000 bootstrapped samples and interpreted the 95% bias corrected confidence intervals (95%BcCI). In line with Preacher and Hayes’ (2008) recommendations, unstandardized coefficients were interpreted.

4.4 Results

4.4.1 Preliminary Analysis

Results of the CFA analyses can be found in Table 4.1. Examination of the 1 factor ESS model did not produce a good fit to the data. The 2 factor ESS structure with one factor representing importance ESS items and 1 factor representing the descriptive ESS items was a better fit to the data and therefore used for further analyses. The goodness-of-fit statistics for
PNSE-PA responses fell below acceptable criteria. Inspection of the data revealed that standardized loading were all $\geq .77$ and the correlation between psychological need satisfaction latent variables ranged from .40-.60. Modification indices suggested the presence of 2 item cross loadings and many correlated error terms. These modifications were not pursued for theoretical reasons, and because the main analyses used observed variables. Scores from all other instruments demonstrated validity evidence of internal structure. Means, standard deviations, and coefficient alpha and H can be found in Table 4.2. Pearson bivariate correlation revealed statistically significant small-to-large relationships between study variables (see Table 4.2).

### 4.4.2 Main Analysis

The structural model fit the data reasonably well ($\chi^2_{(10)} = 72.97, p < .00$, CFI = .91, SRMR = .07, RMSEA = .20 90% CI = .16-.25; see Figure 4.1). The descriptive component of ESS was positively associated with satisfaction of all three psychological needs. Competence satisfaction was positively associated with physical activity behaviour, vitality, positive affect, and negatively associated with negative affect. Autonomy satisfaction was positively associated with physical activity behaviour and negatively associated with negative affect. Finally, relatedness satisfaction was associated with meaning.

The mediation model was just identified and therefore, goodness-of-fit statistics cannot be generated. Results of the mediation analyses partially supported the study hypothesis (see Figure 4.2). Satisfaction of all three psychological needs mediated the relationships between descriptive ESS and vitality (total indirect $b = 0.13$, BcCI = 0.07-0.20; specific indirect $b_{\text{competence}} = 0.11$, BcCI = 0.07-0.17), positive affect (total indirect $b = 0.10$ BcCI =0.06-0.15; specific indirect $b_{\text{competence}} = 0.10$ BcCI = 0.07-0.15) and negative affect (total indirect $b = -0.03$ BcCI = -0.06--0.004; specific indirect $b_{\text{competence}} = -0.02$ BcCI = -0.05--0.001). Although the total indirect
The purpose of this investigation was to examine the role of psychological need satisfaction in the relationship between exercise self-schema and well-being/physical activity behaviour. A secondary purpose was to examine score validity and reliability for the ESS. Results of the CFA’s indicated that a 2-factor structure of the ESS provided the best account of the data. The results of the mediation analysis revealed that satisfaction of all three psychological needs mediated the relationship between descriptive ESS and well-being, with competence satisfaction emerging as a specific mediator. Satisfaction of competence and relatedness were significant mediators between descriptive ESS and physical activity behaviour. Finally, results from this investigation demonstrated that descriptive ESS produced the majority of the effects, underscoring the importance of examining exercise self-schemas as two characteristics of the self rather than a classification of schematic vs. nonschematic (Sheeran & Orbell, 2000).
4.5.1 Measurement of Exercise Self-Schema

Building on Sheeran and Orbell’s (2000) contention that exercise self-schema may best be operationalized as a characteristic of an individual, this study provided preliminary evidence for the validity of the ESS scores based on internal structure. Berry and colleagues (2013) found that the 2-factor Exercise Identity Scale correlated strongly with the 2-factor ESS. Therefore, based on the psychometric investigations by (Vlachopoulos et al., 2011; Wilson & Muon, 2008) using the Exercise Identity Scale and the results of Berry and colleagues findings, it is not surprising that the 1-factor model of the ESS comprised of both the descriptive and importance components of schema did not fit the data. Instead a 2-factor model of the ESS comprised of 1 descriptive factor and 1 importance factor provided a superior fit and demonstrated little error variance. This is the first investigation to specifically examine aspects of score validity and reliability for the ESS used as a continuous measure. The results from this investigation also support the use of the ESS as a continuous variable and revealed that the descriptive and importance component of schemas may be related differentially to outcome variables. Since score validation is an ongoing process, future research should continue to examine scores of the ESS.

4.5.2 Exercise Self-Schema Predicting Psychological Need Satisfaction

In the structural model, descriptive ESS was most important for predicting psychological need satisfaction in physical activity contexts. Importance ESS was not directly related to perceptions of any of the psychological needs in the structural model. Although the outcome variables were different, this finding is counter to Sheeran and Orbell (2000) who found importance ESS to be the most salient component because importance ESS significantly interacted with exercise intention to predict behaviour. Examination of the bivariate correlations
revealed that importance ESS was significantly associated with psychological need satisfaction and outcome variables, suggesting that suppression or multicollinearity between descriptive and importance ESS could be affecting the results. Notwithstanding, in the identity literature, Vlachopoulos et al., (2011) and Wilson and Muon (2008) found role identity to be more strongly related to SDT variables. Vlachopoulos suggested that the role identity (more strongly correlated with descriptive ESS; Berry et al., 2013) constitutes the identification of being an exerciser whereas exercise beliefs (more strongly correlated with importance ESS; Berry et al., 2013) reflects the centrality and importance of thoughts about exercise. It is possible that descriptive ESS is more important for predicting psychological need satisfaction because the descriptive ESS items query more integrated traits of the individuals’ self, whereas the importance items may be interpreted as more outwardly focused, or reflect thoughts or ruminations (Vlachopoulos, et al., 2011; Wilson & Muon, 2008) about exercise, regardless of whether that trait describes their self. Future research may wish to examine how the descriptive and importance ESS items relate to psychological need satisfaction and other SDT constructs including motivational regulations to further elucidate this finding.

4.5.3 Psychological Need Satisfaction Predicting Well-Being and Physical Activity

Results of the path analysis revealed that perceived competence satisfaction during physical activity was associated with all the outcome variables except for meaning. This finding is not surprising and supports the growing number of investigations that indicate that competence is a particularly salient need for predicting well-being and physical activity behaviour especially when taken at a single point in time (Edmunds et al., 2006; Gunnell et al., 2011; Mack et al., 2012). The finding that autonomy emerged as a significant predictor of physical activity behaviour in the presence of the other psychological needs is novel and contrary to previous
research (e.g., Edmunds et al., 2006), yet supports Ryan, Patrick, and colleagues (2008) contentions that competence alone is not enough to propel individuals to engage in behaviour. Indeed, Ryan and Patrick et al. (2008) contend that a sense of volition must accompany behavioural engagement. Future research should replicate and further explore the autonomy-physical activity behaviour link. In particular, given the speculation that psychological need satisfaction may vary over time, or depending on the stage of exercise adoption (Edmunds et al., 2007; Wilson & Muon, 2008), future research should examine longitudinal relationships using individuals in different stages of behavioural adoption (e.g., exercise initiates vs. maintainers).

Finally, perceptions of relatedness was the only psychological need to emerge as a predictor of meaning suggesting that feelings of connectedness or belonging are particularly important for feeling a sense of meaning as a result of physical activity. Given the salient role of competence in this investigation and previous research for predicting vitality and affect (Gunnell et al., 2011; Mack et al., 2012) it was surprising that competence was not associated with meaning in the path models. It has been argued that vitality is more closely aligned with hedonic well-being and affective states (Fowers, Mollica, & Procacci, 2010) and that meaning may be more aligned with the cognitive components of eudaimonic well-being (e.g., an individual comprehends the value and experience of an activity; Huta & Ryan, 2010). Based on these arguments, it seems reasonable to suggest that perceptions of competence are important for affective components of well-being, yet perceptions of relatedness are more salient for cognitive evaluative components of well-being such as meaning. Future research is needed to elucidate and cross-validate this finding.
4.5.4 The Role Psychological Need Satisfaction

Results of the mediation analysis demonstrate that descriptive ESS is a particularly important component for predicting well-being and physical activity outcomes. Perceptions of competence, autonomy and relatedness mediated the relationships between descriptive ESS and vitality, positive affect and negative affect. When specific indirect effects were considered, competence emerged as a significant mediator in these relationships. This finding is consistent with two investigations where competence satisfaction was found to be particularly salient in relation to exercise identity (Vlachopoulos et al., 2011; Wilson & Muon, 2008) and previous research that has examined psychological need satisfaction as mediators (Gunnell et al., 2011; Mack et al., 2012). Interpretation of these results suggest that feeling effective within physical activity environments could be associated with enhanced self-description which is positively associated with well-being and physical activity behaviour. Researchers or health specialists who are attempting to integrate exercise self-schemas in individuals may do well to create environments that foster psychological need satisfaction, particularly competence.

Although there was no total indirect effect, descriptive ESS was associated with increased physical activity behaviour because of perceptions of competence and relatedness. However, the coefficient for relatedness was negative and contrary to hypotheses for both importance and descriptive ESS predicting physical activity. Inspection of the Pearson bivariate correlations indicated a non-significant association between relatedness and physical activity. We suspect that the negative association found in the path model was the product of a statistical artifact that could have been caused by suppression or multicollinearity. Notwithstanding this aberrant finding, the results of the mediational analysis between ESS and physical activity reveal that having high descriptive ESS could be associated with increased behaviour because of
perceptions of competence. Given the results of this investigation and previous research (Edmunds et al., 2006; Vlachopoulos et al., 2011; Wilson & Muon, 2008) targeting perceptions of competence may represent one viable route to increasing self-schema and physical activity.

Contrary to our hypothesis, psychological need satisfaction did not have a total indirect effect on the relationship between importance ESS and well-being or physical activity behaviour. Although there was no total indirect effect, specific indirect effects were found (Preacher & Hayes, 2008). Perceptions of relatedness served as an indirect effect in the relationship between importance ESS and meaning. The results of the mediation analysis also support the contention that in this investigation, importance ESS may not be as salient as descriptive ESS. Using the argument outlined above, it is possible that descriptive ESS is more important because the descriptive items tap more integrated self-descriptive statements about the self, whereas the importance items query more outwardly focused thoughts about the importance of those traits. Alternatively, bivariate relationships revealed associations between importance ESS and well-being/behaviour and psychological need satisfaction, suggesting that suppression or multicollinearity could have been influencing the results. Future research should continue to examine the role of importance ESS.

Lastly, the finding that psychological need satisfaction mediated the relationships between descriptive ESS and well-being/physical activity supports Ryan’s (1995) contention that self-schemas may vary in their degree of integration towards the self. This also supports assertions by Sabiston and colleagues, (2012) that self constructs such as self-schema may be best understood using SDT. The results of this investigation indicate that the investigation of self-schemas may be advanced if the degree of integration towards the self is taken into account. Researchers should continue to examine this line of inquiry to determine if (a) psychological
need satisfaction mediates the self-schema-well-being/physical activity relationships and (b) if perceptions of psychological need satisfaction can be manipulated to increase integration of exercise self-schemas in an effort to promote motivation and self-regulation for exercise behaviour. Such a line of inquiry could provide the impetus for intervention research targeted at increasing both behaviour and well-being.

4.5.5 Limitations and Future Directions

This investigation contributes novel findings to the understanding of well-being and physical activity behaviour literature; however, limitations must be addressed. First and foremost, the data were cross-sectional and as such conclusions are limited and causality cannot be inferred (Preacher & Hayes, 2008). As such, an important avenue for future research is to collect longitudinal data, ideally involving a manipulation to directly test mediation hypotheses. Our sample size was relatively small and therefore precaution is warranted when interpreting the results of the CFA analysis. Furthermore, the PNSE-PA did not provide a good fit to the model and caution should be taken when interpreting the results. Similarly, only one source of score validity evidence was examined (AERA et al., 1999) and therefore future research would do well to continue examining the utility of scores from the ESS, especially predictive evidence. Finally, self-reported physical activity is susceptible to response bias (Nigg, Jordan, & Atkins, 2012). Accelerometers are often described as objective measures of physical activity because they do not rely on participants recall or perceptions (e.g. Nigg et al., 2012). Future research examining exercise self-schemas’ role in predicting well-being and behaviour may benefit from the use of accelerometers as a more objective measure of physical activity. Notwithstanding, it is important to be cognizant that accelerometers are not the panacea for measuring physical activity behaviour because they are susceptible to error. For example, accelerometers can be insensitive to certain
types of movement that do not involve stepping (e.g., arm movements, stationary bicycling) and also to environmental factors such as walking up inclines and walking while carrying loads (Colley et al., 2011).

4.6 Conclusion

This investigation found that descriptive ESS is related to well-being and physical activity behaviour and that this effect could be carried by the satisfaction of key psychological needs. This research represents a preliminary attempt to understand exercise self-schemas through SDT’s psychological needs, and supports Ryan and Deci’s (2003) contention that self-schemas may vary in the degree to which they are integrated into the self, a process facilitated (or hinder) by psychological need satisfaction or (thwarting). Based on the study findings, researchers or applied specialists (e.g., doctors, fitness instructors) would do well to create psychological need satisfying environments such that individuals have opportunities to feel effective, volitional, and a sense of authentic social connectedness. Fulfilling these key psychological needs could engender the integration of an exercise self-schema and facilitate well-being and physical activity behaviour.
Table 4.1 Results of Instrument Confirmatory Factor Analyses

<table>
<thead>
<tr>
<th></th>
<th>$\chi^2$ (df)</th>
<th>CFI</th>
<th>SRMR</th>
<th>RMSEA</th>
<th>90% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Factor ESS</td>
<td>142.76* (9)</td>
<td>.67</td>
<td>.21</td>
<td>.31</td>
<td>.27-.36</td>
</tr>
<tr>
<td>2-Factor ESS</td>
<td>27.08* (8)</td>
<td>.95</td>
<td>.04</td>
<td>.13</td>
<td>.08-.18</td>
</tr>
<tr>
<td>PNSE-PA</td>
<td>375.08* (132)</td>
<td>.87</td>
<td>.07</td>
<td>.11</td>
<td>.10-.12</td>
</tr>
<tr>
<td>SVS</td>
<td>39.42* (14)</td>
<td>.94</td>
<td>.05</td>
<td>.07</td>
<td>.07-.15</td>
</tr>
<tr>
<td>MS</td>
<td>3.26 (2)</td>
<td>.99</td>
<td>.02</td>
<td>.06</td>
<td>.00-.19</td>
</tr>
<tr>
<td>PANAS</td>
<td>47.34 (34)</td>
<td>.98</td>
<td>.05</td>
<td>.05</td>
<td>.00-.08</td>
</tr>
</tbody>
</table>

Note. * $p < .05$; ESS = Exercise Self-Schema Scale, PNSE-PA = Psychological Needs Satisfaction in Exercise Scale modified to Physical Activity, SVS = Subjective Vitality Scale, MS = Meaning Scale, PANAS = Positive and Negative Affect Schedule. $\chi^2$ = chi-square, df = degrees of freedom, CFI = Comparative Fit Index, SRMR, = Standardized Root Mean Square Residual, RMSEA = Root Mean Square Error of Approximation.
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Alpha</th>
<th>H</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<tbody>
<tr>
<td>1. Descriptive ESS</td>
<td>7.89</td>
<td>2.84</td>
<td>.96</td>
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<tr>
<td>2. Importance ESS</td>
<td>8.77</td>
<td>2.29</td>
<td>.92</td>
<td>.94</td>
<td>.41*</td>
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<tr>
<td>3. Competence</td>
<td>4.65</td>
<td>1.16</td>
<td>.94</td>
<td>.95</td>
<td>.66*</td>
<td>.34*</td>
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<td>4. Autonomy</td>
<td>5.33</td>
<td>0.86</td>
<td>.94</td>
<td>.95</td>
<td>.56*</td>
<td>.34*</td>
<td>.54*</td>
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<td>5. Relatedness</td>
<td>4.39</td>
<td>1.34</td>
<td>.95</td>
<td>.95</td>
<td>.45*</td>
<td>.33*</td>
<td>.56*</td>
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<td>6. Vitality</td>
<td>5.39</td>
<td>1.12</td>
<td>.89</td>
<td>.93</td>
<td>.46*</td>
<td>.50*</td>
<td>.61*</td>
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<tr>
<td>7. Meaning</td>
<td>5.20</td>
<td>1.23</td>
<td>.87</td>
<td>.91</td>
<td>.58*</td>
<td>.56*</td>
<td>.52*</td>
<td>.42*</td>
<td>.49*</td>
<td>.61*</td>
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<tr>
<td>8. Positive Affect</td>
<td>3.82</td>
<td>0.75</td>
<td>.86</td>
<td>.88</td>
<td>.42*</td>
<td>.44*</td>
<td>.65*</td>
<td>.34*</td>
<td>.43*</td>
<td>.81*</td>
<td>.63*</td>
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<tr>
<td>9. Negative Affect</td>
<td>1.32</td>
<td>0.48</td>
<td>.73</td>
<td>.95</td>
<td>.41*</td>
<td>.19*</td>
<td>.39*</td>
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<td>.18*</td>
<td>.31*</td>
<td>.26*</td>
<td>.16*</td>
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</tr>
<tr>
<td>10. Physical Activity</td>
<td>57.51</td>
<td>37.63</td>
<td>--</td>
<td>--</td>
<td>.49*</td>
<td>.15*</td>
<td>.37*</td>
<td>.29*</td>
<td>.07*</td>
<td>.25*</td>
<td>.36*</td>
<td>.22*</td>
<td>.21*</td>
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</tbody>
</table>

*Note.* *p* < .05. SD = standard deviation, ESS = Exercise self-schema scale, H = Coefficient H, Alpha = Coefficient Alpha.
Figure 4.1 Hypothesized Structural Model.

*Note.* Values represent unstandardized estimates. Values in parentheses represent the 95% BcC I. Only statistically significant paths are shown. LTEQ = Physical Activity, ESS = Exercise Self-Schema Scale.
Figure 4. 2 Hypothesized Mediation Model.

Note. Values represent unstandardized estimates. Values in parentheses represent the 95\%BCI. Only statistically significant paths are shown. LTEQ = Physical Activity, ESS = Exercise Self-Schema Scale.
4.7 Bridging Summary

Study 3 found support for the contention that self-schemas are associated with psychological need satisfaction and in turn, well-being and physical activity behaviour. According to Deci and Ryan (Deci & Ryan, 2011; Deci & Ryan, 2000), individuals are more likely to engage in behaviour and experience well-being when their goals are intrinsic in nature, their motivation is autonomous, their psychological needs are fulfilled and it is part of their identity. Studies 2 and 3 provided evidence that psychological need satisfaction may be the key mechanism that links intrinsic goals, autonomous motivation and exercise self-schemas to well-being and behavioural engagement.

Possible selves is another construct that has been successfully implemented for increased well-being (e.g., Layous et al., 2013) and exercise behaviour (e.g., Murru & Martin Ginis, 2010). Possible selves represent the hoped and feared for selves that people wish to become (Markus & Nurius, 1986). Possible selves do not represent mere desires, but rather represent visions of the self based on self-schemas (Cross & Markus, 1994), goals (Markus & Nurius, 1986), and psychological need satisfaction (Deci & Ryan, 2000; Ryan, 1995). Given the findings from studies 2 and 3, a best possible physical activity self intervention could be one viable route for increasing exercise self-schemas, psychological need satisfaction, well-being and physical activity behaviour.

Investigators have examined exercise-related possible selves and found evidence that generating exercise possible selves can increase exercise behaviour (Harju & Reed, 2003; Murru & Martin Ginis, 2010; Ouellette et al., 2005). Intervention work on possible selves from the positive psychology literature supports theoretical hypotheses and demonstrates that writing about one’s best possible self can lead to greater well-being (King, 2001; Layous et al., 2013;
Therefore the purpose of study 4 was to examine the effect of a best possible physical activity self intervention on outcome variables such as physical activity behaviour, well-being, psychological need satisfaction, and exercise self-schemas.
CHAPTER 5: The Effect of a Possible Physical Activity Self Intervention on Exercise Self-Schema, Psychological Need Satisfaction, Well-Being, and Physical Activity Behaviour

5.1 Introduction

With the emergence of positive psychology and the growing evidence base indicating that psychological well-being is good for individuals’ biological health (Helliwell et al., 2012; Ryff & Burton, 2013), and society as a whole (e.g., promotes pro-social behaviour; Ryan et al., 2013), researchers have turned their attention towards interventions aimed at enhancing individuals’ well-being (Sin & Lyubomirsky, 2009). Positive psychology interventions are activities that individuals can practice in order to enhance positive thoughts and feelings (Layous et al., 2013; Lyubomirsky & Layous, 2013). Activities such as expressing gratitude or writing about a best possible self often increase well-being (Sin & Lyubomirsky, 2009). There is also evidence to suggest that engaging in a positive psychology intervention could also lead to other health promoting behaviours such as physical activity (Boehm, Vie, & Kubzansky, 2012; Emmons & McCullough, 2003). Researchers have recently argued that the investigation of the link between physical activity and well-being would benefit from adopting constructs used within the positive psychology literature because physical activity is linked to well-being (Hefferon & Mutrie, 2012). One positive psychology intervention that has been successful for increasing both well-being (Layous et al., 2013) and exercise (Murru & Martin Ginis, 2010) is the activity of writing about a best possible self.

5.1.1 Possible Selves, Well-Being, and Physical Activity

Possible selves are cognitive manifestations that represent enduring goals, aspirations, motives, and fears. They serve as the mental representation of what an individual perceives as
their own potential in the future (Markus & Nurius, 1986). For example, an exerciser may have a best possible self of completing a marathon. In this case, the best possible self will represent an ideographic goal based on the individual’s desires and self-schemas. Self-schemas are cognitive generalizations about the self (Markus, 1977) that are thought to predict future behaviour within a particular domain, and as a consequence, may serve as a foundation for the development of possible selves (Cross & Markus, 1994). Therefore, an individual who has an exercise self-schema may have the best possible self of running a marathon because the activity is consistent with their exercise self-schema.

When an individual considers a possible self, it can serve to create a positive affective state that energizes action and fosters motivation (Cross & Markus, 1994; Markus & Nurius, 1986). Within positive psychology, numerous investigators have demonstrated that writing about a best possible self can increase well-being (King, 2001; Layous et al., 2013; Lyubomirsky et al., 2011; Peters, Flink, Boersma, & Linton, 2010; Sheldon & Lyubomirsky, 2006). Similarly, a few investigators have demonstrated that writing about an exercise possible self can increase exercise behaviour (Murru & Martin Ginis, 2010; Ouellette et al., 2005). For example, using a randomized controlled experimental design and assessing constructs from Social Cognitive Theory (Bandura, 1997), Murru and Martin Ginis (2010) found that individuals who completed a one time hoped for or feared for exercise-specific possible self writing activity reported more minutes of exercise over 4 and 8 weeks compared to a control group. Moreover, planning self-efficacy was found to partially mediate the effect of the writing intervention on exercise at 4 weeks. Despite the positive findings from previous research, the majority of the investigations conducted (e.g., King, 2001; Peters et al., 2010; Ouellette et al., 2005) have been atheoretical,
thereby making it difficult to determine why writing about a best possible self increased well-being or exercise behaviour.

5.1.2 Possible Selves as a Form of Motivation: A Self-Determination Theory Perspective

Sabiston, Whitehead, and Eklund (2012) argued that possible selves could be advanced by subsuming the constructs under a larger theoretical framework such as Self-Determination Theory (Ryan & Deci, 2002). Using SDT, Deci and Ryan (2000) argue that constructs such as possible selves and self-schemas could vary with regards to the degree of integration towards the self, a process facilitated (or forestalled) by the fulfillment (or thwarting) of basic psychological needs. All people are thought to have innate psychological needs for competence, autonomy, and relatedness. Competence is a feeling of effectance (Ryan & Deci, 2002). Autonomy is a feeling of volition or agency, and relatedness is a feeling of belonging with important others (Ryan & Deci, 2002). Deci and Ryan (2000) contend that when psychological needs are satisfied within a given context, individuals will integrate the behaviour into their sense of self. Therefore, possible selves could be fully integrated towards the self as a function of psychological need satisfaction, or possible selves could be externally imposed, as a function of psychological need thwarting. This process of psychological need satisfaction or thwarting is theorized to differentially predict well-being, ill-being and behavioral engagement or disengagement outcomes (Deci & Ryan, 2011).

Markus and Nurius (1986) suggested that envisioning a possible self will create cognitions around mastery (similar to competence), affiliation (relatedness) and agency (autonomy). Based on tenets outlined within SDT, possible selves that facilitate psychological need satisfaction will be more likely to activate behaviour and promote well-being compared to possible selves that do not (Deci & Ryan, 2011; Deci & Ryan, 2000). Similarly, articulating a
best possible self will involve goal focused visions which should engender greater psychological need satisfaction (Layous, et al., 2013; Sheldon & Elliot, 1999). Indeed, researchers have hypothesized that intentional activities like a best possible selves intervention could increase well-being because of opportunities to satisfy psychological needs (Layous & Lyubomirsky, 2012; Layous et al., 2013). Testing these assertions, Layous et al. (2013) found that a possible selves writing intervention in academic, social, career, and health domains increased perceptions of relatedness, but not competence or autonomy needs satisfaction.

Given the contentions that psychological need satisfaction may be one mechanism responsible for the effectiveness of the possible selves intervention, it is prudent that researchers manipulate perceptions of psychological need satisfaction to directly test these assertions. Although a few investigators have conducted interventions in which psychological need satisfaction was targeted, they often did not measure psychological need satisfaction as an outcome (e.g., Fortier et al., 2011) or they focus on manipulating environmental supports (i.e., autonomy support, structure, and interpersonal relationships) to examine subsequent psychological need satisfaction (Edmunds, Ntoumanis, & Duda, 2008; Rouse, Ntoumanis, Duda, Jolly, & Williams, 2011).

One of the key questions that should be answered through intervention work is how an intervention works such that the causal process of behaviour change can be understood (Michie & Abraham, 2004). Michie and Abraham (2004) argued that intervention investigators who measure psychological antecedents and use manipulations have the greatest potential to test theory. One method of manipulating variables that has been used in SDT research is to prime, or subliminally prompt certain cognitions (Deci & Ryan, 2012). For example, Sheldon and Filak (2008) conducted the first experiment to directly manipulate all three psychological needs
through the use of primers. In their study, the experimenters used either psychological need
satisfaction supportive language or thwarting language prior to participants engaging in a task
(playing boggle). Their result supported the contention that manipulating competence and
relatedness via need supportive language prior to the task had systematic effects on outcomes
such as affect and performance. In another investigation, Sheldon and colleagues (2010)
attempted to manipulate psychological need satisfaction by asking participants to directly pursue
need satisfying goals. Results of their investigation suggested that individuals who pursued
autonomy and relatedness goals had greater happiness than individuals who focused on their life
circumstances (Sheldon et al., 2010). Although these investigations contribute to the extant SDT
literature base regarding the direct effect of manipulating or priming psychological need
satisfaction, few investigators in exercise contexts have attempted to directly manipulate
psychological need satisfaction through the use of priming. Consequently, an important avenue
to test SDT is to manipulate psychological need satisfaction within an experimental design to
examine its effect on well-being and behaviour.

The justification for this research is threefold. First, to date, no published research has
examined the impact of a possible selves intervention tailored to physical activity contexts on
outcomes such as well-being and behaviour. Researchers have demonstrated the effectiveness of
a general best possible self intervention for increasing well-being (King, 2001; Layous et al.,
2013) and researchers have demonstrated the effectiveness of an exercise specific possible self
intervention for increasing exercise (Murru & Martin Ginis, 2010). Given the contentions that
positive psychology interventions could increase health behaviour such as physical activity
(Boehm, et al., 2012), researchers would do well to test a physical activity tailored possible
selves intervention on both well-being and behaviour outcomes. If such an intervention is
effective at increasing well-being and physical activity behaviour, the intervention will hold
great appeal for public health and applied health specialists.

Second, no research has attempted to directly manipulate perceptions of psychological
need satisfaction in their best possible selves intervention. Although Layous and colleagues
(2013) measured perceptions of psychological need satisfaction in their investigation, based on
their study design, they could not make conclusions regarding the role of psychological need
satisfaction in explaining why the possible selves intervention was successful. As such, an
important avenue for investigators using the possible selves intervention is to systematically
examine the effect of manipulating psychological need satisfaction through the best possible
selves intervention. One method to manipulating psychological need satisfaction alluded to
above is through the use of priming. Furthermore, to directly test the effectiveness of the
psychological need satisfaction manipulations, researchers should employ a research design that
allows for the comparison between groups of individuals who received the prime, and those who
did not. One of the main aims of the current research is to systematically examine the
effectiveness of manipulating psychological need satisfaction through primes in the possible
selves intervention script.

Finally, researchers have argued that positive psychology interventions should be studied
in populations other than university students (Layous & Lyubomirsky, 2013; Seear & Vella-
Brodrick, in press). The majority of investigators targeting well-being have used university
undergraduate students (King, 2001; Layous et al., 2013; Sheldon & Lyubomirsky, 2006).
Moreover, the exercise specific possible selves intervention used participants who exercised
fewer than 3 times a week and who wanted to become more active (Murru & Martin Ginis,
2010). Although these investigations were important for developing baseline evidence for the
possible selves intervention, more research is needed to examine the effectiveness of the possible selves intervention in populations other than university students or low-active participants. To this end, in an effort to test the generalizability of the possible selves intervention, the current investigation will examine the effectiveness of the physical activity possible selves intervention in a sample of participants drawn from the general population.

5.2 Research Question and Hypotheses

The purpose of this investigation was to determine if writing about a best possible physical activity self would increase psychological need satisfaction, exercise self-schema, well-being, and physical activity behaviour. A secondary purpose was to determine if receiving psychological need satisfaction primers in the possible selves writing instruction facilitated increased perceptions of psychological need satisfaction. Based on theory (Deci & Ryan, 2000; Markus & Nurius, 1986) and previous research from the possible selves-behaviour literature (Murru & Martin Ginis, 2010; Ouellette et al., 2005) and from the positive psychology literature (Layous et al., 2013; Sheldon & Lyubomirsky, 2006), 3 hypotheses were forwarded:

H1: The best possible physical activity intervention groups will have increased psychological need satisfaction and well-being compared to the control group

H2: The best possible physical activity intervention groups will have increased physical activity behaviour compared to the control group.

H3: The best possible physical activity group that receives the psychological need primers will have greater psychological need satisfaction compared to the regular best possible physical activity possible selves group and the control group.

Because little research is available delineating the process of changes related to self-schemas (Strachan & Whaley, 2013), we were unsure if a brief 4 week intervention could change
self-schemas. As such, no specific hypotheses were forwarded regarding the effect of the intervention on exercise self-schemas.

5.3 Methods

5.3.1 Design and Procedures

A randomized controlled 3 (group) by 3 (time) experimental design was used. Participants completed a baseline questionnaire (week 0), a post-intervention questionnaire (week 5) and a 1 month follow-up questionnaire (week 9; see Figure 5.1). First, a pilot investigation was conducted on volunteers between the age of 25-65 (n = 6) to examine instruction clarity. Based on feedback from the pilot participants, changes to the intervention scripts were made. Second, a priori power analyses were conducted using GPower, specifying a medium effect (based on results of Sin & Lyubomirsky, 2009 meta-analysis), alpha = .05, power = .80, and 2 groups. The necessary sample size across pre-test/post-test was 34 and across pre-test/post-test/follow-up was 28. Eligible participants were recruited using online announcements, email, snowball sampling, and recruitment posters placed around the university (please see Appendix E-1-E-3). The study recruitment material advertised a “self intervention”.

Upon completion of the baseline questionnaire, participants were randomized using a random number generator (random.org) into one of three groups: (1) a best possible physical activity self group (BPP), (2) a best possible physical activity self plus psychological need satisfaction primer group (BPP+) and, (3) a control group. Participants were asked to read a set of instructions and write about what they imagined for a minimum of ten minutes once a week for 4 weeks. Participants received an email every Monday for 4 weeks that contained the link to their writing instructions (please see Appendix E-4). If the participant did not complete the
writing task, they were sent a reminder email on Wednesday of that week (please see Appendix E-5). In order to reduce demand effects, the post intervention questionnaire was completed on the Monday following the fourth writing activity (i.e., approximately 1 week after they had completed their last writing activity). Finally, participants received an email with a link to the final follow-up questionnaire 4 weeks after their last writing activity (see Appendix E-7 and E8).

5.3.2 Best Possible Physical Activity Self (BPP)

The script for the BPP group was based on previous research (Murru & Martin Ginis, 2010; Sheldon & Lyubomirsky, 2006; please see Appendix D-1). Participants randomized to the BPP group read the following script:

Think about your life in the future. You have worked hard and succeeded at accomplishing all of your physical activity goals. Imagine that everything has gone as well as it possibly could. Think of this as a realization of the best possible physically active life you could ever have hoped for. We are interested in your impression of yourself 5 to 10 years from now. More specifically, we would like you to think about yourself in the future as a person who is a healthy, physically active person. You follow a healthy lifestyle which includes engaging in regular physical activity. Five to ten years from now, you are at a healthy weight and have the energy to carry out your daily tasks. When you think about yourself five to ten years from now as a healthy regularly physically active person, what images come to mind? Consider yourself in the future and anything you consider to be related to physical activity. Some examples of physically active future selves include: possible selves about weight, activity levels, engagement in different activities, energy, and health. There are no right or wrong best possible selves. In all cases you are identifying the best possible way that things might turn out in relation to your physical activity in the future, in order to help guide your decisions now. So we’d like to ask you to continue thinking in this way over the next few weeks, following up on the initial writing that you’re about to do. Now write about what you imagined. Please write for a minimum of 10 minutes.

5.3.3 Best Possible Physical Activity Self Plus Primer (BPP+)

Participants randomized to the BPP+ group were asked to read the same instructions as the BPP group (see above), with the addition of a script intended to prime participants to write
about psychological need satisfying experiences (please see Appendix D-2). The primer script
was based on previous research (Sheldon & Filak, 2008). The psychological need primer script
that followed the general possible selves script was:

Something to remember while you write about your future self is that being
physically active is your decision. You may wish to write about engaging in
physical activities that you find personally enjoyable. You may wish to write
about continuing the physical activity you already do. The decision to be
physically active is yours. You could write about physical activity possible
selves that are reasonable, or personally challenging to you. One thing you
can think about is writing about something you are good at! You may wish to
write about yourself in the future engaging in activity with other meaningful
people. You may see yourself in the future engaging in physical activity with
people you share a common bond with.

5.3.4 Control Group

Participants in the control group were asked to read the following script used in previous
research (Layous et al., 2013; please see Appendix D-3):

Please take a moment to think about what you did during the last 24 hours.
That is, create a mental outline of what you did during that time. Please write
out these activities in a list format. Next, choose one of the activities you listed
and write about it in even more detail. You want to dissect the activity you
previously listed into smaller pieces to describe exactly what you did. Repeat
this process until you have written for a minimum of 10 minutes. Be as detail
oriented as possible, but try to leave out emotions, feelings, or opinions
pertaining to your plans. In other words, focus on exactly what you did.

In all three groups, participants were encouraged to write using whatever style they
wanted, to be as creative and imaginative as they wanted, and instructed that they could write
about the same thing each week or something different. They were also told they could write on
a piece of paper in their own home or type in the box provided online. They were given the
option of submitting their writing to be used for research purposes or to delete their writing and
not allow it to be used for research purposes. Finally, they were instructed to read the instructions
each time they completed the writing task. This instruction was given to ensure that participants
were (a) following the instructions each week and (b) that those in the BPP+ group were being primed prior to each writing activity. Participants were told their email addresses would be entered into a draw to win one of three $50 cash prizes each time they submitted a questionnaire (i.e., participants could have up to 3 ballots in the draw).

5.3.5 Participants

Please see Figure 5.1 for a flow chart of participants through the intervention study. Participants who completed pre-test/post-test were 53 individuals from the general population ($M_{age} = 42.45, SD = 13.09; 69.8\%$ female) with an average body mass index of 25.73 kg/m$^2$ ($SD = 5.26$). Participants were mostly white (94.3\%) followed by South Asian (1.9\%), and Chinese (3.8\%). The majority of participants reported being married (73.6\%), followed by single/never married (20.8\%) and separated/divorced (5.7\%). Participants reported educational attainment as: university/college degree (60.4\%), graduate degree (32.1\%), and high school diploma (7.5\%).

5.3.6 Measures

5.3.6.1 Psychological need satisfaction

The Psychological Need Satisfaction in Exercise scale (PNSE; Wilson, Rogers, et al., 2006; please see Appendix C-7) was modified to physical activity contexts (PNSE-PA; Gunnell et al., 2012). The PNSE-PA assesses perceptions of competence (6 items), autonomy (6 items), and relatedness (6 items) experienced during physical activity. Participants were asked to respond to each item on scale of 1 (false) to 6 (true). Evidence for score validity and reliability has been demonstrated in previous research (Gunnell et al., 2012; Mack et al., 2012).
5.3.6.2 Well-being

Well-being was assessed with a combination of instruments to reflect the distinction between hedonic and eudaimonic well-being (Ryan et al., 2013). All instructional stems for the well-being instruments directed participants to answer each item according to how they typically felt when engaged in physical activity. Hedonic well-being was assessed with the 10-item Positive and Negative Affect Schedule (PANAS; Mackinnon et al., 1999; Watson et al., 1988) (please see Appendix C-6). Participants were asked to rate 5 positive and 5 negative affect items on a scale of 1 (very slightly or not at all) to 5 (extremely). Eudaimonic well-being was assessed with the 7-item Subjective Vitality Scale (SVS; Ryan & Frederick, 1997; please see Appendix C-5) and 4 items (‘valuable’, ‘full of significance’, ‘meaningful’, and ‘dear to me’) from the Meaning Scale (MS; Huta & Ryan, 2010; please see Appendix C-4). Participants were asked to respond to SVS items on a scale of 1 (not at all true) to 7 (very true). Following the MS stem: “to what degree do you typically feel that your physical activity and physical activity experiences are...” participants were asked to respond to each item on a scale of 1 (not at all) to 7 (very much). Score reliability and validity for each well-being instrument has been demonstrated in previous research (Huta & Ryan, 2010).

5.3.6.3 Exercise self-schemas

Kenzierski’s (1988) exercise self-schema scale (ESS; please see Appendix C-3) was used. The ESS contains three phrases: (1) someone who exercises regularly”, (2) “someone who keeps in shape”, and (3) “physically active”. Participants are first asked to rate each phrase according to how self-descriptive each trait is on a scale of 1 (does not describe me) to 11 (describes me). Next, participants are asked to rate each phrase according to how important it is, regardless of whether the trait described them, on a scale of 1 (not at all important) to 11 (very
important). Previous research has used the ESS as a continuous scale reflecting a descriptive factor (descriptiveESS) and an importance factor (importanceESS; Berry et al., 2013).

5.3.6.4 Physical activity

Self-reported physical activity was assessed using the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985; please see Appendix C-8). This instrument asks participants to record the number of times they engage in strenuous, moderate, and mild physical activity in a typical week. A physical activity score is then created using the formula $\Sigma[(9\text{*strenuous})+(5\text{*moderate})+(3\text{*mild})]$. 

5.3.6.5 Treatment fidelity

Participants were asked to rate on a scale 0 (not much) to 5 (a lot) “how much effort would you say you put into the writing task?” and “to what extent did you engage in and make use of the writing activity?” (please see Appendices C9-C10). Participants were also asked “if you stopped completing the writing task, or did not complete it at all 4 time points, why? Response options provided included: not enough time, too demanding, didn’t find it useful, forgot, lost interest, not meeting needs, boring, and other. At week 9, the 1-month follow up questionnaire included a feedback section. Participants were asked “after the intervention portion (writing) was complete, did you continue engaging in the writing task? (yes/no), and if so, how often would you say you would engage in the writing task 1 (never) 5 (very often)$^{13}$. 

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$^{13}$ Participants were also given the opportunity to provide feedback for consideration of future possible selves interventions. Feedback questions included: Have you made any changes in your life to pursue the physical activity-related self (or selves) you wrote about? If so, what? What did you find effective? What could have been more effective? What did you like? What did you dislike? Please see Appendix C-10
5.3.7 Data Analysis

Data were screened for completeness and adherence. Please refer to Figure 5.1 for summary statistics on participation attrition. Participants who completed <50% of items per subscale were removed from further analysis. Assuming the remaining missing data were missing at random, an expectation maximum algorithm (Enders, 2006) was used to impute missing data per treatment group and per subscale. Based on self-reported data, participants who completed < 3 writing activities were excluded from analysis. A manipulation check was conducted by the first author who read participants’ writing to examine if the participant followed the writing instructions. Participants who did not write about their best possible physical activity self, who did not follow the instructions, or who declined permission for the researcher to view their writing and only spent 2 minutes on the writing task were removed from further analysis. Attrition analysis (t-test, chi-square, or Kruskall-Wallis tests) was conducted to compare baseline participants (n = 155) with participants who completed the intervention. Using the final sample of participants (across pre-test/post-test n = 53 and across pre-test/post-test/follow-up n = 45), descriptive statistics were then calculated along with estimates of internal consistency and Pearson bivariate correlations. Next, the assumptions for ANOVA were checked. To test the main study hypotheses, a series of repeated measures ANOVA’s were tested, specifying group as the between factor variable and time as the within factor variable. Because a priori hypotheses were forwarded, Bonferroni corrections were not used (Keppel & Zedeck, 1989). Due to participant attrition from time 2 to 3, separate analyses were conducted across time 1-2 and across time 1-3. This procedure is consistent with a previous investigation (Murru & Martin Ginis, 2010). Using the final samples (pre-test/post-test n = 53 and pre-test/post-test/follow-up n = 45), analysis was conducted to determine if there were any
significant differences between participants who completed all three time points versus those who only completed two time points.

5.4 Results

5.4.1 Manipulation Check and Implementation Fidelity

Of the participants who allowed the researcher to read their writing, 12 were deleted because they did not follow the instructions (e.g., wrote “see last week” or wrote about their activity in the past). Four more were deleted because they did not spend more than 3 minutes on the page and did not write anything so it was assumed they did not engage in the writing task. At post-intervention, participants indicated they put effort into the writing task ($M = 3.43, SD = .97$), and engaged in, and made use of the writing activity ($M = 3.33, SD = 1.22$) above the midpoint of the 5 point scales. The most frequently reported reason for not completing all 4 writing activities was “not enough time” followed by ‘other’ (including technical issues and wasn’t totally clear), forgot, too demanding, and lost interest. At 1-month follow-up, 11 participants (25.6%) indicated that they continued engaging in the writing task with a mean frequency between ‘never’ and ‘rarely’ 1.47 ($SD = 1.03$).

5.4.2 Attrition Analysis

In total, 155 participants completed the baseline questionnaire. Using the baseline data, mean difference tests with a Bonferroni correction $p < .003$ revealed no statistically significant differences on all outcomes variables and demographic variables. Also, no significant differences on outcome variables, demographics, and group assignment were found between individuals who completed pre-test/post-test but did not complete the one month follow-up ($p > .05$).
5.4.3 Preliminary Analysis

Mean difference tests with a Bonferroni correction (\( p < .003 \)) were conducted to examine if differences between groups existed on all outcome and demographic variables at baseline. No statistically significant differences were noted (effect sizes: Cohen’s \( d \) range .08-.82; phi range .00-.22; \( r \) range .08-.12) in the pre-test/post-test data or the pre-test/post-test/follow-up data. Scores from the negative affect subscale demonstrated low reliability (\( \alpha_{\text{time1}} = .56, \alpha_{\text{time2}} = .52, \alpha_{\text{time3}} = .52 \)). As such, two items (distressed and upset) were deleted from the subscale for further analysis. The assumption of homogeneity of variance was violated for pre-test/post-test relatedness and descriptiveESS, and testing hypothesis 3 across pre-test/post-test/follow-up for autonomy. A cubic transformation was used; however, the results of the significant tests were similar and therefore untransformed results are presented. Descriptive statistics for each main analysis are presented in Table 5.1. Pearson bivariate correlations and estimates of internal consistency for each time point are presented in Table 5.2.

5.4.4 Pre-Test Post-Test Results

Hypothesis 1 was partially supported; at post-test, a statistically significant group by time interaction emerged for positive affect [\( F(1,51) = 5.30, p = .03, \eta^2 = 0.09 \)]. Mean positive affect increased in the possible selves group and decreased in the control group (see Table 5.1). No statistically significant differences appeared for vitality [\( F(1,51) = 2.01, p = .16, \eta^2 = 0.04 \)], meaning [\( F(1,51) = 0.31, p = .58, \eta^2 = 0.01 \)], negative affect [\( F(1,51) = .17, p = .68, \eta^2 = .003 \)], competence [\( F(1,51) = 2.18, p = .15, \eta^2 = 0.04 \)], autonomy [\( F(1,51) = 1.12, p = .29, \eta^2 = 0.02 \)], or

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14 Analyses were conducted with all five items of the negative affect subscale and a similar pattern of results were noted. All repeated measures ANOVA’s for negative affect were statistically non-significant.
15 Various transformations were unsuccessfully attempted to reduce homogeneity of variance for time 3 autonomy. As such, caution should be taken when interpreting the results of hypothesis 3 for autonomy across 3 time points.
relatedness \( [F(1,51) = 0.25, p = .62, \eta^2 = 0.005] \). Hypothesis 2 was not supported: no statistically significant group by time differences were noted for physical activity \( [F(1,50) = 0.41, p = .58, \eta^2 = 0.01] \). Finally no statistically significant differences were noted for descriptive ESS \( [F(1,49) = 2.02, p = .16, \eta^2 = 0.04] \), and importance ESS \( [F(1,50) = 0.79, p = .38, \eta^2 = 0.02] \). To test hypothesis 3, the BPP+ group was compared first against the BPP group and then against the control. No statistically significant group by time interactions were noted for competence satisfaction (vs. PBP; \( [F(1,33) = 0.36, p = .56, \eta^2 = 0.01] \) or vs. control; \( [F(1,34) = 0.87, p = .36, \eta^2 = 0.03] \)), autonomy satisfaction (vs. PBP; \( [F(1,33) = 0.23, p = .63, \eta^2 = 0.01] \) or control: \( [F(1,34) = 0.40, p = .53, \eta^2 = 0.01] \)), or relatedness satisfaction (vs. PBP; \( [F(1,33) = 1.73, p = .20, \eta^2 = 0.05] \) or control; \( [F(1,34) = .12, p = .73, \eta^2 = 0.003] \)).

### 5.4.5 Pre-Test to Follow-Up

All hypotheses were rejected when examining the effects of the intervention across pre-test/post-test/follow up (see Table 5.2). No statistically significant group by time differences were noted for vitality \( [F_{\text{Greenhouse-Geiser}}(1.63,70.03) = 0.77, p = .44, \eta^2 = 0.02] \), meaning \( [F(2,86) = 0.03, p = .98, \eta^2 = 0] \), positive affect \( [F(2,86) = 1.75, p = .18, \eta^2 = 0.04] \), negative affect \( [F_{\text{Greenhouse-Geiser}}(1.69,72.77) = 0.85, p = .42, \eta^2 = 0.02] \), competence satisfaction \( [F(2,86) = 0.72, p = .49, \eta^2 = 0.02] \), autonomy satisfaction \( [F(2,86) = 0.53, p = .59, \eta^2 = 0.01] \), relatedness satisfaction \( [F(2,86) = 0.11, p = .90, \eta^2 = 0.003] \), descriptive ESS \( [F(2,80) = 0.97, p = .39, \eta^2 = 0.02] \), importance ESS \( [F_{\text{Greenhouse-Geiser}}(1.67,76.10) = 0.90, p = .39, \eta^2 = 0.02] \), or physical activity.

\[16\] One extreme outlier (\( z = 7.19 \)) was detected for physical activity across pre-test/post-test and removed.

\[17\] Descriptive statistics (Means and Standard Deviations) for these analyses are available from the first author upon request.
activity $[F(2,82) = 0.36, p = .70, \eta^2 = 0.01]$\(^{18}\). To test hypothesis 3, the PBP+ group was compared first against the PBP group and then against the control. No statistically significant group by time interactions were noted for competence satisfaction (vs. PBP; $[F(2,54) = 1.58, p = .22, \eta^2 = 0.05]$) or vs. control; $[F(2,56) = 0.01, p = .99, \eta^2 = 0]$), autonomy satisfaction (vs. PBP; $[F(2,54) = 1.76, p = .18, \eta^2 = 0.06]$ or control; $[F(2,56) = 0.01, p = .99, \eta^2 = 0]$), or relatedness satisfaction (vs. PBP; $F_{\text{Greenhouse-Geisser}}(1.59,43.03) = 1.49, p = .24, \eta^2 = 0.05$) or control; $[F(2,56) = 0.26, p = .77, \eta^2 = 0.01]$\(^{19}\).

### 5.5 Discussion

The purpose of this investigation was to test the effect of a best possible physical activity self intervention on outcomes such as self-schema, psychological need satisfaction, well-being and physical activity behaviour. This investigation represented a preliminary attempt to combine aspects of the positive psychology intervention with the exercise behaviour possible selves intervention to increase well-being and physical activity behaviour. The strengths of this investigation were that it was a randomized controlled trial over 9 weeks, it was theory-driven, it recruited participants from the general population rather than university students, and that it attempted to directly manipulate perceptions of psychological need satisfaction. The results of the main analyses indicated that, except for the significant group by time interaction for positive affect across pre-test/post-test, the intervention was unsuccessful.

\(^{18}\)Two extreme outliers ($z = 6.34$ and $5.00$) were detected for physical activity and removed.

\(^{19}\)Descriptive statistics (Means and Standard Deviations) for these analysis are available from the first author upon request.
5.5.1 Best Physical Activity Possible Selves and Positive Affect

The only statistically significant finding for the effect of the intervention was for positive affect across pre-test/post-test. Previous research has demonstrated the effectiveness of the possible self intervention for increasing positive affect (Layous et al., 2013; Sheldon & Lyubomirsky, 2006). Individuals in the best possible physical activity self groups demonstrated an increase in positive affect while individuals in the control group had a decrease in positive affect over 5 weeks. More importantly, the effect size for this finding was medium, indicating that regardless of sample size, the intervention accounted for a medium proportion of the variability in positive affect (Keppel & Zedeck, 1989). Moreover, within broaden and build theory, Fredrickson and Joiner (2002) contend that positive emotions broaden attention and cognition and as a consequence, create trends towards increasing emotion and well-being. Although the effect was not robust at the 1 month follow-up, it is encouraging to note that the intervention did increase positive affect at post-test given that even transient increases in affect could create positive spirals upwards (Fredrickson & Joiner, 2002). Future research is needed to explore this sole significant finding to determine if it can be replicated.

5.5.2 Comparisons to Previous Research

5.5.2.1 Self-schemas

Because little research was available to forward hypothesis regarding the process of self-schema development or internalization (Strachan & Whaley, 2013), we did not forward any hypothesis regarding the impact of the intervention on self-schemas. Our results suggest that the possible self intervention had no effect over time in the intervention group on exercise self schema compared to the control group. It is possible that simply writing about physical activity
possible selves is not sufficient for increasing exercise self-schema because people need to engage in the behaviour to begin to develop schemas for that domain. Alternatively, it is possible that people who did not hold exercise self-schemas wrote about physical activity possible selves that were not aligned with their current self-schemas and therefore the possible self remained external to their self. Future research should examine the process of change and internalization of self-schemas to examine how self-schemas can be altered.

5.5.2.2 Marker of well-being

This investigation revealed that the best possible physical activity self intervention did not have an impact on the more eudaimonic markers of well-being (i.e., subjective vitality, meaning) or the antecedents of well-being (i.e., psychological need satisfaction). Previous research using the best possible selves intervention has noted a similar pattern. Notably, the interventions have been effective for increasing the more transient hedonic type constructs such as positive affect (Layous et al., 2013; Meevissen et al., 2011; Peters et al., 2010; Sheldon & Lyubomirsky, 2006) and optimism (King, 2001; Meevissen et al., 2011; Peters et al., 2010); yet the results of the possible selves intervention on more cognitive components of well-being have been equivocal. For example, King (2001) found that individuals who wrote about their best possible selves had higher psychological well-being, yet a footnote revealed that the decomposed effect for satisfaction with life ($p < .09$) did not reach conventional statistical significance ($p < .05$). Similarly, Lyubomirsky and colleagues (2011) and Meevissen and colleagues (2011) found no overall effect for satisfaction with life after the best possible selves intervention. Finally, Seear and Vella-Brodrick (in press) noted a similar trend whereby mental well-being composed of cognitive evaluations about life did not increase after the best possible selves intervention. Despite these aberrant findings, one investigation did find that the possible selves intervention
increased flow (Layous et al., 2013). It is possible that the possible selves intervention may serve to increase hedonic components of well-being such as emotion or affect, yet remains ineffective for the more enduring long lasting feelings of eudaimonic well-being (Seear & Vella-Brodrick, in press). Given the mixed findings from previous research and the results of this investigation, future research could examine if the best possible selves intervention is targeted at increasing positive thoughts and feelings, rather than the more complex cognitive, and eudaimonic markers of well-being.

5.5.2.3 Participant motivation

Previous research has suggested that for individuals to gain the greatest increases in well-being or happiness, individuals must continue to pursue their goals (Sheldon et al., 2010) or have prior motivation to become happier (Lyubomirsky, et al., 2011). For example, Lyubomirsky and colleagues (2011) found that the best possible selves intervention was ineffective for increasing mood, satisfaction with life, and happiness; however, when the effects were decomposed they discovered that the individuals who self-selected themselves into a ‘happiness intervention’ demonstrated increases in well-being relative to the controls. This finding suggests that when participants know about the purpose of the intervention, they are more likely to see gains in well-being and that it is not a placebo effect since the control participants did not have an increase in well-being. Indeed previous successful possible selves interventions have directly told participants that they were attempting to increased happiness (Layous et al., 2013; Sheldon & Lyubomirsky, 2006). Consistent with a previous investigation that did not reveal the study purpose to participants (Peters, Meevissen, & Hanssen, 2013), it is possible that the results of this investigation did not reach statistical significance because participants were not aware that they were in a happiness intervention. Regardless, it seems prudent to determine if participants’
motivation and *a priori* knowledge of the intervention purpose is important, or if participants with higher motivation differ on some unknown variable (e.g., a personality trait such as openness; Lyubormirsky, et al., 2013).

5.5.2.4 Participant characteristics

Meevissen et al. (2011) suggested that imagining a best possible self in the future may be easier for younger individuals who have time to work on their potential future self. Furthermore, university students are thought to endorse many possible selves because their sense of self is still being established (Markus & Cross, 1986). To this end, investigators (Layous & Lyubomirsky, 2012; Layous et al., 2013; Lyubomirsky & Layous, 2013) called for more research examining the effectiveness of the possible selves intervention on participants other than university students. The current investigation used participants from the general population who had an age range of 25-65 (*M* = 42.45 years old). Another investigation using participants in their mid-thirties has also found the possible selves intervention to be ineffective for increasing positive affect (Seear & Vella-Brodrick, in press). It seem plausible to suggest that university students used in previous research may be able to imagine a myriad of possible selves that they could become whereas individuals 25-65 imagine possible selves that were already aligned with their current self. Put simply, it is possible that individuals in this investigation were imagining a possible self that is closely aligned with their current self rather than writing about something they can become. The results of this investigation, combined with the results of Seear and Vella-Brodrick (in press) suggest that best possible selves intervention may not be as effective for individuals in their 30’s and 40’s.

Alternatively, the disparate finding regarding the effectiveness of the possible selves intervention could be attributed to what the participants wrote about. For example, Hooker and
Cross (1994) found that young adults (age 24-39) and middle aged adults (aged 40-59) were more likely to report feared for health related possible selves. Although participants in this investigation were asked to write about positive hoped for possible selves, it is possible that they were writing with underlying cognitions of fear about not becoming that possible self. This may have impeded with positive feelings that should theoretically be elicited by the writing activity.

Finally, the null results could simply reflect ceiling effects, indicating that participants’ baseline well-being were already high and had little room to increase. Moreover, the participants appeared to be highly active at baseline (compared to previous research using the LTEQ; McDonough & Crocker, 2007). Previous exercise possible selves interventions that found positive effects on behaviour used participants who exercised less than 3 times per week and intended to exercise regularly in the future (Murru & Martin Ginis, 2010). Therefore, it is possible that the intervention is only effective for individuals who are currently inactive and are looking to become more active. Furthermore, results suggest that individuals in this investigation on average, reported high exercise self-schemas, supporting the contention that the participants may have already viewed themselves as exercise schematics and may therefore have had no intention of increasing their physical activity behaviour. It is possible that individuals in this investigation were merely writing possible selves about maintaining activity levels rather than adopting or increasing activity levels. Future researchers conducting possible selves interventions targeted at increasing physical activity should examine samples that are inactive and wish to become active. Based on results from Whaley (2003), it may also be useful to conduct a physical activity possible selves intervention across groups of individuals in various stages of exercise adoption, using the stages of change model.
5.5.3 Design Factors

Lyubomirsky and Layous (2013) hypothesize that dosage and variety could be factors that affect the results of positive psychology interventions. Although we selected the once a week writing activity based on previous research that suggested dosage may be best once a week (Layous et al., 2013; Lyubomirsky & Layous, 2013; Sin & Lyubomirsky, 2009), it is possible that the intervention effect was “watered down” (Lyubomirsky & Layous, 2013, p. 2) or that the dosage would have been better if it was self-selected by the participants. For example, one study that examined users of a happiness increasing iPhone application reported that participants who accessed and practiced the positive psychology interventions more frequently had greater gains in well-being (Parks, Della Porta, Pierce, Zilca, & Lyubomirsky, 2012). Alternatively, it is possible that there was not enough variety in the writing activity because participants were given the same writing instruction each week for 4 weeks. Although the participants were told they could write about the same thing each week or write about something different, it is possible that the participants experienced hedonic adaptation to the writing instructions. Future research should examine the effect of changing the writing instructions. For example, in the first week, participants could be instructed to write about physical activity and how it makes them feel. In the second week, participants could be instructed to write about physical activity and how it effects their physical health.

Another explanation for the null findings could be attributed to the length of the intervention. Boehm et al., (2012) suggested that short term positive psychology interventions ranging from 1-12 weeks may not be sufficient for increasing health behaviour changes. Although the results of Murru and Martin Ginis’ (2010) intervention supported the effectiveness of a one time manipulation, it is conceivable that in a sample of individuals wishing to become
more active, a one time intervention is enough to propel behaviour. Given that participants in the
current investigation were drawn from the general population regardless of prior activity levels it
could indicate that a longer intervention is needed to produce change when individuals do not
possess explicit intention to change. Designing a long term intervention would require careful
planning to reduce hedonic adaption, ensuring that there is variety for participants to remain
motivated to participate (Boehm et al., 2012). It would be worthwhile to examine the dosage and
variety of the possible selves intervention in future research.

Finally, it is possible that the timing of the post-intervention assessment influenced the
results of this investigation. In order to reduce demand effects, the current intervention had a 1
week delay from the last writing activity to post intervention assessment. Previous interventions
employed post-intervention assessments immediately following the writing activity (Layous et
al., 2013; Sheldon & Lyubomirsky, 2006). It is conceivable that the results of this investigation
did not significantly increase well-being or behaviour because the post-test occurred 1 week after
the last writing activity. Although attempts have been made to examine the effect of the possible
selves intervention over a longer period of time, long term results often fail to research statistical
significance ($p > .05$; Lyubomirsky et al., 2011; Peters et al., 2013). This finding suggests that
future research should examine if the best possible selves intervention elicits a demand effect or
reliably increases affective states or moods.

5.5.3.1 Instruments and primer script

Another limitation of this investigation was the use of self-report instruments that are
susceptible to response bias and particularly social desirability responding (Nigg et al., 2012).
Notably, the assessment used for physical activity was based on self-report data. Future research
may benefit from the use of accelerometers or from the use of triangulation (Treuth, 2002).
Triangulation involves the inclusion of three different methods for measuring physical activity such as self-report, diary, and accelerometers. Biological markers of well-being or other reports (e.g., informant reports, experience sampling) could also be employed to examine the effects of the intervention on physical health (Ryff & Burton, 2013).

A final consideration for explicating the results of this study involves the psychological need satisfaction primer script. Individuals assigned to the best physical activity possible self group plus psychological need primers did not experience greater perceptions of psychological need satisfaction. Our primer script was based on Sheldon and Filak’s (2008) psychological need satisfaction primer scripts. It is possible that reading the script alone was not sufficient to illicit feelings of competence, autonomy, or relatedness satisfaction. Layous and colleagues (2013) contend that if participants were prompted to pursue their goals, it may foster psychological need satisfaction during the possible self intervention. Indeed, Sheldon and colleagues (2010) found that participants who pursued autonomy and relatedness satisfaction goals had greater sustained increases in well-being. Future research interested in a best possible physical activity self intervention may wish to examine the role of implementation strategies and examine if participants pursue their best possible self.

5.6 Conclusion

Although this investigation examined a novel intervention using a controlled experimental design, the results indicated that the best possible physical activity self intervention was largely unsuccessful for increasing psychological need satisfaction, well-being and physical activity behaviour. There was one statistically significant finding that indicated that participants assigned to the best possible physical activity selves groups experienced greater positive affect one week after the writing intervention compared to the control group. Future research is needed
to further elucidate this finding. It is possible that this intervention was unsuccessful because of
the highly active general population used, the dosage and repetitiveness of the writing
instructions, or because positive psychology interventions are more successful when the
participants know the purpose of the intervention (Lyubomirsky et al., 2011).
Figure 5. 1 Flow Chart of Participants Through The Study
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*Note. p < .05. PA = Positive Affect, NA = Negative Affect, LTEQ = Leisure Time Exercise Questionnaire, DesESS = descriptive exercise self-schema, ImESS = importance exercise self schema. Time 1 and 2 n’s range from 52-53. Time 3 n’s range from 43-45. Coefficient Alpha is located along the diagonal.*
Table 5. 2 Descriptive Statistics from the Repeated Measures ANOVA

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<th></th>
<th>Pre/Post (N = 53)</th>
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<td>0.01</td>
<td>Int</td>
<td>5.51(1.17)</td>
</tr>
<tr>
<td></td>
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*Note. Unless otherwise noted, across pre/post-test, the BP group had a sample size of 34 and the control group had a sample size of 19 and across pre/post/follow up the BP group had a sample size of 29 and the control group had a sample size of 16. Int = intervention groups (both PBP and PBP+ combined), C = control group. LTEQ = Leisure Time Exercise Questionnaire. DesESS = descriptive exercise self-schema. imESS = importance exercise self-schema. η² = eta squared*
CHAPTER 6: General Discussion

This program of research contributes novel information to the literature about the role psychological need satisfaction plays in association with well-being and physical activity behaviour. Results from 4 investigations supported the salience of competence, autonomy, and relatedness satisfaction in physical activity and supported theoretical tenets (Deci & Ryan, 2000) that facilitating psychological need satisfaction during physical activity is associated with psychological well-being and physical activity behaviour. This program of research highlights the importance of setting intrinsic goals for physical activity, being autonomously motivated to engage in physical activity, and the role that descriptive exercise self-schema plays in promoting psychological need satisfaction. Results of a best possible physical activity intervention indicated that a writing intervention, contrary to hypotheses, was largely unsuccessful at increasing self-schemas, psychological need satisfaction, well-being, and physical activity behaviour. Although this program of research contributes to the body of literature highlighting the key role psychological need satisfaction has in promoting well-being and physical activity behaviour, future research is warranted to investigate strategies and interventions that could be used to enhance psychological need satisfaction.

6.1 Synthesis of Study Findings

Taken together, the results of studies 1 through 3 provided evidence that psychological need satisfaction during physical activity is (a) a salient construct that can be assessed using scores from a modified version of the PNSE (the PNSE-PA), and (b) is associated with EWB, HWB and physical activity behaviour. Study 1 examined the psychometric properties associated with scores from the PNSE-PA. Measurement experts have extolled the importance of examining score validity when an instrument is used within a different context or sample (Kane, 2013).
Therefore, examining score validity and reliability was deemed an important preliminary investigation to conduct prior to examining variables associated with psychological need satisfaction because researchers (McDonough & Crocker, 2007; Peddle et al., 2008) have documented concerns with modifying the PNSE from its original context of structured exercise. Furthermore, examining score validity and reliability is an important step in any research endeavour such that inferences made from the scores are meaningful (Gunnell, Shellenberg, et al., forthcoming; Zumbo, 2009). The results obtained from study 1 indicated that scores from the PNSE-PA could be used to assess perceptions of competence, autonomy, and relatedness experienced during physical activity in a sample of participants drawn from the general population. This is important because the PNSE-PA produced meaningful scores with minimal error variance and indicated it could assess perceptions of psychological need satisfaction in physical activity contexts.

Having documented preliminary support for the utility of PNSE-PA scores to assess perceptions of competence, autonomy, and relatedness experienced during physical activity, the purpose of study 2 was to examine a model of SDT wherein changes in relative intrinsic goals → changes in motivation → changes in psychological need satisfaction → changes in well-being and physical activity. Indirect effects were examined to determine the mediating role of psychological need satisfaction. Researchers examining tenets outlined within GCT, OIT, and BPNT in exercise contexts have supported the use of 1 or 2 of the mini-theories for predicting outcomes such as well-being and physical activity behaviour (Edmunds et al., 2006; Gillison et al., 2006; Ingledew & Markland, 2009; Sebire et al., 2009; Wilson & Rogers, 2008), but few investigations have examined the utility of using all three mini-theories simultaneously to account for variation in well-being and physical activity behaviour. Specifically, researchers
examining goal contents and motivation have typically assumed that the process is facilitated by psychological need satisfaction rather than directly testing the role of psychological need satisfaction (Ingledew & Markland, 2009). Therefore, study 2 represented a novel contribution to the literature because it sought to (a), test 2 hypothesized sequences of how constructs housed within the 3 mini-theories incrementally predict change in well-being and physical activity, and (b) understand the mediational role of psychological need satisfaction. Results supported the hypothesized sequence wherein changes in relative intrinsic goals \( \rightarrow \) changes in motivation \( \rightarrow \) changes in psychological need satisfaction \( \rightarrow \) changes in well-being and physical activity over 6 months. Psychological need satisfaction mediated the relationships between changes in autonomous motivation and changes in well-being. Moreover, changes in competence satisfaction emerged as a significant independent mediator in the relationship between changes in autonomous motivation and changes in physical activity behaviour.

When examining the indirect effects in the relationship between relative intrinsic goals and well-being, results in study 2 generally revealed indirect effects though autonomous motivation, competence and relatedness satisfaction. Finally, when examining the relationship between relative intrinsic goals and physical activity, an indirect effect emerged for autonomous motivation through competence satisfaction. As such, results from study 2 supported the hypotheses that changes in relative intrinsic goals positively predict autonomous motivation and negatively predict controlled motivation. In turn, changes in autonomous motivation increased perceptions of competence, autonomy, and relatedness, and subsequently, increased well-being and physical activity behaviour.

Researchers examining sequences of SDT often specify psychological need satisfaction as the antecedent to motivation (e.g., McDonough & Crocker, 2007; Milyavskaya & Koestner,
Interpretation of the alternative model based on previous research revealed a poor fit to the data, indicating that in the current sample, changes in motivation precedes changes in psychological need satisfaction. As such study 2 contributed unique information to the evidence base informing the sequence in which changes in individual psychological need satisfaction variables facilitates changes in well-being and physical activity behaviour.

Ryan and Deci (2011) contend that another important construct for predicting well-being and behavioural engagement is identity and the self. Identities are thought to be formed because of opportunities to satisfy competence, autonomy, and relatedness needs (Ryan & Deci, 2011). Two constructs that are closely aligned with the concept of identity are: self-schemas and possible selves (future oriented self-schemas; Berry et al., 2013; Strachan & Whaley, 2012). Ryan (1995) and Deci and Ryan (2000), describe self-schemas and possible selves as ranging along the self-determination continuum from autonomously motivated or externally regulated, with the degree of internalization dependent on the degree of psychological need satisfaction. In other words, the more an individual satisfies their psychological needs, the more likely the self-schema will be self-determined. Moreover, possible selves and self-schemas are thought to be related to motivation and intrinsic goal contents (Markus & Nurius, 1986). Therefore, based on the findings from study 2 regarding the role of autonomous motivation, relative intrinsic goals, and psychological need satisfaction for predicting well-being and physical activity behaviour a best possible physical activity self intervention was conducted (study 4). Prior to examining the results of the intervention, baseline data provided by participants who began the intervention were analyzed in study 3.
The purpose of study 3 was to conduct a preliminary investigation to examine the relationship between exercise self-schema and well-being and physical activity behaviour, through the indirect effect of psychological need satisfaction. Based on cross-sectional analysis, the results supported the contention that the descriptive component of exercise self-schema was positively associated with competence, autonomy, and relatedness satisfaction, and in turn, well-being and physical activity behaviour. Study 3 represents one of the first investigations conducted in the SDT literature to directly test, and find support for Ryan and Deci’s (2011) contention regarding the role of psychological need satisfaction in self-schema development. It is important to note however, that caution should be taken because the results of the analysis do not infer causality.

Building on the results from studies 2 and 3 the purpose of study 4 was to test the effect of a ‘best possible physical activity self’ intervention on outcome variables such as exercise self-schemas, psychological need satisfaction, well-being, and physical activity behaviour. The intervention was generally unsuccessful at increasing exercise self-schemas, psychological need satisfaction, well-being, or physical activity behaviour across pre-test/post-test and pre-test/post-test/follow-up. As discussed in chapter 5, there were several limitations to the intervention and future recommendations were forwarded. Continued inquiry into issues surrounding sample (undergraduate students vs. general population), measurement, and dosage are required for the physical activity possible selves intervention.

6.1.1 Antecedents of Psychological Need Satisfaction

Deci and Ryan (2000) contend that there are many variables that can lead to psychological need satisfaction or thwarting. Emphasizing the dialectic nature of SDT, Ryan and Deci (2002) acknowledge that humans are active and growth oriented - meaning that they will
naturally seek out opportunities for growth and psychological need satisfaction; however, humans are also influenced by the social environment in which they find themselves.

Researchers in sport and exercise contexts have supported Ryan and Deci’s (2002) hypotheses that environmental factors such as autonomy support provided in a social context can facilitate (or thwart) basic psychological needs, and in turn differentially influence well-being (or ill-being; Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Edmunds et al., 2006; Ng et al., 2012). This program of research examined the other side of the dialectic coin of SDT: the natural integrative tendencies humans pursue such as goals, motives, self-schemas, and possible selves as antecedents to psychological need satisfaction.

Deci and Ryan (2000) hypothesize that humans will develop identities or self-schemas, and pursue many types of goals with various underlying motivations to achieve satisfaction of competence, autonomy, and relatedness needs within a domain. That is, within SDT, goals, motivation, self-schemas, and possible selves can be seen as vehicles to psychological need satisfaction (or thwarting; Deci & Ryan, 2000; Ryan & Deci, 2000). Testing these assertions, this program of research found support that in physical activity contexts, describing yourself as exercise self-schematic and pursuing physical activity goals for intrinsic reasons relative to extrinsic reasons such as for health and social affiliation positively predicted autonomous motivation to participate in physical activity which in turn resulted in greater psychological need satisfaction. Taken together, this program of research highlights the role that relative intrinsic goals, autonomous motivation, and descriptive exercise self-schemas may play as antecedents in facilitating psychological need satisfaction in physical activity.

Not all of the findings presented in studies 2-4 supported the study hypotheses regarding the antecedents of psychological need satisfaction. Contrary to hypotheses, controlled motivation
was not associated with a lack of psychological need satisfaction. Recently, Bartholomew and colleagues (2011) have distinguished active psychological need thwarting from lack of need satisfaction. The finding that changes in controlled motivation did not negatively predict changes in psychological need satisfaction could be the result of measurement instruments used to assess psychological need satisfaction. In other words, the PNSE-PA assesses perceptions of psychological need satisfaction not psychological need thwarting. Therefore, our hypotheses were specific to controlled motivation predicting a lack of psychological need satisfaction rather than psychological need thwarting. Future research should examine whether controlled motivation predicts changes in psychological need thwarting directly.

Another aberrant finding was that the importance component of exercise self-schema was not associated with psychological need satisfaction in the combined predictive model. As suggested in chapter 4, it is possible that the descriptive exercise self-schema component is more salient for predicting psychological need satisfaction because the descriptive items tap into the more integrated traits an individual possesses whereas the importance items tap into outwardly focused ruminations or thoughts about exercise, regardless of if they describe the individual (Vlachopoulos, et al., 2011; Wilson & Muon, 2008). Notwithstanding, bivariate correlations between psychological need satisfaction and the importance exercise self-schema component were statistically significant and suggest that suppression could have been effecting the results of the structural model. Future research is needed to further examine the role of importance exercise self-schemas in association with psychological need satisfaction.

Based on previous research (Layous et al., 2013; Sheldon & Lyubomirsky, 2006) it was hypothesized that a best possible selves intervention would increase perceptions of psychological need satisfaction. Despite our hypothesis, the best possible physical activity self intervention was
unsuccesful at increasing psychological need satisfaction. Based on theory, results obtained from study 3, and given assertions that positive psychology interventions could facilitate perceptions of psychological need satisfaction (Layous et al., 2013), it was surprising that the intervention had no effect on psychological need satisfaction, even in the group of individuals who received psychological need satisfaction primers. As outlined in chapter 5, there are numerous plausible explanations why this intervention failed to increase psychological need satisfaction. For example, simply writing about need satisfying possible physical activity selves may not be enough to engender greater perceptions of need satisfaction. Layous and colleagues (2013) suggested that for the intervention to successfully increase psychological need satisfaction, participants may have to physically pursue their possible selves. Alternatively, it is possible that the psychological need satisfaction primer script was not sufficient for increasing perceptions of psychological need satisfaction while writing about a physical activity self. Overall, the best possible physical activity self intervention was not seen as a useful method for changing psychological need satisfaction.

6.1.2 Outcomes of Psychological Need Satisfaction

6.1.2.1 Well-being

Numerous investigators have found support for claims made within SDT that psychological need satisfaction in sport and exercise is associated with greater well-being (Adie et al., 2012; Edmunds et al., 2007; Gunnell et al., 2013; Gunnell et al., 2011; Mack et al., 2012; McDonough & Crocker, 2007; Reinboth & Duda, 2006; Sylvester et al., 2012; Wilson et al., 2006). Studies 2 and 3 of this program of research also supported these contentions, and extend the body of knowledge by examining unique antecedent variables (e.g., goal contents, motivation, self-schemas), examining general physical activity contexts (vs. exercise or sport
only), and by using participants from a general population rather than university students. Results of the current program of research indicate that a small to moderate proportion of the variance (between 7 and 49%) in well-being outcomes was accounted for by psychological need satisfaction, relative intrinsic goals, motivation, and especially exercise self-schema.

Examining the independent contribution of each psychological need satisfaction variable revealed a pattern of results consistent with previous research. Using vitality and meaning as indicators of EWB, the results of studies 2 and 3 suggested that competence and relatedness satisfaction appear to be unique and salient psychological needs associated with EWB. It was, however, surprising that autonomy did not emerge as a significant predictor of EWB in the predictive models given tenets made by Ryan and colleagues (2009) and findings by Mack et al., (2012) who suggested that perceptions of autonomy are a necessary perquisite for EWB. Examination of the bivariate correlations indicated that it is possible that perceived competence or relatedness washed out the independent effect attributable to autonomy satisfaction. Consistent with previous investigations, competence and relatedness satisfaction emerged as significant predictors when positive affect served as an indicator of HWB (Mack et al., 2012; McDonough & Crocker, 2007; Sylvester et al., 2012; Wilson & Bengoechea, 2010). Finally, Sheldon and colleagues (2001) have suggested that psychological need satisfaction may be best suited for predicting well-being outcomes rather than negative outcomes. Indeed, one recent investigation supported Sheldon and colleagues (2001) claims and found no association between negative affect and psychological need satisfaction (Sylvester et al., 2012). Consistent with McDonough and Crocker’s (2007) results, when negative affect served as the indicator of HWB, only autonomy (in studies 2 and 3) and competence (in study 3) significantly negatively predicted negative affect. Evidently, the results obtained herein and from previous investigations
suggest that more research is needed to understand why certain psychological needs emerge as significant predictors of well-being while others do not. Alternatively, researchers could examine the utility of examining an overall need satisfaction composite variable as has been done in previous research (e.g., Sebire et al., 2009).

6.1.2.2 Physical activity

Although Deci and Ryan (2011) contend that psychological need satisfaction also provides the energy and direction necessary to engage in behaviour, researchers have been slow to directly test these assertions. More commonly, investigators have examined behavioural regulations as predictors of physical activity engagement (Brunet & Sabiston, 2011; Daley & Duda, 2006; McDonough & Crocker, 2007; Wilson, Rodgers, Fraser et al., 2004). Based on their review articles, Wilson, Mack, Gunnell, and colleagues (2008) and Teixeira and colleagues (2012) have suggested that psychological need satisfaction is associated with physical activity behaviour. The current program of research adds to this emerging area of research and supports Deci and Ryan’s (2011) hypothesis that fulfilling psychological needs in a physical activity context is positively associated with physical activity behaviour (study 3) and changes in physical activity behaviour (study 2). Moreover, the models in studies 2 and 3 accounted for 7% and 29%, respectively, in physical activity, a robust finding given the small variance accounted for in previous research (R² = .04, McDonough & Crocker, 2007; R² = .18, Edmunds et al., 2006).

When considering physical activity as the outcome of interest, individual psychological need satisfaction variables emerged as more salient than others. For example, in both studies 2 and 3, competence satisfaction emerged as a unique predictor of physical activity behaviour.
This is not surprising given previous research findings obtained in review articles (Teixeira et al., 2012; Wilson, Mack, Gunnell et al., 2008) and a meta-analysis of health behaviours (Ng et al., 2012) that indicated the strongest association between exercise behaviour and psychological need satisfaction emerged for competence. Furthermore, researchers using alternative theoretical frameworks such as Social Cognitive Theory (Bandura, 1997) have consistently linked self-efficacy (similar to competence) with exercise behaviour (McAuley & Blissmer, 2000). In addition to competence satisfaction, in study 3, autonomy satisfaction emerged as having a significant association with physical activity behaviour. This finding is consistent with theory (Deci & Ryan, 2000; Ryan & Deci, 2000) yet represents a novel finding in the physical activity literature. It is possible that autonomy emerged in study 3 because study 3 did not include an assessment of autonomous motivation. Researchers should cross-validate and further explore the autonomy satisfaction-physical activity link.

Relatedness satisfaction was not associated with physical activity in the expected direction in study 3. The lack of association between relatedness and physical activity could be due to the fact that majority of the participants used in this program of research were in the maintenance stage of physical activity (Edmunds et al., 2007). Based on assertions by Deci and Ryan (2000) regarding the more distal role of relatedness, it may be that relatedness is more important for exercise initiates and less important for those already adhering to a physical activity program (Edmunds et al., 2007). Based on these overall research findings from this program of research and those of previous SDT based research findings (c.f. Teixeira et al., 2012) and research using Social Cognitive Theory (McAuley & Blissmer, 2000; McAuley, Mailey, Szabo, & Gothe, 2013) it seems reasonable to suggest that perceptions of competence during physical activity lead to greater physical activity engagement.
6.1.3 Psychological Need Satisfaction as a Mediator

Researchers have called for further inquiry into the mechanisms responsible for increasing well-being through physical activity (Fox, 1999; Netz et al., 2005). Answering these calls using SDT, a few investigators have examined psychological need satisfaction as the vehicle that transmits the effect between physical activity and well-being (Gunnell et al., 2011; Mack et al., 2012; Sylvester et al., 2012), between autonomy support and well-being (Adie et al., 2012), and between goal contents and well-being (Sebire et al., 2009). However, we are not aware of any published research that has examined the mediational role of psychological need satisfaction between independent variables such as relative intrinsic goal contents, motivation, exercise self-schemas, possible selves, and outcomes such as well-being or physical activity behaviour. Consequently, this program of research provides novel information to the literature informing well-being and physical activity research. Studies 2 and 3 revealed that satisfaction of all three psychological needs served as mediators between relative autonomous motivation and descriptive exercise self-schema \(\rightarrow\) well-being. This finding is consistent with previous theoretical tenets (Deci & Ryan, 2011; Deci & Ryan, 2000; Ryan et al., 2013) and highlights the critical role that fulfilling psychological need satisfaction plays in promoting well-being.

In studies 2 and 3 satisfaction of all three psychological needs produced an indirect effect between select independent variables and the dependent variables; yet, examination of specific indirect effects revealed a pattern such that satisfaction of certain psychological needs appeared as unique contributors above and beyond satisfaction of other psychological needs. Specifically, across studies 2 and 3, competence satisfaction was an important need for predicting both EWB and HWB. Competence has emerged in previous investigations as a salient psychological need in exercise contexts (Ng et al., 2012; Teixeira et al., 2012; Wilson, Mack, Gunnell et al., 2008).
Combining the results of this investigation and previous research, the accumulating evidence for the critical role of competence for predicting well-being is mounting and indicates that facilitating perceptions of competence may be one important avenue implicated in increased well-being and physical activity.

Researchers examining exercise contexts often document a lack of relationship with relatedness as a variable predicting well-being (Wilson, Longley et al., 2006) in the presence of competence and autonomy. In study 2, however, relatedness satisfaction emerged as a significant predictor of EWB and HWB. This finding is novel and was replicated in study 3 for the relationship between importance ESS and meaning. This result could be the result of the context queried (i.e., general physical activity as opposed to structured exercise). Indeed, two recent investigations have found support for relatedness when predicting well-being in the context of health-enhancing physical activity (vs. structured exercise; Mack et al., 2012; Sylvester et al., 2012). In explicating this finding, Teixeira and colleagues (2012) suggested that exercise could be performed with solitary pursuits whereas the more general context of physical activity could include team sports and group activity. Alternatively, relatedness could have emerged as a significant predictor of well-being in study 2 because change scores were analyzed rather than a cross-sectional analysis, indicating that perhaps over time, relatedness becomes more important to well-being. The finding that relatedness emerged as a significant predictor of meaning but not subjective vitality or affect in study 3 suggests that relatedness may be more salient for the more cognitive evaluative sources of well-being such as meaning rather than the affective type operationalizations of EWB such as subjective vitality (Fowers et al., 2010).

With regard to the mediational role of psychological need satisfaction when the outcome variable was physical activity, no overall indirect effect was observed. Notwithstanding, a
significant overall indirect effect is not needed to examine specific indirect effects (Hayes, 2013; Hayes, 2013; Rucker, Preacher, Tormala, & Petty, 2011). When specific indirect effects were examined, competence emerged as a significant mediator between changes in autonomous motivation and physical activity and between descriptive exercise self-schema and physical activity behaviour and between relative intrinsic goals and physical activity through autonomous motivation. In the past, researchers have found that competence satisfaction predicts exercise (Edmunds et al., 2006) and sport performance (basketball; Sheldon et al., 2013). Taken together, results of the current investigation indicate that although no total indirect effect was found for all three psychological needs, competence satisfaction in physical activity contexts appears to be a dominate psychological need for predicting both well-being and physical activity.

6.2 Contributions of the Research

There are several contributions that this program of research has made to the bourgeoning body of literature examining tenets outlined within SDT in physical activity contexts. These include the examination of eudaimonic and hedonic well-being, testing 3 SDT mini-theories simultaneously, examining self-schemas through the lens of SDT, testing a novel possible selves intervention and finally, examining physical activity contexts rather than structured exercise.

6.2.1 Eudaimonic and Hedonic Well-Being

Researchers are increasingly acknowledging the independent role that EWB and HWB well-being play in promoting physical health (Ryff & Burton, 2013). Notably, it has been argued that HWB is not as sustainable as EWB, and that pursuing eudaimonia leads to longer, more persistence feelings of meaning, (Huta & Ryan, 2010). One viable route for increasing overall well-being could be to pursue eudaimonic activities because HWB is thought to be a by-product of EWB (Waterman et al., 2008). To this end, Ferguson and colleagues (2012) found that simply
engaging in physical activity did not increase EWB, but rather experiencing eudaimonia during physical activity was associated with EWB. Indeed, a qualitative component to Ferguson and colleagues investigation found that participants felt that their physical activity led to greater EWB. Theorists argue that intrinsic motivation, intrinsic goals, internalized self-schemas, and psychological need fulfillment are thought to increase experiences of EWB; however, no discernible pattern was noted in this program of research when predicting the outcomes of EWB and HWB based on the aforementioned variables. Indeed, through study 2 and 3, relative in intrinsic goals, autonomous motivation and the descriptive component of exercise self-schema predicted both HWB and EWB through the indirect effect of satisfying psychological needs. At this point, it is difficult to disentangle the complex relationships between EWB and HWB. It is possible that autonomous motivation, relative intrinsic goals, descriptive exercise self-schemas and psychological need satisfaction equally contributed to both EWB and HWB. Alternatively, it is possible that the aforementioned variables contributed to EWB, and as consequence, participants experienced HWB.

6.2.2 Testing Three SDT Mini-Theories Simultaneously

Investigators examining well-being and physical activity have examined sequences of motivation based on 1 or 2 mini-theories posited within SDT, and generally used cross-sectional designs. Study 2 combined 3 mini-theories of SDT to examine how change across 6 months in SDT constructs predicts well-being and physical activity. Moreover, researchers have typically examined psychological need satisfaction as an antecedent to motivational regulations (McDonough & Crocker, 2007; Ng et al., 2012; Wilson & Rogers, 2008); however, that sequence is not wholly consistent with tenets outlined in BPNT wherein psychological need satisfaction is thought to directly predict well-being. As such, study 2 represents one of the first
investigations to provide evidence for a sequence in which changes in relative intrinsic goals → changes in motivation → changes in psychological need satisfaction → changes in well-being and physical activity.

6.2.3 Self-Schema as Conceptualized Within SDT

Although some investigators have examined how self-schemas relate to motivation using SDT (Bober & Grolnick, 1995; Saebu & Sørensen, 2011), few have examined the utility of examining exercise self-schemas in direct relation to psychological need satisfaction. Findings from study 3 supported Ryan and Deci’s (2011) contention that individuals’ self-schemas are associated with their satisfaction of competence, autonomy, and relatedness needs. In turn, psychological need satisfaction was found to carry the indirect effect of the relationship between descriptive components of exercise self-schemas and well-being and physical activity behaviour. These results suggest that opportunities to satisfy psychological needs may produce the effect between self-schema and well-being or physical activity, although causality cannot be inferred from the cross-sectional design. Therefore researchers should target perceptions of psychological need satisfaction in an effort to bolster exercise self-schema. This finding is in stark contrast to the strategies Kendzierski (1988) outlined to facilitate the adoption of exercise self-schemas. Basing her suggestions on previous research about the material self (Swann, 1983), Kendzierski (1988) suggested that individuals may be able to become exercise self-schematics by purchasing equipment (e.g., jogging shoes, jogging t-shirts, jogging magazines etc.). From an SDT perspective, focusing on material objects may undermine autonomous motivation and foster external or introjected forms of regulation, characterized by psychological need thwarting or lack of psychological need satisfaction. The finding that exercise-self-schema was related psychological need satisfaction is novel and warrants further consideration as a possible
mechanism applicable to increasing exercise self-schemas. Moreover, researchers should conduct investigations that allow them to systematically examine the relationships between exercise self-schema, psychological need satisfaction, and well-being.

Another novel contribution emanating from this investigation was the examination of score validity and reliability for the exercise self-schema scale used as a continuous variable. Although researchers have employed the exercise self-schema scale as a continuous measure (Banting et al., 2009; Berry et al., 2013; Sheeran & Orbell, 2000), our results are the first to provide empirical support for score validity and reliability of a 2-factor correlated measurement model of exercise self-schemas. This finding is particularly meaningful because researchers have argued that when instruments are modified from their original use, evidence of score validity must be demonstrated to have any faith in the interpretation of the results (Gunnell, Schellenberg, et al., forthcoming).

6.2.4 Testing a Novel Intervention

Study 4 examined the effectiveness of the possible selves intervention tailored to physical activity and tailored to directly test psychological need satisfaction primers. The best possible physical activity self intervention has only been evaluated as a one-time manipulation, using university student who want to become more active (Murru & Martin Ginis, 2010). Moreover, psychological well-being has not been assessed as an outcome associated with the best possible physical activity self intervention. Although the intervention was largely unsuccessful, it examined participants from the general population regardless of baseline physical activity levels and it examined psychological well-being. Finally, the intervention attempted to directly manipulate psychological need satisfaction through the use of primers. Although primers have
been used in previous SDT research (Sheldon & Filak, 2008), primers have yet to be employed in possible selves interventions.

6.2.5 The Use of Psychological Need Satisfaction Primers

Another critical contribution made to the possible selves intervention literature base was the use of psychological need satisfaction primers in an attempt to directly manipulate perceptions of psychological need satisfaction. Although investigators using SDT based interventions have attempted to manipulate psychological need satisfaction through the use of autonomy support, structure, and interpersonal involvement (Edmunds et al., 2008), few researchers have attempted a simple direct manipulation of psychological needs through scripts such as the manipulation employed in Sheldon and Filak’s (2008) investigation. Furthermore, Michie and Abraham (2004) have argued that a critically important element of theory based interventions is to examine the causal mediating structures responsible for the intervention effect. One method of manipulating variables that has been used in SDT research is to prime, or subliminally prompt certain cognitions (Deci & Ryan, 2012). The intervention employed herein represented a test of SDT because it attempted to examine the effect of a psychological need satisfaction primer script used in one treatment group compared to the other treatment group and a control group. To our knowledge, there is only one other investigation that has used a primer script in an attempt to directly manipulate psychological need satisfaction, and therefore, directly test tenets of SDT (Sheldon & Filak, 2008). Although the intervention was generally unsuccessful at changing outcomes, the design of the intervention represented a test of both theory and the effects of the intervention.
6.2.6 Physical Activity vs. Exercise

Researchers examining SDT variables have typically examined sport contexts or structured exercise rather than the more general domain of physical activity. Ryan (1995) has made a cogent argument for the examination of specific domains where different forces could be acting to influence psychological need satisfaction. With the accumulation of evidence for SDT in exercise (Edmunds et al., 2006; Edmunds et al., 2007; Wilson & Rogers, 2008; Wilson, Longley, et al., 2006) and sport contexts (Adie et al., 2012; Reinboth et al., 2004; Reinboth & Duda, 2006), a logical next step was to examine a more global domain of physical activity that includes both exercise and sport. Structured exercise represents a component of physical activity and is characterized by repetitive, goal oriented movement, typically with a specific goal such as fitness (Bouchard et al., 2012). Sport is a form of physical activity as well, but it typically contains a competitive component (Bouchard et al., 2012). Physical activity on the other hand, is defined as any movement produced by skeletal muscles that increases energy expenditure above resting rate (Bouchard et al., 2012). Therefore, under the categorization of physical activity, individuals work activity (e.g., lifting, walking), commuting activity (e.g., bicycle transportation), leisure activity (e.g., gardening), sport, and exercise contributed towards the accumulation of physical activity. In other words, by measuring only exercise, researchers are imposing a narrow and restrictive assessment of energy expenditure. Indeed, Caspersen, and colleagues (1985) contend that the different subcategories of physical activity may have differential effects of fitness and health. Consequently, it is important to examine more general physical activity contexts to gain a better understanding of how different antecedent variables relate to different outcomes.
6.3 Methodological Implications

6.3.1 The Unique Contribution of Satisfying Each Psychological Need

Within SDT, Ryan and Deci (Deci & Ryan, 2000) assert that all three psychological needs independently contribute to positive outcome such as well-being and behaviour. Sheldon and colleagues (2013) contend that examining a composite score of psychological need satisfaction comprised of the average of all three psychological needs can mask relevant and unique findings. Testing these assertions, several researchers have found evidence that psychological needs independently contribute to outcomes (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000; Sheldon et al., 2001) and certain needs emerge in physical activity contexts as more salient in the presence of the other psychological needs (Adie et al., 2012; Gunnell et al., 2011; Mack et al., 2012). Results from previous investigations corroborate the current findings and highlight the importance of examining each psychological need independently. Consistent with previous research (Gunnell et al., 2011; Mack et al., 2012; Reinboth & Duda, 2006), results from studies 2 and 3 suggest that satisfying certain psychological needs may contribute unique information above and beyond other psychological needs in physical activity contexts, particularly competence satisfaction. This program of research emphasizes the unique role that satisfaction of each psychological need plays in physical activity contexts and supports the growing evidence base suggesting that when all three psychological needs are considered simultaneously perceived competence is a particularly important need for well-being and physical activity behaviour outcomes. Researchers examining the role of psychological need satisfaction in the future may wish to examine psychological needs separately rather than creating an overall composite need satisfaction variable to further elucidate the role of each psychological need. Moreover, at this stage, research is needed to examine why certain
psychological needs emerge above others. It is possible that sample or measurement errors are contributing to these findings.

6.3.2 Measurement, Data Analysis, and Design

In order to have confidence in the inferences made from the results of a study, the investigation should have a solid methodological foundation. The investigations comprising this program of research used a variety of research designs to answer the overall research question regarding the role of psychological need satisfaction. The first study examined the psychometric properties of the PNSE-PA. This investigation compared the original PNSE in undergraduate university students to the PNSE-PA in a sample from the general population. Furthermore, a third sample of individuals with osteoporosis was used to examine invariance of the scores from the PNSE-PA across populations. Examining multiple components of score validity contributes to the ongoing process of score validation and adds evidence to the validity argument that can be made for scores of the PNSE-PA (Kane, 2013). Moreover, each investigation presented herein examined sources of score reliability and validity evidence for each instrument used. This was an important step in each investigation as conclusions derived from each investigation have little merit if scores from the instrument used did not possess sound psychometric properties (Gunnell, Shellenberg, et al., forthcoming; Hubley & Zumbo, 1996). Consequently, each investigation presented in this program of research provided at least some evidence of score validity or reliability.

The second advantage of study 1 was the method in which the data were analyzed. First, the data were considered categorical in nature given the 6 point Likert scale format. As such, polychoric correlation matrices were analyzed using robust maximum likelihood estimation to estimate the measurement models. Using polychoric correlation matrices is advantageous
because research has shown that treating ordinal data as continuous and using the Pearson correlation matrix can lead to inflated chi-squared values and lower parameter coverage of the factor loadings (Lubke & Muthen, 2004). Second this investigation tested measurement invariance using a means and covariance approach (MACS) rather than the commonly used covariance structures approach (Wu et al., 2007). Had the MACS approach not been used, differences across subsamples caused by unequal intercepts would not have been found. The finding of unequal intercepts indicates that means across studies should not be directly compared without caution. As such, study 1 represented an examination of scores from the PNSE-PA that was able to uncover potential bias in item intercepts across instrument formats and populations.

Another important factor to consider when evaluating the inferences made from research is the design employed to answer the research question. In study 2, the research question was specific to change. As such, a 2 time point design over 6 months was employed. As commonly used in social sciences (Zumbo, 1999), the 2 time point design allows for the analysis of change scores. In light of the debate regarding the use of difference scores due to their perceived low reliability compared to the reliability of the two base measures (Thomas & Zumbo, 2012; Zumbo, 1999), recommendations by Zumbo (1999) were followed prior to analyzing our data. First, Zumbo (1999) demonstrated that there is nothing inherently wrong with the difference score and that most previous research stating the contrary assumed little to no individual differences (variation) in change. Second, Zumbo (1999) provided a decision rule based on the correlations between time 1 and time 2 and the ratio of standard deviations. Based on those results, the residualized change score was calculated and robust methods to attenuate non-normality were employed (Zumbo, 1999). Examining change in SDT constructs represents an important contribution to the literature since the majority of investigations have been cross-
sectional in nature (Teixeira et al., 2012). Within SDT, individuals are thought to be active and
growth oriented, and such growth is a dynamic process facilitated by psychological need
satisfaction (or thwarting; Ryan & Deci, 2002). Consequently, through the examination of
change, results from study 2 were able to highlight how changes in one variable may influence
changes in another. As such the design and treatment of the data presented in study 2 followed
recommendations advocated by experts and was able to elucidate the dynamic process of SDT
wherein changes in certain variables predicted changes in outcome variables.

Another important methodological implication to this program of research concerned the
examination of a theory based intervention. Rothman (2004) has argued for the importance of
theory driven intervention work in health behaviour research on the basis that theoretically
driven interventions allow interventionist to gain a precise list of causal variables that may have
led to a successful intervention. Using a theory based intervention, study 4 employed an
experimental design, randomly assigning participants into either at treatment group or control
group, to test theoretical tenets. Experimental designs allow researchers to have more confidence
in the conclusions and inferences based on sound procedures (Keppel & Zedeck, 1989).
Although the intervention was largely unsuccessful, it employed rigorous methods and represents
an important contribution to the possible selves intervention literature. At this point, it is difficult
to determine if the intervention was ineffective in its own right, or if limitations regarding
sample, dosage, or measurement/prime scripts caused the null findings. Future research should
examine the best possible physical activity intervention using manipulations under experimental
designs.
6.3.3 Testing Mediation

6.3.3.1 Bootstrapping and multiple mediation

In studies 2 and 3, the indirect effects of psychological need satisfaction were estimated using bootstrapping procedures advocated by experts (Hayes, 2013; Preacher & Hayes, 2008; Rucker et al., 2011). Bootstrapping is a resampling technique wherein 5000 resamples from the original data set were created. Bootstrapping is advantageous to other mediation approaches such as the causal steps approach used in Baron and Kenny’s (1986) because bootstrapping does not assume normality, allows for the covariation of mediators, and reduces Type I error rates (Preacher & Hayes, 2008). As recommended the interpretation of the bias corrected confidence intervals was used to infer statistical significance rather than using normal theory tests ($p$ values) (Preacher & Hayes, 2008). The bias corrected confidence intervals (BcCI’s) are advantageous over the use of conventional statistical significant tests ($p < .05$) because they are asymmetrical around the point estimate, indicating that they do not rely on the normal distribution or the standard error.

Finally, we examined complex mediation models specifying multiple mediators, multiple independent variables and multiple dependent variables. Multiple mediator models were examined rather than examining each independent psychological need satisfaction variable independently because the three psychological needs are thought to be correlated. In so doing, we were able to uncover the unique contribution of each psychological need. If each mediator were tested independently it would have inflated the Type I error rate, and may have produced different results pertaining to the unique contribution of satisfying each psychological need. Moreover, multiple antecedent variables and outcome variables that are hypothesized to be related because of psychological need satisfaction were examined. The advantage to including
multiple antecedents and outcome variables in one model is that it allows for the examination of how one antecedent variable affected one outcome variable while controlling for alternative antecedent and outcome variables (Hayes, 2013). Nevertheless, one disadvantage to including multiple antecedent and outcome variables is the possibility of multi-collinearity impacting the results or causing inconsistent mediation. Because SDT is a complex macro-theory of motivation, modeling multiple antecedent and multiple outcome variables allowed for the interpretation of the dynamic nature of goals, motivation, psychological need satisfaction and well-being/physical activity.

6.3.3.2 Alternative model testing

When testing mediation, it is important to have an \textit{a priori} model based on theory (Hayes, 2013; Preacher & Hayes, 2008). Researchers have argued that finding statistical support for one mediation model does not rule out alternative accounts of the data (Hayes, 2013; Little, Card, Bovaird, Preacher, & Crandall, 2007). Study 2 tested a complex model based on 3 mini-theories of SDT that few researchers have examined. As such, although an \textit{a priori} model was specified based on SDT, recommendations were followed to test an alternative model (Hayes, 2013; Kline, 2010; MacCallum & Austin, 2000). The alternative model tested was based on theory and previous research (McDonough & Crocker, 2007; Milyavskaya & Koestner, 2011; Ng et al., 2012). Testing an alternative model is recommended because it reduces confirmation bias and is considered an important step in theory testing (Kline, 2010; MacCallum & Austin, 2000). Evaluating an alternative mode provided a more thorough test of SDT.
6.4 Limitations and Future Directions

Despite the novel contributions of this research, there were several limitations to each investigation that must be addressed including study designs, narrow focus on variables of interest, measurement, and sample characteristics.

6.4.1 Study Design

The design of studies 2 and 3 do not allow for causal interpretation of the mediational models. In study 3, cross-sectional analysis limits conclusions that can be inferred from the mediation analysis (Hayes, 2013). Similarly, although study 2 employed a 2 time point design, causality cannot be inferred. As such, caution is warranted when interpreting the mediation results presented in studies 2 and 3. Although not without controversy (Hayes, 2013; Kenny, 2008), researchers have argued that true tests of mediation cannot be examined without the presence of a manipulation through experimental designs (Stone-Romero & Rosopa, 2008). In an attempt to directly examine the hypothesized mediators, study 4 unsuccessfully used psychological need satisfaction primer scripts. The use of manipulations to directly examine the mediational role of psychological need satisfaction represents an avenue of research ripe for inquiry.

6.4.2 Limited Scope of Variables Considered

While this program of research contributed novel information regarding antecedent variables to psychological need satisfaction such as relative intrinsic goals, motivation, and self-schemas, only a few of the possible myriad of factors impacting psychological need satisfaction were examined. Based on theoretical models forwarded by Deci and Ryan (e.g., Ryan, Patrick, et al., 2008) social environmental factors such as autonomy support, structure, and interpersonal involvement influence psychological need satisfaction. It is conceivable that in physical activity
contexts, interpersonal supports (e.g., fitness instructors, doctors) impact the facilitation of psychological needs or impose external contingencies that forestall psychological need satisfaction. With a few researchers finding support for aspects of the social environment as an antecedent to psychological need satisfaction (Adie et al., 2008; Edmunds et al., 2008) researchers would do well to examine how goal contents, motivation, and self-schemas contribute to psychological need satisfaction in the presence of social environmental factors. Such a complex model may best be examined using Sheldon and colleagues (2011) Multilevel Personality in Context (MPIC) model. In the MPIC model, 4 levels of personality (needs/universals, traits/dispositions, goals/motives, and self/self-narratives) serve as the layered foundation to the top 2 levels of organization (social relations and cultural context; Sheldon, Cheng, & Hilpert, 2011).

While researchers support the overall mediational role of psychological need satisfaction, other variables have been suggested as being important to consider that were not considered in this research. For example, examining components of physical activity (effort vs. duration) or motives for physical activity could provide insight into the role of psychological need satisfaction for well-being. Sylvester et al., (2012) found that when physical activity was broken down into frequency, duration, and effort, effort served as a key antecedent to EWB and HWB, which was mediated by psychological need satisfaction. Similarly, Ferguson and colleagues (2012) found that overall health-enhancing physical activity was not associated with EWB, yet engaging in physical activity with eudaimonic motives was associated with EWB. It would be beneficial for researchers in the future to examine the eudaimonic or hedonic motives underlying physical activity behaviour to gain more insight into how psychological need satisfaction may serve are mediators transmitting effects to well-being and physical activity.
6.4.3 Limitations of the Intervention

Despite the positive findings from previous research regarding the efficacy of a best possible selves intervention for increasing both well-being and exercise behaviour (Layous et al., 2013; Murru & Martin Ginis, 2010), the best possible physical activity intervention employed in study 4 was largely unsuccessful. Limitations of the intervention investigation included the sample characteristics, dosage, and measurement. Notably, the individuals used in this investigation were comprised of individuals from the general population with a mean age of approximately 42 years old ($SD = 13.03$). Previous successful possible selves interventions have used university students with a mean age between 19-23 (Layous et al., 2013; Lyubomirsky et al., 2011; Meevissen et al., 2011). Furthermore, researchers have used individuals who were currently not active and seeking to become more active (Murru & Martin Ginis, 2011). Although the sample used in this investigation may be a limitation, the finding might simply indicate that the best possible physical activity intervention is not effective for the general, active population.

Another limitation of the intervention concerned the dosage of the intervention (once a week for 4 weeks) and the lack of variety for the writing instructions. While researchers have hypothesized about the variables associated with successful positive psychology interventions when considering well-being outcomes (e.g., Lyubomirsky & Layous, 2013), little research is available delineating the characteristics that are useful when physical activity serves as the outcome of interest. Therefore, future research may wish to examine different characteristics that are effective for increasing physical activity such as dosage, variety, and sample. Future research may wish to alter the dosage, allow participants to self-select how frequently they engage in the writing task, and change the writing instructions to queue participants to write about different aspects associated with their physical activity possible selves (e.g., fitness, affective feelings,
etc.). Finally, physical activity and well-being were assessed through self-report data. Researchers have argued for the use of more objective measures of well-being (e.g., informant report; Pavot, 2008) and physical activity (e.g., accelerometers; Nigg et al., 2012) because they are less susceptible to errors associated with memory recall, social desirability responding, and response bias. It is important, however, to recognize that there is no gold standard for measuring well-being and physical activity behaviour, and researchers have generally found moderate correlations between self-report and objective indicators of well-being (Pavot, 2008) and physical activity (Loney, Standage, Thompson, Sebire, & Cumming, 2011). Nevertheless, future research may wish to use alternative assessments other than self-report well-being and physical activity.

### 6.4.4 Measurement Properties of the PNSE-PA

Another limitation of study 2 and 3 concerned the measurement properties of the PNSE-PA. Despite having found evidence for score validity and reliability associated with the PNSE-PA in study 1, the goodness of fit statistics fell outside of conventional criteria and modification indices noted a few item cross loading or correlated measurement errors. These modifications were not pursued because observed variables were used for the main analyses. Nonetheless, future research should continue to examine the validity of scores from the PNSE-PA. Researchers could employ Exploratory Structural Equation Modelling (ESEM), a technique that has been advanced for use when item cross loadings are present (Asparouhov & Muthen, 2009; Marsh et al., 2009).

It is also possible that the discrepant findings were caused by estimating CFA’s using the Pearson correlation matrix instead of the polychoric correlation matrix. Unfortunately, in order to retain sample size, an expectation maximum likelihood algorithm was used to replace missing
data. This procedure imputes missing data using non-integer values, making the estimation of polychoric correlations matrices impossible. Currently, the majority of missing data strategies for imputation are based on normal theory of continuous variables (Allison, 2003) and therefore may not extend to ordinal or categorical variables. One possible solution for imputing missing data is to conduct the imputation and then round the estimates to make them integer values (Schafer & Graham, 2002). This approach, however, has been discouraged because rounding adds more variability to the data set (Graham, 2009). As such, in order to retain sample size we used expectation maximum imputation, estimated the CFA based on the covariance matrix, but accounted for the non-normality of the data by using Robust Maximum likelihood estimation and bootstrapping procedures. The estimation based on the covariance matrix versus the polychoric correlation matrix is one plausible explanation for the discrepant findings between study 1 and studies 2 and 3.

6.4.5 Sample Characteristics

Although the sample of participants drawn from the general population can represent a strength of this program of research because it extends results beyond university students, it could also represent a limitation. Scientists (Helliwell et al., 2012) have argued that the bulk of research examining well-being outcomes has used WEIRD participants (individuals from Western, Educated, Industrialized, Rich, Democracies; Henrich, Heine, & Norenzayan, 2010). Although emerging research has begun to examine positive psychology interventions using cross-cultural samples (e.g., Boehm, Lyubomirsky, & Sheldon, 2011; Layous, Hyunjung, Choi, & Lyubomirsky, in press), the current state of research focuses largely on Western undergraduate students, with the underlying assumption that becoming happy or experiencing well-being is an important life goal regardless of culture. Although participants from the general population were
used in the current program of research and not undergraduate students, caution is warranted when generalizing our results across all populations because the participants in these investigations were mostly Caucasian and highly educated (Henrich et al., 2010). In addition, Deci and Ryan (2000) have asserted that psychological need satisfaction is universal across cultures. Although some researchers have supported this contention outside of exercise contexts (Ryan, La Guardia, Solky-Butzel, Chirkov, & Kim, 2005; Sheldon et al., 2004), recently, Edmunds and colleagues (2010) found only partial support for this contention in exercise contexts. Aside from the measurement invariance tests conducted across cultures within exercise (e.g., Vlachopoulos et al., 2010; Vlachopoulos et al., 2013), there has been little attempt to examine psychological need satisfaction as mediators across cultures. As such, future research would do well to investigate tenets of SDT in physical activity contexts to test the universality hypothesis.

6.6 Practical Implications

It is now well recognized that psychological well-being is associated with a myriad of positive health benefits such as reduced cardiovascular disease, better neuroendocrine function, lower inflammatory markers, and longer REM sleep (Ryff & Burton, 2013); yet only 31% of Canadians report excellent mental health (Canadian Institute for Health Information, 2009). Consequently, an important research agenda for public health concerns identifying methods to increase well-being and reduce incidences of depression (Helliwell et al., 2012; Ryff & Burton, 2013). Physical activity has been forwarded as one cost-effect, non-pharmacological method for reducing depression (Penedo & Dahn, 2005; Scully et al., 1998) and increasing markers of psychological well-being (Chodzko-Zajko et al., 2009; Netz et al., 2005; Penedo & Dahn, 2005). Despite the broad appeal of physical activity as a tool responsible for increasing physical health
and psychological well-being, 85% of Canadian adults are insufficiently active to accrue health benefits (Colley et al., 2011). Consequently, research is needed to identify the variables that are associated with physical activity behaviour and well-being. To this end, various researchers have examined factors such as motivation (McDonough & Crocker, 2007; Wilson & Rogers, 2008), goals (Sebire et al., 2011; Sebire et al., 2009), identity or self (Strachan et al., 2012; Vlachopoulos et al., 2011; Wilson & Muon, 2008), and psychological need satisfaction (Edmunds et al., 2006; Mack et al., 2012) as a mechanism associated with well-being and physical activity behaviour. Extending previous research from exercise and sport contexts, this dissertation contributes to the growing evidence implicating psychological need satisfaction during physical activity as one key ingredient for facilitating psychological well-being and behavioural outcomes.

This research also suggests that increased well-being and physical activity behaviour can be achieved through psychological need satisfaction in more general physical activity contexts. Results from this investigation can be generalized to individuals who engage in any form of physical activity, therefore making the results more inclusive and not restricted to only individuals engaged in structured exercise or sport. Finally, the outcome variables examined in this program of research represent both conceptualizations of well-being characterized by maximizing pleasure (HWB) and reaching human potentials (EWB). Taken together, this research has important implications for researchers, physicians, fitness instructors, support networks, and other applied health practitioners who are seeking for methods to increase well-being and physical activity behaviours.
6.6.1 Study Implications for Increasing Well-Being

There is now considerable evidence to suggest the psychological well-being is good for physical health (Ryff & Burton, 2013). Physical activity is one possible intentional activity that could enhance individuals’ well-being, yet the reason why physical activity is linked with well-being is not well understood (Fox, 1999; Netz et al., 2005). Results from this program of research suggest that one of the possible reasons individuals experience well-being is because of opportunities to feel competent, autonomous, and related during physical activity. Consequently, researchers and applied health specialists who are attempting to enhance participants feelings of well-being should be encouraging individuals to engage in activities that provide optimal challenge for their skill level, provide perceptions of choice and offer them opportunities to feel connected to important others in their environment. Also, based on the results examining possible variables that predict psychological need satisfaction, health practitioners may wish to encourage individuals to set goals related to health, social affiliation, and skill development, encourage participants to identify their own self-determined reasons for engaging in physical activity, and encourage participants to engage in physical activity that they find personally descriptive.

6.6.2 The Role of Exercise Self-Schemas

This program of research suggests that describing yourself as an exerciser (i.e., descriptive self-schema) is positively associated with satisfaction of competence, autonomy, and relatedness, and in turn well-being and physical activity. That is, facilitating individual’s feelings of effectance, belonging, and personal choice, may be associated with increased self-description of being an exercise. With research suggesting that having an exercise identity or exercise self-schema is related to physical activity behaviour (Estabrooks & Courneya, 1997; Kendzierski,
targeting perceptions of self-schemas seems like one viable route researchers of health specialists can pursue. Finally, self-schemas are thought to produce the possible selves individuals envision for themselves. Unfortunately, the best possible physical activity self intervention outlined in Chapter 5 did not result in greater exercise self-schemas for individuals in the treatment group. As such, the best possible selves intervention presented herein is not recommended as a method for enhancing exercise self-schemas in individuals.

6.6.3 Increasing Perceptions of Competence, Autonomy, and Relatedness

Overall, these investigations suggest that setting intrinsic physical activity goals, having autonomous motivation, and describing yourself as an exerciser is associated with increased well-being and physical activity behaviour and that this effect could be transmitted through opportunities to satisfy key psychological needs. Researchers, health specialists, physicians, or fitness instructors who are attempting to promote physical activity behaviour and well-being outcomes should target perceptions of psychological need satisfaction. Within SDT, there are three environmental factors that can be manipulated in order to enhance psychological need satisfaction: autonomy support, structure and interpersonal involvement (Deci & Ryan, 1990). Autonomy supportive environments occur when exercisers are given choice about the type of activity to be completed, pressure is minimized, and the individual’s perspectives are acknowledged (Deci & Ryan, 1990; Edmunds, Ntoumanis, & Duda, 2009). Structure involves clear expectations, and clear informational and meaningful feedback (Edmunds et al., 2009). Finally, interpersonal involvement is about the quality of the relationship between the individual and the health specialist (Edmunds et al., 2009). Environments that provide autonomy support, structure, and involvement will enhance behaviour and well-being because they facilitate psychological need satisfaction and self-determined motivation (Deci & Ryan, 1990). As such,
all practitioners, whether they are researchers conducting interventions or applied health specialist working with clients, should promote an environment in which they ensure they are being autonomy supportive for their participants, providing structure, and ensuring a good interpersonal relationships. Such an approach to client care, or intervention research has been shown to lead to greater psychological need satisfaction and ultimately, greater well-being and behavioural engagement.

There are alternative methods to environmental supports that individuals can personally pursue to increase the satisfaction of each psychological need (Rodgers & Loitz, 2008; Ryan et al., 2008). In order to directly target perceptions of competence satisfaction, meaningful successes should be celebrated, while not over celebrating inconsequential tasks. Similarly in order to experience mastery, the individual should select optimally challenging activities based on their current capabilities. If an individual is working with a partner or instructor, clear language should be used while communicating, and the instructor should provide effectance feedback and input, while supporting and respecting the individual’s efforts (Rodgers & Loitz, 2008; Ryan et al., 2008). In an effort to increase perceptions of autonomy satisfaction, individuals should feel as though they have choices and options that reflect their personal goals. If an individual is working with an instructor, the instructor should avoid using controlling language (e.g., “run for 10 minutes”) and encourage ownership or volition over the activities that can be engaged in (e.g., “you could get aerobic activity by running, using the elliptical, or stationary bicycling”). Individuals should select meaningful intrinsic goals that are personally valued or identified (creating autonomous motivation). Finally, to increase perceptions of relatedness satisfaction, individuals should select activity that provides them with a sense of meaningful connection with important people in their lives. For example, someone who would
like to become a runner may wish to join a running club with like-minded runners. Fitness instructors could introduce clients to other class members or individuals engage in similar physical activity programs. Fitness instructors could also provide instructions and tips regarding expected behavioural etiquette within fitness facilities. Finally, instructors should understand, respect, and care for each individual’s perspective.

Based on the overall results of these investigation, researchers or applied health specialists who are seeking to improve well-being and encourage physical activity behaviour with their participants would do well to encourage the adoption of intrinsic goals (e.g., for health, for mastery), and encourage autonomous motivation (e.g., “because I value the health benefits of physical activity”). Individuals should also be encouraged to engage in activity that they find personally descriptive of themselves in an effort to increase perceptions of their exercise self-schema. When an individual adopts physical activity behaviour characterized by intrinsic goals, autonomous motivation, and it is highly self-descriptive, they will be more likely to satisfy psychological needs and in turn, will likely experience greater well-being and engage in more physical activity. Because psychological need satisfaction was found to be a key element transmitting the effects between relative intrinsic goals, autonomous motivation and descriptive self-schema to well-being and physical activity behaviour, individuals should be encouraged to engage in activity that they feel personally skilled at, activity that they chose, and activity that makes them feel as though they share meaningful connections with important others.

6.7 Concluding Remarks

Overall, the results of this investigation support the important role psychological need satisfaction plays in physical activity contexts. Specifically, support was found for scores of an instrument modified to physical activity contexts to measure psychological need satisfaction
(PNSE-PA). Psychological need satisfaction in physical activity was found to mediate relationships between antecedent variables such as relative intrinsic goals, autonomous motivation, and descriptive exercise self-schemas and outcomes such as EWB, HWB, and physical activity behaviour. Despite these findings, a best possible physical activity self intervention was only successful for increasing HWB one week after the intervention, and not successful for increasing perceptions of exercise self-schemas, psychological need satisfaction, well-being or physical activity behaviour. Taken together, the results from each of the 4 studies presented in this program of research contribute to the growing literature implicating psychological need satisfaction in general physical activity contexts as a possible mechanism responsible for the relationship between motivational and self factors and outcomes related to well-being and physical activity in individuals drawn from the general population.
References


doi:10.1016/j.psychsport.2010.09.006


203


http://www.earth.columbia.edu/sitefiles/file/Sachs%20Writing/2012/World%


220


226


Appendix A

Study 1 and Study 2 Questionnaire Package

A-1: Informed Consent
A-2: Demographic Information
A-3: Stages of Change Measure
A-4: Subjective Vitality Scale
A-5: Short Positive and Negative Affect Scale
A-6: Psychological Need Satisfaction in Exercise Scale - Physical Activity
A-7: Behavioural Regulations in Exercise Questionnaire -2R
A-8: Goal Contents in Exercise Questionnaire
Appendix A-1: Informed Consent

Informed Consent

Physical activity and well-being: The role of goals, motives and psychological needs

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School of Human Kinetics
University of British Columbia
Contact: kgunnell10@gmail.com

Purpose of the Project: You are invited to take part in a research study entitled: “Physical activity and well-being: The role of goals, motives and psychological needs”. The purpose of this research is to examine the relationship between physical activity goals, motives, needs and well-being. People engage in physical activity for varying reasons, have different goals, and experience different feelings towards physical activity. It is important to examine these variables because they may be associated with outcomes such as well-being experienced in physical activity contexts.

Participation: If you agree to participate you will be invited to complete a questionnaire at two separate time points, separated by six months. It is anticipated that the questionnaire will take approximately 15 to 20 minutes to complete. The questionnaire will ask about various feelings towards physical activity, your physical activity goals and motives, along with general demographic information. You will also be asked to provide contact information (i.e., email address or phone number). Approximately six months after completing the questionnaire, you will be contacted and asked to complete the questionnaire again. You do not have to answer any question you do not feel comfortable answering. Also, if you wish to withdraw from the study, you may do so at any time without having to give any reason for doing so. Withdrawing from the study will not result in any negative consequences for you.

Potential Risks: There are no foreseeable risks associated with your involvement in this study. This study will not subject you to any physical risk. You can refuse to answer any question and doing so will result in no penalty to you or anyone else. You can discontinue your involvement in the study at any time, again resulting in no penalty. Any data collected prior to this point will be omitted from the study and destroyed. In the event that you would like to further discuss your feelings regarding the topics in the questionnaire, UBC Counselling Services (604-822-3811) or Student Health (604-822-7889) can be of
assistance.

**Potential Benefits:** There are no guaranteed benefits if you agree to participate in this study. *All participants will be entered into a draw for a chance to win one of three cash prizes of $50.00 upon completing the first questionnaire.* There is the potential for participation to help increase your own understanding about your own physical activity goals and motives. Understanding more about your physical activity goals, motives and feelings may help you to articulate more clearly why you engage in physical activity.

If you would like to know about the results of the study, feel free to contact Katie Gunnell using the information above. A summary of the results and copies of any resulting publications will be provided at your request.

**Confidentiality:**
Information gathered on the questionnaire will be used for research purposes only, and the identity of individual participants will only be known to members of the research team. Once both questionnaires are completed, they will be identified by code number only and will be securely stored for a minimum of five years as required by the University of British Columbia guidelines. Data collected online will be stored using Edudata Canada, a University of British Columbia-based company that provides online data collection services (http://www.edudata.ca). Edudata provides a secure facility for storing personal information, and complies with British Columbia’s Freedom of Information and Protection of Privacy Act. Participants will not be identified by name in any reports of the completed study.

- Results of this study will be analyzed in group form and will be used in the preparation of a presentation and an academic research publication, all of which are public documents. A summary of the results will be available upon request.
- You do not waive any legal rights by reading or agreeing to consent to participate in this study.
- You are free to withdraw from this study at any time with absolutely no penalty. The decision to withdraw will NOT result in any loss of services or any other negative consequences.

**Contact Information about the Study:** If you have any questions or want further information about the study please contact Dr. Peter Crocker and/or Katie Gunnell at the contact information provided at the beginning of this form.

**Contact for Concerns about the Rights of Research Subjects:** If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at [604-822-8598](tel:604-822-8598) or if long distance e-mail to [RSIL@ors.ubc.ca](mailto:RSIL@ors.ubc.ca).

Thank you for your time. This study has been reviewed and approved by the University of British Columbia’s Behavioural Research Ethics Board (file H10-02671).

**Consent:**
- I understand that my participation in this study is entirely voluntary and that I may refuse to
participate or withdraw from the study at anytime without any penalty.
• I have read the consent form and know who to contact if I have any further questions.
• I understand that I may complete this questionnaire at a later date
• By returning the first completed questionnaire you are consenting to participate in this study. Please keep a copy of this consent form for your records.
Appendix A-2: Demographic Information

About This Study

This confidential questionnaire is about physical activity and well-being. There are no right or wrong answers to any of these questions. Please read all questions carefully and answer each one according to what is true for you. This is a very thorough questionnaire. Consequently some questions may appear similar to each other.

Section 1: This first part of the questionnaire is designed to describe the people participating in this study. All information received is held in confidence. Please provide your...

Today’s Date: ________________________________

Please provide an email address or telephone number you can be contacted at in 6 months to complete another questionnaire: ________________________________

Age

Height __________ Feet/inches or __________ Metres

Weight __________ Pounds (lbs) or __________ Kilograms (Kgs)

Please check one of the following...

1. What is your gender?
   0 Male  0 Female

2. What is your current marital status?
   0 Married/ Common Law  0 Widowed  0 Separated/ Divorced  0 Single/ Never Married

3. How would you describe your ethnic origin?
   0 Aboriginal  0 White  0 Asian  0 Filipino
<table>
<thead>
<tr>
<th></th>
<th>Black</th>
<th>Arab</th>
<th>West Asian</th>
<th>Chinese</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Japanese</td>
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<td>Southeast</td>
<td>South</td>
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<td></td>
<td></td>
<td></td>
<td>Asian</td>
<td>Asian</td>
<td></td>
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</tbody>
</table>

### 4. What is your highest level of education completed?

- [ ] Some High School completed
- [ ] High School Diploma
- [ ] University/College degree
- [ ] Graduate Degree

Please keep this definition of physical activity in mind as you respond to the following questions.

Please keep this definition of physical activity in mind as you respond to the following questions.
Appendix A-3: Stages of Change Measure

(Mullan & Markland, 1997)

The following statements pertain to your participation in physical activity. For the purposes of these statements, physical activity is defined as...

⇒ Any bodily movement produced by the skeletal muscles that results in a substantial increase over the body’s energy expenditure.

⇒ Physical activity can include planned or structured exercise, sports, commuting activities by foot or bicycle, household chores (e.g., vacuuming), work activity (e.g., lifting heavy boxes) and leisure time hobbies (e.g., gardening)

<table>
<thead>
<tr>
<th>According to the definition provided above, do you participate in physical activity?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, I <strong>have been</strong> regularly engaged in physical activity for <strong>more than 6 months</strong></td>
</tr>
<tr>
<td>Yes, I <strong>have been</strong> regularly engaged in physical activity but for <strong>less than 6 months</strong></td>
</tr>
<tr>
<td>No, but I <strong>intend</strong> to engage in physical activity in the <strong>next 30 days</strong></td>
</tr>
<tr>
<td>No, but I <strong>intend</strong> to engage in physical activity in the <strong>next 6 months</strong></td>
</tr>
<tr>
<td><strong>No, and I do not intend to engage in physical activity in the</strong> next 6 months **</td>
</tr>
</tbody>
</table>
Appendix A-4 Leisure Time Physical Activity Questionnaire

(Godin & Shephard, 1985)

During a typical 7-Day period (a week), how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time (write in each space the appropriate number)

<table>
<thead>
<tr>
<th>Intensity of Activity</th>
<th>Times Per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strenuous Activity</strong> (Heart beats rapidly)</td>
<td></td>
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<tr>
<td>E.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling</td>
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<tr>
<td><strong>Moderate Activity</strong> (Not exhausting)</td>
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<tr>
<td>E.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing</td>
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<tr>
<td><strong>Mild Activity</strong> (Minimal effort)</td>
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<tr>
<td>E.g., yoga, archery, fishing from a river bank, bowling, horseshoes, golf, snow-mobiling, easy walking</td>
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</table>
Appendix A-5: Subjective Vitality Scale

(Ryan & Frederick, 1997)

These questions pertain to feelings people typically have when they engage in physical activity. Please respond to each of the following statements by indicating the degree to which the statement is true for **YOU when engaged in physical activity**. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel alive and vital.</td>
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<tr>
<td>2. I don’t feel very energetic.</td>
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<tr>
<td>3. Sometimes I feel so alive I just want to burst.</td>
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<td>4. I have energy and spirit.</td>
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<td>5. I look forward to each new day.</td>
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<td>6. I nearly always feel alert and awake.</td>
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<td>7. I feel energized.</td>
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</table>
Appendix A-6: Short Positive and Negative Affect Schedule

(Mackinnon et al., 1999; Watson, Clark, & Tellegen, 1988)

*This scale contains a number of words describing different feelings and emotions. Indicate to what extent you generally feel this way when you engage in physical activity. That is, how YOU feel on the average when you engage in physical activity.*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Distressed</strong></td>
<td></td>
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<tr>
<td><strong>2. Alert</strong></td>
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<tr>
<td><strong>3. Scared</strong></td>
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<tr>
<td><strong>4. Determined</strong></td>
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<tr>
<td><strong>5. Afraid</strong></td>
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<tr>
<td><strong>6. Nervous</strong></td>
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<tr>
<td><strong>7. Excited</strong></td>
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<tr>
<td><strong>8. Upset</strong></td>
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<tr>
<td><strong>9. Inspired</strong></td>
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<tr>
<td><strong>10. Enthusiastic</strong></td>
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</tbody>
</table>

1. Very slightly or not at all
2. A little
3. Moderately
4. Quite a bit
5. Extremely
Appendix A-7: Modified Psychological Need Satisfaction in Exercise Scale

(Wilson, Rogers, et al., 2006)

The following statements represent different feelings people have when they engage in physical activity. Please answer the following questions by considering how you typically feel when **YOU** engage in physical activity. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel that I am able to complete physical activities that are personally challenging</td>
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<tr>
<td>2. I feel attached to my physical activity companions because they accept me for who I am</td>
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<tr>
<td>3. I feel like I share a common bond with people who are important to me when we do physical activity together</td>
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<tr>
<td>4. I feel confident I can do even the most challenging physical activities</td>
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<tr>
<td>5. I feel a sense of camaraderie with my physical activity companions because we do physical activity for the same reason</td>
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<tr>
<td>6. I feel confident in my ability to perform physical activities that personally challenge me</td>
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<tr>
<td>7. I feel close to my physical activity companions who appreciate how</td>
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<tr>
<td>difficult physical activity can be</td>
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<td>8. I feel free to do physical activity in my own way</td>
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<tr>
<td>9. I feel free to make my own physical activity program decisions</td>
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<tr>
<td>10. I feel capable of completing physical activities that are challenging to me</td>
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<tr>
<td>11. I feel like I am in charge of my physical activity program decisions</td>
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<tr>
<td>12. I feel like I am capable of doing even the most challenging physical activities</td>
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<tr>
<td>13. I feel like I have a say in choosing the physical activities that I do</td>
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<tr>
<td>14. I feel connected to the people who I interact with while we do physical activity together</td>
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<td>15. I feel good about the way I am able to complete challenging physical activities</td>
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<tr>
<td>16. I feel like I get along well with other people who I interact with while we do physical activity together</td>
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<tr>
<td>17. I feel free to choose which physical activities I participate in</td>
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<tr>
<td>18. I feel like I am the one who decides what physical activities I do</td>
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</tbody>
</table>
Appendix A-8: Modified Behavioural Regulation in Exercise Questionnaire- 2r

(Mullan, Markland, & Ingledew, 1997; Wilson, Rodgers, et al., 2006)

The following list identifies reasons why people engage in physical activity. Please indicate on the scale provided how true each statement is for YOU. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel like a failure when I haven’t been physically active in a while</td>
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<tr>
<td>2. I engage in physical activity because it is consistent with my life goals</td>
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<tr>
<td>3. I get restless if I don’t engage in physical activity regularly</td>
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<tr>
<td>4. I think it is important to make the effort to engage in physical activity regularly</td>
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<tr>
<td>5. I find my physical activity a pleasurable activity</td>
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<tr>
<td>6. It’s important to me to be physically active regularly</td>
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<tr>
<td>7. I get pleasure and satisfaction from participating in physical activity</td>
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<tr>
<td>8. I feel under pressure from my friends/family to engage in physical activity</td>
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<tr>
<td>9. I engage in physical activity because it is fun</td>
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<tr>
<td>10. I engage in physical activity because other people say I should.</td>
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<tr>
<td>11. I feel ashamed when I miss a physical activity session</td>
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<tr>
<td>12. I am physically active because others will not be pleased with me if I don’t.</td>
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</tr>
<tr>
<td>13. I consider physical activity to be part of my identity</td>
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<tr>
<td>14. I enjoy my physical activity sessions.</td>
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<tr>
<td>15. I feel guilty when I don’t engage in physical activity</td>
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<tr>
<td>16. I take part in physical activity because my friends/family/spouse say I should</td>
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<tr>
<td>17. I consider physical activity a fundamental part of who I am</td>
<td></td>
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<tr>
<td>18. I value the benefits of physical activity.</td>
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<tr>
<td>19. I consider physical activity consistent with my values</td>
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</tbody>
</table>
Appendix A-9: Modified Goal Contents in Exercise Questionnaire

(Sebire, et al., 2008)

People have a number of different goals that they endorse when engaging in physical activity. We would like to know more about YOUR physical activity goals. Please indicate on the scale provided how important each goal is for YOU with reference to your physical activity. Use the following scale:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all important</td>
<td>Moderately Important</td>
<td>Extremely important</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. To connect with others in a meaningful manner
2. To improve the look of my overall body shape
3. To increase my resistance to illness and disease
4. To be well thought of by others
5. To acquire new physical activity skills
6. To share my physical activity experiences with people that care for me
7. To improve my appearance
8. To increase my energy level
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>To be socially respected by others</td>
</tr>
<tr>
<td>10.</td>
<td>To learn and exercise new techniques</td>
</tr>
<tr>
<td>11.</td>
<td>To develop close friendships</td>
</tr>
<tr>
<td>12.</td>
<td>To be slim so to look attractive to others</td>
</tr>
<tr>
<td>13.</td>
<td>To improve my overall health</td>
</tr>
<tr>
<td>14.</td>
<td>To gain favourable approval from others</td>
</tr>
<tr>
<td>15.</td>
<td>To become skilled at a certain exercise or activity</td>
</tr>
<tr>
<td>16.</td>
<td>To form close bonds with others</td>
</tr>
<tr>
<td>17.</td>
<td>To change my appearance by altering a specific area of my body</td>
</tr>
<tr>
<td>18.</td>
<td>To improve my endurance, stamina</td>
</tr>
<tr>
<td>19.</td>
<td>So that others recognize me as a physically active person</td>
</tr>
<tr>
<td>20.</td>
<td>To develop my physical activity skills.</td>
</tr>
</tbody>
</table>
Appendix B: Study 1 and Study 2 Recruitment Material

B-1: Recruitment Poster
B-2: Email Recruitment Letter
B-3: Initial Contact Containing Questionnaire Link
B-4: Time 2 Pre-Notice Email
B-5: Time 2 Email Containing Questionnaire Link
B-6: Thank You/Reminder Email
Appendix B-1: Recruitment Poster

Physical Activity and Well-Being

Purpose of Study

To determine the association between physical activity goals, motives, needs and well-being. Attention to these important variables may ultimately help us understand how physical activity promotes well-being.

Requirements

- Participants must be 18 years or older (university students 17 years or older can participate).
- Involves a total time commitment of 15-20 minutes on two occasions separated by 6 months
- You will be asked to complete a questionnaire that asks about your physical activity goals, motives, needs and feelings.
- Any information you provide will remain confidential

For more information, interested individuals can contact:

- Ms. Katie Gunnell........ (604) 822-5580........ kgunnell10@gmail.com
- Dr. Peter Crocker............ (604) 822-5580........ pcроккер@interchange.ubc.ca

Cash Prize

- All participants will be entered into a draw for a chance to win one of three cash prizes of $50.00

Thank you for your interest in our research project.

This study is funded by the Social Sciences and Humanities Research Council of Canada
Appendix B-2: Email Recruitment Letter

Exercise and Sport Psychology Lab
Rm. 220b, War Memorial Gym
6081 University Blvd.
Vancouver, BC V6T 1Z1

School of Human Kinetics

Dear (insert name)

My name is Katie Gunnell and I am a doctoral student at the University of British Columbia. Dr Crocker and I are conducting a study entitled “Physical Activity and well-being: The role of goals, motives and psychological needs”. The purpose of this study is to determine the association between physical activity goals, motives, needs and well-being. It is anticipated that attention to these important variables will help us understand the relationship between physical activity and well-being.

In order to conduct this study, I am hoping that you will be able to assist me by providing a venue to recruit participants to complete a questionnaire. From you, I am requesting permission to place an announcement of our study in your e-newsletter/listerv such that we can invite members of your organization to participate in the study. Your participation is completely voluntary.

Of your members, we will request them to complete two questionnaires that ask about their physical activity goals, motives and feelings on two separate occasions separated by six months. It will take approximately 15 to 20 minutes of their time. The second assessment will take place six months later and will contain a questionnaire that will take 15 to 20 minutes of their time.

It is important to note that all information is confidential and only the research team members will know the identity of the participants and their responses to the questionnaire.

Please respond to this letter if you can or cannot help me with this study. You can contact me by email (kgunnell10@gmail.com) or by phone (604-822-5580). Thank you for your time and consideration.

Sincerely,

Katie Gunnell, MA
Appendix B-3: Initial Contact Containing Questionnaire Link

Greetings,
This e-mail is your invitation to participate in Dr. Peter Crocker and Katie Gunnell's research study entitled “Physical Activity and Well-Being: The role of goals, motives and psychological needs”. The purpose of this study is to determine the association between physical activity goals, motives, needs and well-being. It is anticipated that attention to these important variables will help understand the relationship between physical activity and well-being. Your involvement would be greatly appreciated. If you choose to participate, we will ask that you complete a questionnaire via a secured internet survey at two separate time points. The questionnaire will take approximately 15 to 20 minutes to complete. Six months later, you will be asked to complete another questionnaire that will take 15 to 20 minutes.

All participants will be entered into a draw for a chance to win one of three cash prizes of $50.00
If you wish to participate, please follow the link below.

https://survey.edudata.ca/es/czEzNQ/YzE4NA/

It is important to note that all information is confidential and only the research team members will know the identity of the participants and their responses to the questionnaire.

For more information on the study or on how you can participate please contact Katie Gunnell by email (kgunnell10@gmail.com) or by phone (604-822-5580).

Thank you for your time and consideration.

If you know anyone (i.e., friends/family/contacts) that might be interested in participating in this study, we ask that you discuss this research with them to determine their interests in volunteering to participate. Those individuals interested in participation should then contact the research team to volunteer.

Sincerely, Katie Gunnell, MA
Appendix B-4: Time 2 Pre-Notice Email

Dear Participant,

My name is Katie Gunnell and I’m a graduate student at UBC in human kinetics. If you’ll remember, about six months ago you completed a questionnaire about physical activity and well-being. I wanted to take this opportunity to sincerely thank you for your participation.

In a week from now you will receive an email containing information about the second and final phase of this study, and a link to a brief online questionnaire. The questionnaire will be similar to the one you completed six months ago, and should take you about 15-20 MINUTES to complete.

I am contacting you in advance because many people prefer to know ahead of time when they will receive an online questionnaire. The questions in this questionnaire will be similar to those that you completed during the first phase of this study, and will ask you about physical activity and well-being. In order to compare experiences over six months, it is important that both phases of the study are completed.

Thank you for your involvement in this study. If you have any questions, please don’t hesitate to ask!

Sincerely,

Katie Gunnell
Appendix B-5: Time 2 Email Containing Link to 2 Time Questionnaire

Dear Participant,

I would like to invite you to participate in the second phase of the Physical Activity and Well-Being Study. Your participation in the study will involve completing a brief online questionnaire. It should take you about 15-20 MINUTES to complete.

The questionnaire can be accessed by clicking on the link below. When you click on the link, you will be redirected to the first page of the questionnaire (consent form), which contains information about the study such as the potential risks (none), benefits, contact information, and the purpose of the study. Clicking on the link does not automatically involve you in this phase of the study, you must read this page first and then click “continue” to participate.

TO ACCESS THE CONFIDENTIAL QUESTIONNAIRE, CLICK ON THE FOLLOWING LINK:

https://survey.edudata.ca/es/czEzNQ/YzIxNQ/

Again, thank you for your involvement in this study. If you have any questions, please don’t hesitate to ask (you can reply to this email, or use the contact information provided by clicking the link).

Sincerely

Katie Gunnell
Appendix B-6: Thank You/Reminder Email

Dear Participants,

A week ago an e-mail invitation was sent to you to participate in the Physical activity and Well-Being study. If you have already completed the online questionnaire, please accept our sincere thanks. If not, please do so today by clicking on the link below:

https://survey.edudata.ca/es/czEzNQ/YzE4NA/

We are especially grateful for your help because it is only by asking people like you to share your experiences that we can understand the association between physical activity and well-being.

Sincerely,

Katie Gunnell
Appendix C: Study 3 and Study 4 Questionnaire Package

C-1: Informed Consent
C-2: Demographic Information
C-3: Exercise Self-Schema Questionnaire
C-4: Meaning Scale
C-5: Subjective Vitality Scale
C-6: Short Positive and Negative Affect Schedule
C-7: Modified Psychological Need Satisfaction in Exercise Scale
C-8: Leisure Time Exercise Questionnaire
C-9: Implementation Fidelity Questions at Post-Intervention
C-10: Feedback at 1-Month Follow-Up
Appendix C-1: Informed Consent

Peter Crocker, PhD
School of Kinesiology
University of British Columbia

Katie Gunnell, MA
School of Kinesiology
University of British Columbia

Purpose of the Project:
You are invited to take part in a research study entitled: “Self and Well-Being: The role of Psychological Needs. People engage in physical activity for varying reasons, have different goals, and experience different feelings towards physical activity. It is important to examine these variables because they may be associated with outcomes such as well-being experienced in physical activity contexts. The purpose of this investigation is to evaluate the effectiveness of a ‘self’ intervention on outcomes such as psychological need satisfaction, physical activity behaviour, and well-being.

Participation:
Interested adults aged 25 to 65 years old will be invited to take part in an intervention. You will be randomly assigned to one of three groups: one of two ‘self’ groups or an extended group. All three groups will take part in a writing task once a week for 4 weeks, on their own time, at their own convenience, online. Participants will also be asked to complete 3 brief questionnaires over 9 weeks (weeks 1, 5 and 9). Following this, participants who were assigned to the extended treatment will be given the opportunity to engage in the ‘self’ writing treatment.

Completion of the online questionnaires will take approximately 10 minutes each (3 questionnaires over 9 weeks). The writing exercise will take approximately 10 minutes (once a week, for 4 weeks).

As part of this study, you will be asked to engage in a writing activity. You will decide prior to each writing activity if you give the researcher permission to view your writing and use it for research purposes. For example, we may examine what participants write about, and look for similarities across participants. Data obtained from the content of the writing will be presented in group form (e.g., 12 participants wrote about health). If direct quotes are used, no identifying information such as your name will be used. You can choose to submit your writing electronically to the researcher through the host website (described in the confidentiality section below). If you do not wish for your writing to be used for research purposes, you can write on a piece of paper in your own home and dispose of it yourself. You can make the decision to provide your writing to the researcher (or not) when you engage in each writing task (for a total of 4). If you decide to provide your writing the first time, you do not have to decide to provide it
at a subsequent time; you decide each time you write.

You can write about anything you want, or do not want. Also, if you wish to withdraw from the study, you may do so at any time without having to give any reason for doing so. Withdrawing from the study will not result in any negative consequences for you.

**Potential Risks:**
This study will not subject you to any physical risk. You can refuse to answer any questions in the questionnaire package and/or withdraw from the study at any time and doing so will result in no penalty to you or anyone else. Although we do not expect any psychological risk, if we feel participation is placing you under undo stress we will discontinue your involvement in the study and direct you to appropriate resources, again resulting in no penalty. Any data collected prior to this point will be omitted from the study and destroyed.

**Potential Benefits:**
There are no explicit or guaranteed benefits to taking part in this study. However, there is the potential for participation to enable the development for an increased understanding about your own physical activity self, well-being and behaviour.

All participants' email addresses will be placed into a random draw after submitting the time 1 questionnaire for a chance to win 1 of 3 cash prizes of $50.00. An additional entry into the draw will be made for each participant that submits time 2 and time 3 questionnaires. For example, if a participant submits all three questionnaires, their name will be entered 3 times in to the draw. A participant can only win 1 cash prize. Participants will still be eligible to win the prize if they withdraw from the study early, submit incomplete questionnaires, or do not complete every writing task. Participants chance to win is not contingent on full completion of the questionnaires.

If you would like to know about the results of the study, feel free to contact Katie Gunnell (kgunnell10@gmail.com). A summary of the results and copies of any resulting publications will be provided upon request.

**Confidentiality:**
Information gathered will be used for research purposes only and participants will not be matched to individual responses. All data will be collect online and will be stored using Edudata Canada, a University of British Columbia-based company that provides online data collection services (http://www.edudata.ca). Edudata provides a secure facility for storing personal information, and complies with British Columbia’s Freedom of Information and Protection of Privacy Act. Participants will not be identified by name in any reports of the completed study. Once questionnaires are completed, they will be identified by code number only and will be securely stored for a minimum of five years as required by the University of British Columbia guidelines.

Results of this study will be analyzed in group form and will be used in the presentation of academic presentations and publications, all of which are public documents. If you choose to allow us to use what you write about each week, we will not use your name or email address in
You do not waive any legal rights by consenting to participate in this study.

**Contact Information about the Study:**
Your participation in this research is entirely voluntary and you may withdraw from the study at any time without having to give any reason for doing so and without experiencing any negative consequences. In the event that a participant withdraws, the participant will still be entered in to the cash prize draw. If you have any questions or want further information about the study please contact Dr. Peter Crocker and/or Katie Gunnell at the contact information provided at the beginning of this form.

**Contact for Concerns about the Rights of Research Subjects:**
If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at [email_address] or if long distance e-mail to [email_address].

**Consent:**
By submitting the first questionnaire, you are consenting to participate in this study. Please keep a copy of this consent form for your records.
Appendix C-2: Demographic Information

Section 1: This first part of the questionnaire is designed to describe the people participating in this study. All information received is held in confidence. Please provide your...

Today’s Date: ____________________________
Please provide an email address you can be contacted at to complete the intervention and follow-up questionnaires: ____________________________
Age

Height ________ Feet/inches or ________ Metres
Weight ________ Pounds (lbs) or ________ Kilograms (Kgs)

Please check one of the following...

1. What is your gender?
   θ Male   θ Female

2. What is your current marital status?
   θ Married/ Common Law   θ Widowed   θ Separated/ Divorced   θ Single/ Never Married

3. How would you describe your ethnic origin?
   θ Aboriginal   θ White   θ Asian   θ Filipino
   θ Black   θ Arab   θ West Asian   θ Chinese   θ Other
   θ Japanese   θ Korean   θ Southeast Asian   θ South Asian

4. What is your highest level of education completed?
   θ Some High School completed   θ High School Diploma   θ University/ College degree   θ Graduate Degree
Appendix C-3: Exercise Self-Schema Scale

(Kendzierski, 1988)

Please keep this definition of physical activity in mind as you respond to the following questions.

Section 2: The following statements pertain to your participation in physical activity. For the purposes of these statements, physical activity is defined as...

- Physical activity can include planned or structured exercise, sports, commuting activities by foot or bicycle, household chores (e.g., vacuuming), work activity (e.g., lifting heavy boxes) and leisure time hobbies (e.g., gardening).

- Physical activity is any bodily movement produced by the skeletal muscles that results in a substantial increase over the body’s energy expenditure.

Below are some questions regarding the way you view yourself. Please answer each question honestly. Indicate your answer by circling the appropriate number on the scale below the question.

<table>
<thead>
<tr>
<th>Question</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SOMEONE WHO EXERCISES REGULARLY</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
<tr>
<td>Does not describe me</td>
<td>Describes me</td>
</tr>
<tr>
<td>2. How important is BEING SOMEONE WHO EXERCISES REGULARLY to the image you have of yourself, regardless of whether or not the trait describes you?</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
<tr>
<td>Not at all important</td>
<td>Very important</td>
</tr>
<tr>
<td>3. SOMEONE WHO KEEPS IN SHAPE</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
<tr>
<td>Does not describe me</td>
<td>Describes me</td>
</tr>
<tr>
<td>4. How important is BEING SOMEONE WHO KEEPS IN SHAPE to the image you have of yourself, regardless of whether or not the trait describes you?</td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
<tr>
<td>Not at all important</td>
<td>Very important</td>
</tr>
<tr>
<td>5. PHYSICALLY ACTIVE</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Does not describe me</td>
<td>Describes me</td>
</tr>
</tbody>
</table>

6. How important is **BEING PHYSICALLY ACTIVE** to the image you have of yourself, regardless of whether or not the trait describes you?

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all important</td>
<td>Very important</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C-4: Meaning Scale
(Huta & Ryan, 2010)

*To what degree do you typically feel that your physical activity and physical activity experiences are...*

<table>
<thead>
<tr>
<th>1. Meaningful</th>
<th>2. Valuable</th>
<th>3. Precious</th>
<th>4. Full of significance</th>
<th>5. Something I can treasure</th>
<th>6. Dear to me</th>
<th>7. Playing an important role in some broader picture</th>
<th>8. Making a lot of sense to me</th>
<th>9. I can see where they fit into the bigger picture</th>
<th>10. I can see how they all add up</th>
<th>11. They contribute to various aspects of myself</th>
<th>12. They contribute to my community or the broader world</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Not at all</td>
<td>2.</td>
<td>3.</td>
<td>4.</td>
<td>5.</td>
<td>6.</td>
<td>7.</td>
<td>8.</td>
<td>9.</td>
<td>10.</td>
<td>11.</td>
<td>12.</td>
</tr>
</tbody>
</table>
Appendix C-5: Subjective Vitality Scale

(Ryan & Frederick, 1997)

These questions pertain to feelings people typically have when they engage in physical activity. Please respond to each of the following statements by indicating the degree to which the statement is true for YOU when engaged in physical activity. Use the following scale:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not at all true</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very true</td>
</tr>
<tr>
<td>1.</td>
<td>I feel alive and vital.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>I don’t feel very energetic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Sometimes I feel so alive I just want to burst.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>I have energy and spirit.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I look forward to each new day.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>I nearly always feel alert and awake.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>I feel energized.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C-6: Short Positive and Negative Affect Schedule

(Mackinnon et al., 1999; Watson et al., 1988)

This scale contains a number of words describing different feelings and emotions. Indicate to what extent you generally feel this way when you engage in physical activity. That is, how YOU feel on the average when you engage in physical activity.

<table>
<thead>
<tr>
<th></th>
<th>1 Very slightly or not at all</th>
<th>2 A little</th>
<th>3 Moderately</th>
<th>4 Quite a bit</th>
<th>5 Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Distressed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Alert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Scared</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Determined</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Afraid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Nervous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Excited</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Upset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Inspired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Enthusiastic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C-7: Modified Psychological Need Satisfaction in Exercise Scale

(Wilson, Rogers, et al., 2006)

The following statements represent different feelings people have when they engage in physical activity. Please answer the following questions by considering how you typically feel when *YOU engage in physical activity*. Use the following scale:

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel that I am able to complete physical activities that are personally challenging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I feel attached to my physical activity companions because they accept me for who I am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I feel like I share a common bond with people who are important to me when we do physical activity together</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I feel confident I can do even the most challenging physical activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I feel a sense of camaraderie with my physical activity companions because we do physical activity for the same reason</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I feel confident in my ability to perform physical activities that personally challenge me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I feel close to my physical activity companions who appreciate how difficult physical activity can be</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I feel free to do physical activity in my own way</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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</tr>
<tr>
<td>9. I feel free to make my own physical activity program decisions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I feel capable of completing physical activities that are challenging to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I feel like I am in charge of my physical activity program decisions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I feel like I am capable of doing even the most challenging physical activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I feel like I have a say in choosing the physical activities that I do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I feel connected to the people who I interact with while we do physical activity together</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. I feel good about the way I am able to complete challenging physical activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I feel like I get along well with other people who I interact with while we do physical activity together</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I feel free to choose which physical activities I participate in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I feel like I am the one who decides what physical activities I do</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C-8: Leisure Time Exercise Questionnaire

(Godin & Shephard, 1985)

During a typical 7-Day period (a week), how many times on average do you do the following kinds of physical activity for more than 15 minutes during your free time (write in each space the appropriate number)

<table>
<thead>
<tr>
<th>Intensity of Activity</th>
<th>Times Per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Strenuous Activity</strong></td>
<td></td>
</tr>
<tr>
<td>E.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling</td>
<td></td>
</tr>
<tr>
<td>• <strong>Moderate Activity</strong></td>
<td></td>
</tr>
<tr>
<td>E.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing</td>
<td></td>
</tr>
<tr>
<td>• <strong>Mild Activity</strong></td>
<td></td>
</tr>
<tr>
<td>E.g., yoga, archery, fishing from a river bank, bowling, horseshoes, golf, snow-mobiling, easy walking</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C-9: Implementation Fidelity Questions at Post-Intervention

How many times did you complete the writing task? (please circle one number)

1  2  3  4

How much effort would you say that you put in to the writing task?

0 (not much)  1  2  3  4  5 (a lot)

To what extent did you engage in and make use of the writing activity?

0 (not much)  1  2  3  4  5 (a lot)

If you stopped completing the writing task, or did not complete it at all, why? (if applicable, please circle one)

a. Not enough time
b. Too demanding
c. Didn’t find it useful
d. Forgot
e. Lost interest
f. Not meeting needs
g. Boring
f. Other (please describe):
Appendix C-10: Feedback at 1-Month Follow-Up

Thank you for participating in this study. In order to better understand your experience, please take a few moments to provide us with some feedback. This information will be considered in the design and implementation of future interventions of this nature.

1. After the study was complete, did you continue engaging in the writing task? (please circle one)

Yes/no

2. Have you made any changes in your life to pursue the physical activity-related self (or selves) you wrote about? If so what?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Please answer the following in regard to the writing you were involved in as part of this study:

3. Since the formal 4 week intervention was completed, how often would you say you would engage in the writing task? (please circle one response only)?

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
4. What did you find effective?

5. What could have been more effective?

6. What did you like?

7. What did you dislike?

8. Any other comments?
Appendix D: Intervention Scripts

D-1: Best Possible Physical Activity Self Script

D-2: Best Possible Physical Activity Self Script plus Psychological Need Satisfaction Primers

D-3: Control Group Script
Appendix D-1: Best Possible Physical Activity Self Script

Important: It is important that you read the instructions each time you complete the writing task. If you want to allow the researcher to use your writing for research purposes, please write in the box below. If you want to keep your writing private you can write in the box and then delete the writing BEFORE submitting, or write on a piece of paper in your own home. You may use whatever writing style you like. When you write, be as creative and as imaginative as you want, and provide as much detail as you choose. You can write about the same thing each week, or something different.

Writing Task
Think about your life in the future. You have worked hard and succeeded at accomplishing all of your physical activity goals. Imagine that everything has gone as well as it possibly could. Think of this as a realization of the best possible physically active life you could ever have hoped for. We are interested in your impression of yourself 5 to 10 years from now. More specifically, we would like you to think about yourself in the future as a person who is a healthy, physically active person. You follow a healthy lifestyle which includes engaging in regular physical activity. Five to ten years from now, you are at a healthy weight and have the energy to carry out your daily tasks. When you think about yourself five to ten years from now as a healthy regularly physically active person, what images come to mind? Consider yourself in the future and anything you consider to be related to physical activity. Some examples of physically active future selves include: possible selves about weight, activity levels, engagement in different activities, energy, and health. There are no right or wrong best possible selves.

In all cases you are identifying the best possible way that things might turn out in relation to your physical activity in the future, in order to help guide your decisions now. So we’d like to ask you to continue thinking in this way over the next few weeks, following up on the initial writing that you’re about to do. Now write about what you imagined. Please write for a minimum of 10 minutes.

Please select one:

☐ I consent to allow the researcher to use my writing for future research. If this data is used, pseudonyms would be used and participants will not be identifiable.

☐ I do not want my writing to be used for research (please delete any text from the above box before pressing complete)
Appendix D-2: Best Possible Physical Activity Self Script Plus Psychological Need Satisfaction Primers

**Important:** It is important that you read the instructions each time you complete the writing task. If you want to allow the researcher to use your writing for research purposes, please write in the box below. If you want to keep your writing private you can write in the box and then delete the writing **BEFORE** submitting, or write on a piece of paper in your own home. You may use whatever writing style you like. When you write, be as creative and as imaginative as you want, and provide as much detail as you choose. You can write about the same thing each week, or something different.

**Writing Task**

Think about your life in the future. You have worked hard and succeeded at accomplishing all of your physical activity goals. Imagine that everything has gone as well as it possibly could. Think of this as a realization of the best possible physically active life you could ever have hoped for. We are interested in your impression of yourself 5 to 10 years from now. More specifically, we would like you to think about yourself in the future as a person who is a healthy, physically active person. You follow a healthy lifestyle which includes engaging in regular physical activity. Five to ten years from now, you are at a healthy weight and have the energy to carry out your daily tasks. When you think about yourself five to ten years from now as a healthy regularly physically active person, what images come to mind? Consider yourself in the future and anything you consider to be related to physical activity. Some examples of physically active future selves include: possible selves about weight, activity levels, engagement in different activities, energy, and health. There are no right or wrong best possible selves.

Something to remember while you write about your future self is that being physically active is your decision. You may wish to write about engaging in physical activities that you find personally enjoyable. You may wish to write about continuing the physical activity you already do. The decision to be physically active is yours. You could write about physical activity possible selves that are reasonable, or personally challenging to you. One thing you can think about is writing about something you are good at! You may wish to write about yourself in the future engaging in activity with other meaningful people. You may see yourself in the future engaging in physical activity with people you share a common bond with.

In all cases you are identifying the best possible way that things might turn out in relation to your physical activity in the future, in order to help guide your decisions now. So we’d like to ask you to continue thinking in this way over the next few weeks, following up on the initial writing that you’re about to do. Now write about what you imagined. Please write for a minimum of 10 minutes.
Please select one:

☐ I consent to allow the researcher to use my writing for future research. If this data is used, pseudonyms would be used and participants will not be identifiable.

☐ I do not want my writing to be used for research (please delete any text from the above box before pressing complete)
Appendix D-3: Control Group

**Important:** It is important that you read the instructions each time you complete the writing task. If you want to allow the researcher to use your writing for research purposes, please write in the box below. If you want to keep your writing private you can write in the box and then delete the writing **BEFORE** submitting, or write on a piece of paper in your own home. You may use whatever writing style you like. When you write, be as creative and as imaginative as you want, and provide as much detail as you choose.

**Writing Task**

Please take a moment to think about what you did during the last 24 hours. That is, create a mental outline of what you did during that time. Please write out these activities in a list format. Next, choose one of the activities you listed and write about it in even more detail. You want to dissect the activity you previously listed into smaller pieces to describe exactly what you did. Repeat this process until you have written for a minimum of 10 minutes. Be as detail oriented as possible, but try to leave out emotions, feelings, or opinions pertaining to your plans. In other words, focus on exactly what you did.

Please select one:

- I consent to allow the researcher to use my writing for future research. If this data is used, pseudonyms would be used and participants will not be identifiable.

- I do not want my writing to be used for research (please delete any text from the above box before pressing complete)
Appendix E: Study 3 and 4 Recruitment and Procedures Material

E-1: Recruitment Poster

E-2: Email Recruitment Letter

E-3: Initial Contact Emailing Containing Baseline Questionnaire Link

E-4: Sample Intervention Email

E-5: Sample Reminder Intervention Email

E-6: Post-Intervention Email

E-7: 1 month Follow-up Email

E-8: Sample Reminder Email for Questionnaire
Appendix E-1: Recruitment Poster

Self and Well-Being:
The Role of Psychological Needs

Purpose of Study

To evaluate the effectiveness of a ‘self’ intervention on outcomes such as psychological need satisfaction, physical activity behaviour, and well-being. Attention to these important variables may ultimately help us understand well-being experienced in physical activity.

Requirements

- Participants must be 25 to 65 years old
- The Intervention involved 10 minutes of writing for 4 weeks, online and at your own convenience
- You will be asked to complete 3 ten to fifteen minute questionnaires about your physical activity, psychological needs, and well-being
- Any information you provide will remain confidential

For more information, interested individuals can contact:

- Ms. Katie Gunnell........ (604) 822-5580........ kgunnell10@gmail.com
- Dr. Peter Crocker........... (604) 822-5580........ pcrocker@interchange.ubc.ca

Cash Prize

- All participants will be entered into a draw for a chance to win one of three cash prizes of $50.00
Thank you for your interest in our research project.

This study is funded by the Social Sciences and Humanities Research Council of Canada
Dear (insert name)

My name is Katie Gunnell and I am a doctoral student at the University of British Columbia working under the supervision of Dr. Peter Crocker. We are currently looking for adults 25 to 65 years old to take part in an online intervention that examines the effectiveness of a self intervention on outcomes such as psychological need satisfaction, physical activity behaviour and well-being.

In order to conduct this study, I am hoping that you will be able to assist me by providing a venue to recruit participants to participate in this study. From you, I am requesting permission to place an announcement of our study in your e-news letter/listerv such that we can invite people to participate in the study. Your participation is completely voluntary.

Participants will be asked to complete questionnaires at three different time points (all online, at their convenience). Participants will be asked to engage in a writing exercise for 10 minutes once a week for 4 weeks as part of this intervention.

It is important to note that all information is confidential and only the research team members will know the identity of the participants and their responses to the questionnaire.

Please respond to this letter if you can help me with this study. You can contact me by email (kgunnell10@gmail.com). Thank you for your time and consideration.

Sincerely,
Katie Gunnell, MA, Ph.D Candidate
University of British Columbia
Appendix E-3: Initial Contact Emailing Containing Baseline Questionnaire Link

Greetings,

This e-mail is your invitation to participate in Dr. Peter Crocker and Katie Gunnell's research study entitled "Self and Well-Being: The role of Psychological Needs. The purpose of this investigation is to evaluate the effectiveness of a 'self' intervention on outcomes such as psychological need satisfaction and well-being. People engage in physical activity for varying reasons, have different goals, and experience different feelings towards physical activity. It is important to examine these variables because they may be associated with outcomes such as well-being experienced in physical activity contexts.

Interested adults aged 25 to 65 years old will be invited to take part in an intervention. If you choose to participate, we will ask that you complete a questionnaire via a secured internet survey. You will be randomly assigned to one of three groups and be asked to complete ten minutes of writing once a week for 4 weeks. You will then be asked to complete a brief questionnaire (10 minutes) at the end of 5 weeks and again after 1 month. Following this, participants who were assigned to the extended treatment will be given the opportunity to engage in the self writing treatment.

All participants will be entered into a draw for a chance to win one of three cash prizes of $50.00

If you wish to participate, please follow the link below.

$link$

It is important to note that all information is confidential and only the research team members will know the identity of the participants and their responses to the questionnaire.
For more information on the study or on how you can participate please contact Katie Gunnell by email (kgunnell10@gmail.com) or by phone (604-822-5580). Thank you for your time and consideration.

If you know anyone (i.e., friends/family/contacts) that might be interested in participating in this study, we ask that you discuss this research with them to determine their interests in volunteering to participate. Those individuals interested in participation should then contact the research team to volunteer.

Sincerely,
Katie Gunnell
Dear Participant,

I would like to invite you to participate in the intervention portion of the Self and Well-Being: The role of Psychological Needs study. You have been randomly assigned to one of three groups. Your participation in the intervention phase of this research will involve completing a brief ten minute writing activity once a week, for 4 weeks. You will receive a reminder email each week to complete the writing activity. It is important you read the instructions for the writing activity EACH time you complete the activity.

*Please note: Given the time sensitive nature of this intervention, it is important you engage in the writing task as soon as possible when you get the reminder email! If you do not log on within the next few days, you may receive another reminder email for this week’s component. If you are going to do the writing task on a piece of paper at home, please ensure you still follow the link and enter your email address so that I don’t keep sending you reminder emails!

The instructions to the writing activity can be accessed by clicking on the link below. When you click on the link, you will be redirected to the informed consent. If you agree to continue, you will then be given instructions for the 10 minute writing activity.

**TO BEGIN THE INTERVENTION, CLICK ON THE FOLLOWING LINK:**

https://survey.edudata.ca/es/czl1OA/YzMzMA/

Again, thank you for your involvement in this study. I really appreciate it! If you have any questions, please don’t hesitate to ask (you can reply to this email, or use the contact information provided by clicking the link).

Sincerely

Katie Gunnell
Appendix E-5: Sample Reminder Intervention Email

Dear Participant,

This is just a friendly reminder to complete the first 10 minute writing activity. If you completed the writing activity on a piece of paper in your own home, I still need you to enter your email address on the web page such that I know you did the activity.

The intervention is time sensitive so if you can log on and complete the activity as soon as possible, it would be greatly appreciated!

To access the writing activity instructions, please click the link below

https://survey.edudata.ca/es/czl10A/YzMzMA/

Sincerely,

Katie Gunnell
Appendix E-6: Post-Intervention Email

Dear Participant,

The intervention/writing portion of this research is now complete! I would like to invite you to participate in the follow-up questionnaire. It is important to complete this questionnaire to determine the intervention’s effect. Your participation in this follow-up questionnaire is GREATLY appreciated.

Even if you didn’t engage in all the writing tasks, we would still like you to complete the follow-up questionnaire!

The follow-up questionnaire can be accessed by clicking on the link below.

**TO BEGIN THE POST INTERVENTION QUESTIONNAIRE, CLICK ON THE FOLLOWING LINK:**

https://survey.edudata.ca/es/czl1NA/YzMzMw/

Thank you so much for your efforts and involvement in this research! I really appreciate the time you have taken to participate. If you have any questions, please don’t hesitate to ask (you can reply to this email, or use the contact information provided by clicking the link).

Sincerely

Katie Gunnell
Appendix E-7: 1 Month Follow-Up Email

Dear Participant,

I would like to invite you to participate in the 3rd and FINAL phase of this study – a brief questionnaire. The final questionnaire is expected to take approximately 10-15 minutes to complete. This questionnaire is important to complete because it will tell us the interventions longer-term effect. Furthermore, it will provide us with an opportunity to get feedback about the intervention from you!

The final questionnaire can be accessed by clicking on the link below.

Even if you didn’t engage in all the writing tasks or questionnaires, we would still like you to complete the follow-up questionnaire!

TO BEGIN THE FINAL QUESTIONNAIRE, CLICK ON THE FOLLOWING LINK:

https://survey.edudata.ca/es/czl1Ng/YzMzNA/

I want to take the time to thank you very much for your involvement in this study. I really appreciate it! It is only through participants such as yourself who give freely of their time that we are able to conduct this valuable research. If you have any questions, please don’t hesitate to ask (you can reply to this email, or use the contact information provided by clicking the link).

If you would like to receive a summary report about the results of this study, please send me an email requesting this information.

Sincerely

Katie Gunnell
Appendix E-8: Sample Reminder Email

Dear Participant,

This is just a reminder to complete the post intervention questionnaire. The writing portion of this study is now over and it is very important that you complete the post intervention questionnaire to determine the intervention’s effect.

Even if you missed some of the writing activities, we’d still like you to complete this questionnaire.

This study is time sensitive, so if you can log on and complete the questionnaire as soon as possible, it would be greatly appreciated!

To access post intervention questionnaire, please click the link below

https://survey.edudata.ca/es/czl1NA/YzMzMw/

Sincerely,

Katie Gunnell