EXPLORING MOTIVATIONAL MECHANISMS IN EXERCISE BEHAVIOUR

Applying Self-determination theory in a person-centred approach

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ABSTRACT

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Involvement in physical activity (PA) and exercise behaviour is multifaceted and depends on bidirectional correlations between multiple factors; one avenue to increase the understanding of sustainable exercise behaviours would be to employ a motivational perspective. In this thesis, this was done by placing the primary focus on Self-determination theory (SDT) as a person-centred approach to study the motivational mechanisms believed to impact exercise behaviour based on the SDT process model. **Study 1,** conducted in a cross-sectional design, included 1,091 members of a web-based exercise service. Based on sophisticated mediation analysis, the results support the hypothesized associations between latent constructs and exercise behaviour in the related steps of the SDT process model. Moreover, moderating effects were discovered, demonstrating that these associations could differ in different subgroups based on gender and age. The results of Study 1 thereby represent a first indication that exercise intervention design might benefit from slightly different approaches when addressing different demographical groups like gender and age. **Study 2** was conducted in a two-wave RCT design to test an SDT-informed intervention on 64 voluntary participants. Components of Motivational interviewing (MI), the Relapse prevention model (RPM) and Cognitive behavioural therapy (CBT) were used as practical application guidelines to deliver the intervention content. Results showed intervention effects on exercise level, exercise intensity and motivation quality as well as mediating effects of the RAI (Relative Autonomy Index; an index of the degree of self-determination), and identified regulation in relation to exercise behaviour. The experimental group also demonstrated significantly lower levels of extrinsic motivation than the control group post-intervention. Besides strong support for applying the basic tenets of SDT in the exercise domain, there are some main findings in this thesis. First of all, self-determined motivation was found to act as a mediating variable in the relationship between psychological need satisfaction and exercise, and these patterns of indirect effects differed across age and gender. This indicates that mechanisms in the SDT process model could vary (qualitatively) depending on subgroup, which carries potential implications for practice. Second, the results of Study 2 also provide evidence that the mediating mechanisms of the process model could be manipulated in an intervention, e.g. by creating need-supportive environments facilitating internalization and subsequent exercise behaviour. Furthermore, both studies demonstrated that identified regulation plays a prominent role in the motivational processes, supporting the significance of promoting internalization in activities like exercise. Finally, this thesis represents prospective value for the utility of employing a polytheoretical approach in exercise intervention design, more specifically regarding the prosperous outlooks in combining SDT with other theories and methods.

Key words: autonomy, competence, exercise, intervention, mediation, relatedness

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SWEDISH SUMMARY

Weman-Josefsson, A. K. (2014). *Exploring motivational mechanisms in exercise behaviour. Applying Self-determination theory in a person-centred approach*. Psykologiska institutionen, Göteborgs Universitet.

Motion och fysisk aktivitet är multifacetterade beteenden som påverkas av komplexa samband mellan en mängd olika faktorer och ett sätt öka förståelsen för mekanismerna bakom hållbara motionsbeteenden är att studera motivationsrelaterade förhållanden och förutsättningar. Denna licentiatavhandling har därför en personcentrerad ansats som baseras på en deskriptiv processmodell som ingår i Självbestämmandeteorin (Self-determination theory; SDT). I **Studie 1** genomfördes en tvärsnittsstudie på 1091 medlemmar i en web-baserad motionstjänst och avancerade medieringsanalyser genererade stöd för de hypotetiska relationerna mellan latenta variabler och motionsbeteende i processmodellen. Analyserna visade även modereringseffekter genom att dessa relationer skilde sig åt mellan grupper baserade på kön och ålder. Resultaten representerar därmed en första indikation på att utformandet av motionsinterventioner eventuellt kan gynnas av att anpassas till olika demografiska grupper, t ex baserat på kön och ålder. I **Studie 2** genomfördes en intervention på 64 frivilliga deltagare i form av en RCT-design med två mätpunkter. Det SDT-baserade innehållet i interventionen förmedlades med hjälp av praktiska riktlinjer från metoderna Motiverande samtal (MI), Återfallsprevention (RPM) och Kognitiv beteendeterapi (CBT). Resultaten visade interventionseffekter på motionsbeteenden (mängd och intensitet), samt medieringseffekter av RAI (Relative Autonomy Index; ett index på graden av självbestämmande) och identifierad reglering i relation till motionsbeteende. Experimentgruppen uppvisade även lägre nivåer av yttre motivation än kontrollgruppen efter interventionen. Båda studierna är därmed i linje med det växande empiriska stödet för applicering av SDT inom motionsområdet och bidrar på flera sätt till kunskapsutvecklingen om motivationsrelaterade mekanismer. Det främsta bidraget är att självbestämmande motivation visade sig fungera som en medierande variabel i relationen mellan tillfredsställelse av psykologiska basbehov och motionsbeteende och att dessa latenta effekter skilde sig åt utifrån deltagarnas kön och ålder. Detta pekar på att mekanismerna i processmodellen kan variera i olika grupper, vilket skulle kunna påverka eventuella praktiska implikationer för framtida interventionsdesign. Vidare indikerar resultaten i Studie 2 att medieringsmekanismerna i processmodellen är möjliga att manipulera i en intervention, exempelvis genom att skapa stödjande miljöer som främjar internalisering och därigenom efterföljande motionsbeteenden. Båda studierna visar även att identifierad reglering har en viktig funktion i motivationsprocessen, vilket understryker betydelsen av att främja internalisering i aktiviteter som motion. Slutligen finns det argument för värdet av att anta en poly-teoretisk ansats i skapandet av motionsinterventioner, framförallt genom att kombinera SDT med andra teorier och metoder.

Nyckelord: autonomi, intervention, kompetens, mediering, motivation, tillhörighet

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List of papers

Study 1: Weman-Josefsson, A. K., Lindwall, M., & Ivarsson, A. (submitted). The Role of Psychological Need Satisfaction and Self-Determined Motivation for Exercise: Moderating effects of gender and age.

Study 2: Weman-Josefsson, A. K., Lindwall, M., Fröberg, K., & Karlsson, S. (submitted). The effect of a six-week self-determination intervention on exercise.

Figures

Figure 1 Continuum of self-determination 4
Figure 2 SDT process model 8
Figure 3 Intervention design 17
Figure 4 Basic mediation model outline 18
Figure 5 Mediation model for the full sample 23

Tables

Table 1 Descriptives 21
Table 2 Intercorrelations among the latent factors of psychological need satisfaction (BPNES) and self-determined motivation (BREQ-2) 22
Table 3 Psychological need satisfaction and self-determined motivation (RAI) predicting exercise across gender and age 24
Table 4 Total psychological need satisfaction and self-determined motivation (all five BREQ-2 factors) predicting exercise across gender and age 25
Table 5 The mediating effects of self-determined motivation in the relationship between psychological need satisfaction and exercise across gender and age groups 26
Table 6 Means (SD) of study variables at baseline and post-intervention; within-group changes post-intervention and interaction effects (time*group) 27
Table 7 Thesis overview 44

Table of Contents

Introduction
- Effects of physical activity and exercise ... 1
- Prevalence and involvement ... 1
- Theoretical perspectives on exercise motivation ... 2
  - Self-determination theory (SDT) ... 3
    - Organismic integration theory (OIT) ... 4
    - Basic needs theory (BNT) ... 6
    - Cognitive evaluation and causality orientation ... 7
- SDT-based interventions ... 8
- From SDT theory to practice: autonomy support and motivational interviewing ... 9
- Person-centred perspectives ... 10

Purpose ... 13

Method ... 15
- Participants ... 15
  - Study 1 ... 15
  - Study 2 ... 15

Measures ... 15
- Psychological need satisfaction ... 15
- Behavioural regulation ... 15
- Self-reported exercise ... 16

Procedure ... 16
- Study 1 ... 16
- Study 2 ... 16
  - Intervention ... 17
- Mediation and moderation ... 18
- Data analysis ... 19
  - Study 1 ... 19
  - Study 2 ... 20

Results ... 21
- Study 1 ... 21
  - Factor validity of instruments and invariance testing ... 21
  - Psychological need satisfaction and self-determined motivation predicting exercise ... 22
  - Moderating effects of gender and age ... 23
  - Mediation in self-determined motivation, psychological need satisfaction and exercise ... 25
- Study 2 ... 26
  - Differences between groups post-intervention ... 26
  - The mediating effect of psychological need satisfaction and motivation quality ... 28

Discussion ... 29
- Study 1 ... 29
  - Relationships between the basic psychological needs ... 29
  - Relationships between psychological needs, regulations and exercise behaviour ... 31
  - Moderated mediation of gender and age ... 31
- Study 2 ... 33
  - Interventions effects ... 33
  - Intervention concerns ... 34
- General discussion ... 37
  - The big puzzle ... 37
  - Putting the pieces together ... 38
  - Strategies for enhancement of exercise motivation ... 39
  - Future directions ... 42
  - Conclusions and contributions ... 43

References ... 45

Introduction

Effects of physical activity and exercise

A considerable number of publications confirm the beneficial effects of physical activity and exercise, e.g. *European Health Reports* (WHO, 2009a, 2013) and *Physical Activity in the Prevention and Treatment of Disease* (YFA, 2010). Equally, there are also many warnings about the risks of physical inactivity and sedentary behaviour. According to the World Health Organization (WHO, 2009b, 2010), physical inactivity constitutes the fourth leading risk factor for global mortality and risk factors for burden of disease, even equivalent to smoking (Lee et al., 2012). It is important to differentiate between a sedentary lifestyle (i.e. a sedentary job situation and/or leisure time) and physical activtity/exercise, since they are considered to be two separate behaviours. Recent research shows that a sedentary lifestyle increases the risks of premature death and a number of common diseases regardless of exercise level (Healy et al., 2012; Katzmarzyk, 2010), suggesting a need for public health strategies aiming not only to increase physical activity (PA) and exercise levels, but also to reduce sitting time (Ekblom-Bak, Hellenius & Ekblom, 2010). Current health recommendations for PA level are to be physically active at moderate intensity for at least 30 minutes five days a week, or to work out at a higher intensity for a minimum of 20 minutes three times a week (Haskell et al., 2007). Due to the dose-response relationship between PA and health, according to Haskell and colleagues, exceeding the minimum recommendations will increase fitness and health benefits. It is essential to study how sustainable and cost-effective physical activity-promoting interventions could be fashioned (WHO, 2009), and already ten years ago, WHO stated that two million deaths and 20 million DALYs (Disability Adjusted Life Years) could be prevented globally through interventions successfully promoting a more physically active lifestyle in the population (Bull et al., 2004). Besides health economy benefits (Bolin & Lindgren, 2005), there are significant benefits for well-being, quality of life and perceived health status (Elley, Kerse, Arrol, & Robinson, 2003; Vuillemin et al., 2005). For instance, PA could be used to prevent and treat diseases like metabolic syndrome (Carroll & Dudfield, 2004), coronary heart disease, obesity, diabetes and insulin resistance (Frank et al., 2005; YFA, 2010) and depression (Josefsson, Lindwall, & Archer, 2013; Rimer et al., 2012). Further, PA has been shown to increase our ability to cope with stress (Georgiades et al., 2000; Traustadottir, Bosch, & Matt, 2005), to have an "anti-ageing effect" on our cell structure by lengthening the protecting telomeres (Cherkas et al., 2008) and, according to experiments on mice, potentially even to influence neurogenesis in the brain (Brene et al., 2007; Onksen, Briand, Galante, Pack, & Blendy, 2012).

Prevalence and involvement

Despite all these recognized benefits, humans have probably never been as sedentary as we are today. According to WHO (2011), approximately 44% of Swedish citizens were insufficiently physically active in 2008, which is fairly comparable to other Western countries. The reasons why so many (at least in Western societies) do not regularly engage in PA and exercise behaviours are undeniably complex. Considering human nature and ecological conditions, modern humans are not typically exposed to the physical demands they are genetically designed to manage. Due to the escalating technical development, most people are no longer forced into daily physical exertion in order to survive. The "Palaeolithic rhythm" coded in human genes (Booth, Chakravarthy, Gordon, & Spangenburg, 2002) means that in the same way people are programmed to use their bodies to hunt for and gather food, they are also programmed to rest when possible in order to save energy. This is a highly

adaptable human instinct when living under hunter-gatherer conditions (i.e. the conditions during approximately 99.9% of human history), but during the past century muscle power has become virtually unnecessary through uncountable clever inventions of machines and instruments, diminishing physical activity in our working lives (robots, computers, transports, communication), our homes (vacuum cleaners, dishwashers, lawnmowers) and our leisure-time activities (TV, smartphones, video games). In principal, today it is possible for most people to almost completely avoid physical exertion thanks to all these time- and effort-saving gadgets. As a result, in modern society PA is no longer required for human survival and people seem to respond to the programmed need to rest and save energy when possible, rather than having an inherent urge for PA. This means that people often have to make an active choice to be physically active outside the demands and societal expectations of their daily lives (e.g., using hidden stairs instead of escalators). In addition, personal beliefs, values and priorities engender different inclinations to engage in these (PA) behaviours, and factors of personal, environmental, psychological, social and cultural nature interrelate and affect these behavioural regulations. In order to understand multifaceted behaviours like PA and exercise, multiple mechanisms of such aspects need to be addressed (Nigg & Geller, 2012).

Despite the amount and variety of health information available today, apparently many people do not lead as healthy lives as they could or sometimes even would like to. Generally, people are most likely aware that regular PA and exercise are beneficial from a health perspective, but apparently this knowledge is not enough to incorporate the behaviour into their daily lifestyle routines, for a variety of possible reasons, as mentioned above. For example, in Sweden only 50% of those who get Physical Activity on Prescription (PaP) increase their PA level (Kallings et al., 2009; Leijon, Bendtsen, Nilsen, Festin, & Stahle, 2009), and for the past 30 years, exercise research has steadily shown that as much as 50% of exercise initiators drop out within three to six months (Buckworth, Dishman, & Tomporowski, 2013; Lox, Martin Ginis, & Petruzzello, 2010; Nigg, Borelli, Maddock, & Dishman, 2008). Hence, not even good intentions and initiated behaviour changes seem to be sufficient for people to be able to adhere to exercise behaviours. Consequently, adherence is a considerable challenge in promoting exercise (Patrick & Canavello, 2011; Portnoy, Scott-Sheldon, Johnson, & Carey, 2008).

In conclusion, involvement in PA and exercise behaviour are multifaceted, and it seems overwhelming to take into account all the plausible factors. One interesting way to narrow the understanding of human behaviour and "why we do what we do" would be to use a motivational perspective (Deci & Flaste, 1996). An established definition of motivation is *"…the internal and/or external forces that produce the initiation, direction, intensity, and persistence of behaviour"* (Vallerand, 2004, p. 428). Since adherence is closely related to motivational aspects, it is important to understand exercise motivation and its relation to adherence in order to construct effective interventions and methods promoting sustainable exercise behaviours. For that reason, the aim of this thesis is to use a motivational perspective to enhance the understanding of the psychological processes behind exercise behaviours for the promotion of behaviour change, adherence and maintenance.

Theoretical perspectives on exercise motivation

Motivation has been one of the most popular research topics for more than a century, and it would be sensible to start by narrowing the focus to exercise-specific theories of motivation. Biddle and Mutrie (2008) made a simple classification of theories of exercise behaviour, differentiating between for example *competence-based* (e.g. Self-efficacy theory), *stage-based* (e.g. Transtheoretical model of behaviour change) and *control-based* (e.g. Self-

determination theory) frameworks. An alternative way to crudely differentiate theories of exercise motivation could be to divide them into theories of *fundamental needs* (e.g. Self-determination theory) and *cognitive* theories (e.g. Self-efficacy theory and Relapse prevention model). There are numerous ways of defining theory foundations, but no matter how frameworks are categorized, they should not be viewed as antagonists but rather perhaps more as complementary efforts to understand and predict exercise behaviour. When behaviour change is the aim, a polytheoretical approach could in fact improve the predictive value and facilitate the effectiveness of interventions (Baranowski, Anderson, & Carmack, 1998), and theoretical utility could indeed be advanced by combining different theoretical approaches or models (Ntoumanis, 2012).

Basing interventions on sound theoretical foundations in order to enhance exercise motivation and behaviour change is strongly advocated (e.g. Biddle, Brehm, Verheijden, & Hopman-Rock, 2012; Fortier, Duda, Guérin, & Teixeira, 2012; Nigg & Geller, 2012), and a Swedish literature review even proposes that theory-based interventions have the potential to increase PA by 10-15% compared with usual care (SBU, 2007; see also Biddle et al., 2012). Theory-based work enables a deeper analysis of the underlying processes, providing a more profound understanding of why some behaviour changes are successful and some are not. It also generates structure, content and adequate evaluation systems for the intervention and enables the identification of contributing factors and for which part of the process each factor is important (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Cerin & MacKinnon, 2008). These aspects are important not only for face-to-face programmes but also in other settings like e-health, in terms of how tools and services are designed, thereby placing high demands on the ability to apply theory to practice. More specifically, theory could be helpful in tailoring personalized programmes, tools and services in interventions, e.g. by identifying stages of change (Transtheoretical model of behaviour change, Prochaska, DiClemente, & Norcross, 1992; Prochaska & Velicer, 1997) or managing barriers and drop-out (Relapse prevention model, Larimer, Palmer, & Marlatt, 1999; Marlatt & Gordon, 1985), promoting perceived ability (Self-efficacy theory, Bandura, 1977; 1986; 1997) or facilitating motivational climate and autonomy support (Self-determination theory; Deci & Ryan, 1985; 2000; 2012, and Motivational interviewing; Miller & Rollnick, 2002; Miller & Rollnick, 2012). This thesis will focus primarily on theory and method concerning motivational climate and autonomy support as a person-centred approach.

Self-determination theory (SDT)

SDT (Deci & Ryan, 1985; 2000; Ryan & Deci, 2002) is a multidimensional theory grounded in both cognitive and humanistic psychology. Its emphasis is on the social context and its ability to facilitate or thwart optimal motivation, and on the extent to which behaviours are generally self-determined or controlled in nature, capturing both situational and personality-related aspects of motivation. From an SDT perspective, humans are proposed to have a natural tendency to explore and master their environment (Ryan & Deci, 2002), i.e. an innate (or intrinsic) drive motivating behaviour, a notion quite contrary to behaviouristic motivation perspectives, which claim that drives are governed by external factors. Intrinsically motivated behaviours are volitional and spontaneous, concurring with our inner interests (i.e. not in order to achieve separate consequences), and hence represent the prototype of self-determined behaviours (Deci, 1975). Deci and Ryan (2000) highlight the distinction between goal content (what) and the regulation processes by which goals are pursued (why), and argue that motivation quality has a significant impact on human behaviour. This "Copernican turn in motivational thinking" (Deci & Ryan, 2013) represents a paradigm shift from traditional views of motivated behaviour. The quantity of motivation

concerns the amount of motivation a person has regarding a certain behaviour, and can be linked to social-cognitive theories (like self-efficacy, see Fortier et al., 2011), representing motivation magnitude or level. The quality of motivation concerns different types of motivation, and according to SDT, specific types of motivation generate different consequences (e.g. related to health and well-being) regardless of motivation quantity (Deci and Ryan, 2000). Consequently, SDT focuses on the quality of motivation in different situations and on how the environment could stimulate or hamper the above-mentioned innate behavioural drive towards certain activities. For example, if the environment is perceived as hindering and/or controlling, natural engagement is assumed to deteriorate (Deci & Ryan, 2000).

Organismic integration theory (OIT)

An essential ingredient of SDT is the sub-theory OIT (Deci & Ryan, 2000), defining (qualitatively) different dimensions of motivation on a continuum. The quality dimensions are relative to the degree of the behaviour being regulated by self-determined versus controlled aspects (see Figure 1). The continuum stretches from highly controlled non-regulation (amotivation), through four types of gradually more autonomous regulations (extrinsic motivation), over to fully self-determined regulation (intrinsic motivation) at the other end. The continuum describes how activities and behaviours vary in the degree of self-determination through the process of *internalization* and integration of regulations. Internalization is a central aspect of human motivation, whereby people integrate values and behaviours of significant others (or a given culture) into the self (Ryan & Deci, 2002). In this manner initially uninteresting, boring or strenuous activities could become more self-regulated and allow people (to various degrees) to feel self-determined or autonomous even when doing extrinsically motivated activities. By integrating and transforming external regulations through internalization, one is able to be more autonomous in executing the behaviour. For example, integrated regulation signify an optimal internalization process through which social regulations are fully accepted as our own, while introjection denotes values and regulations remaining external or only being partially internalized (Ryan & Deci, 2002). With increased internalization the motivation becomes more self-determined, which enhances persistence and adherence (Deci & Ryan, 2000). In this perspective, even extrinsic motivation can be self-determined and people may therefore engage in exercise behaviours not exclusively for intrinsic reasons but also to achieve internalized outcomes (Hagger & Chatzisarantis, 2008).

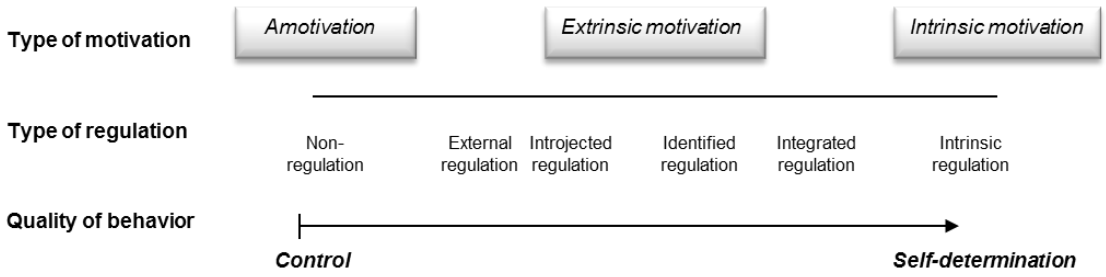

Figure 1 Continuum of self-determination (adapted from Ryan & Deci, 2002, p. 16)

According to OIT (Ryan & Deci, 2002; Deci & Ryan, 2000), *Amotivation* stems from feeling incompetent and helpless (e.g. "It's impossible" or "It's not worth it"), representing non-regulation and non-intentional behaviour. Due to the absence of both intrinsic and

extrinsic motivation, it contains no self-determination. *Externally regulated* behaviours are pursued in order to achieve external rewards or avoid punishment, signified by the classic "carrot and stick" metaphor. This highly controlled form of motivation reduces intrinsic motivation, and since it is contingency-dependent, externally regulated behaviours are assumed to be maintained only as long as the rewards remain present; hence it has low predictive value regarding adherence. *Introjected regulation* is a slightly less controlled motivation, whereby the contingent rewards or punishments are delivered by oneself through feelings like pride, shame or guilt (e.g. "I should" or "I ought to") or in order to maintain self-worth. The internalization process is hereby initiated, and this type of motivation is hypothesized to have a stronger influence on behavioural maintenance than external regulation, albeit not self-determined or integrated with the self. *Identified regulation* represents what happens if the internalization proceeds further and the behaviour becomes increasingly important, valued and volitional. Motivation concerning the behaviour is instrumental (e.g. one exercises because the expected health benefits are important), but it is more self-determined and could thereby be expected to yield higher commitment and maintenance. *Integrated regulation* represents the most self-determined form of extrinsic motivation, which is now optimally internalized and stems from values and beliefs coherent with our identity and integrated with other aspects of the self. In this dimension, external regulation has become self-regulated and volitional (e.g. "Exercise and healthy living is part of who I am"), and the activity also supports other important behaviours or life goals. Nevertheless, even if these features make integrated motivation closely related to intrinsic motivation, it is still instrumental to some degree and therefore also still extrinsic by definition. *Intrinsic regulation*, on the other hand, is completely self-determined and characterized by enjoyment, curiosity and passion; the inherent pleasure of performing the activity in itself (e.g. "I exercise because it's fun and exciting"). When self-determined one experiences volition, self-regulation and autonomy, and as long as the activity is interesting, stimulating and optimally challenging the behaviour can be expected to be self-maintained. Self-determined motivation hence has a strong predictive value for behavioural maintenance (Ryan & Deci, 2002; Deci & Ryan, 2000).

The most important contribution of OIT is the provision of a plausible explanation for how people get motivated to engage in all the (e.g. tedious, uninteresting or exhausting) behaviours that are not energized by intrinsic motivation. It is suggested that internalization is especially important for the regulation and maintenance of demanding or non-enjoyable behaviours like exercise (Deci & Ryan, 2000). For instance, identified regulation has been shown to predict strenuous exercise, implicating the significance of valuing the activity as personally important and meaningful due to, e.g., potential health benefits (Edmunds, Ntoumanis, & Duda, 2006), and Teixeira, Carraca, Markland, Silva and Ryan (2012) even suggested that identified regulation might be "*the single best correlate of exercise*" (p 22). Motivational regulations are strongly linked to goals and motives, and several motives (intrinsic and extrinsic) can be held simultaneously so that any given behaviour contains portions of different types of motivation (e.g., both "I ought to" and "It's fun"), a phenomenon sometimes referred to as "*motivational soup*" (Teixeira, 2013). These multiple reasons can also vary in strength from day to day, but taken together, regulations behind the given behaviour are typically assumed to add up to a more or less controlled or autonomously oriented profile. Furthermore, Vansteenkiste (2013) uses the terms *mustivation* (introjected and external regulations) and *wantivation* (intrinsic, integrated, identified regulations), which in turn could relate to the fact that proximal regulations are expected to correlate with each other in a simplex-like pattern (Ryan & Deci, 2002), a belief supported by research (Markland & Tobin, 2010; McDonough & Crocker, 2007) and highlighted in a recent review by Teixeira et al. (2012). However, Vansteenkiste et al. (2008) also suggest that people could be high in

both controlled and autonomous forms, as well as high autonomous/low controlled or low autonomous/high controlled, which to some extent also corresponds to the notions behind motivational soup. As an example, Gillison, Osborn, Standage and Skevington (2009) found that introjected regulation not only (without apparent negative effects) coexisted with more self-determined forms of motivation, but was also associated with higher levels of physical activity. Although it is argued that introjected motivation also might play an important role in the internalization process (Gillison et al., 2009; Vansteenkiste, Soenens & Vandereycken, 2005), and may serve motivational purposes initially or in the shorter term, it should be kept in mind that even if controlled processes can motivate behaviour, being regulated by feelings of guilt or shame can also have negative effects (Deci & Ryan, 2000).

Basic needs theory (BNT)

In order to get a more comprehensive understanding of the foundations empowering different regulations, some basic elements affecting motivation quality must be considered; that is, human needs. According to SDT, self-determined motivation and psychological well-being will be promoted when certain basic psychological needs are satisfied, described in the sub-theory BNT (Deci & Ryan, 2000; Ryan & Deci, 2002). BNT posits that self-determined motivation is based on the satisfaction of three basic psychological needs: competence, relatedness and autonomy. The need for competence reflects feeling effective when interacting with other people and obtaining desired outcomes (Deci & Ryan, 2000), and is similar to the concept of self-efficacy (Bandura, 1977; 1997), a situation-specific cognitive mechanism and part of Social Cognitive Theory (Bandura 1986), arguing that the strongest force in behaviour change is a personal conviction that one is able to successfully perform the change. An important discrepancy between the need for competence and self-efficacy is that the latter does not distinguish between intrinsic and extrinsic motivation (Deci & Ryan, 2000), hence claiming that all behaviours are merely motivated by desired objectives and the feeling of being capable of reaching these goals or aspirations.

Further, the need for relatedness involves the need to feel connected to other people, to be part of a social context, while the need for autonomy contains feelings of volition and choice, to be the agent of our own actions. SDT stipulates that people seek out need-supportive settings (e.g. objectives and relations), that self-determined motivation and psychological well-being will be promoted when the three needs are satisfied, and that these needs are essential for understanding the "what" (i.e. content) and "why" (i.e. process) of human objectives and behaviours. Basic psychological needs are defined as "*innate psychological nutriments that are essential for on-going psychological growth, integrity and well-being*" (Ryan & Deci, 2002, p 229) and are based on inborn, lifelong propensities to pursue effectance (i.e. to feel effective through mastery and skill development; see White, 1959), coherence and affiliation. Placing this in an evolutionary perspective, the adaptable human would be naturally interested in socializing, practicing abilities and integrating experiences, making basic psychological needs fundamental for motivating action and effectance in social relations.

Deci and Ryan (2000) also suggest that just as people's physical needs can vary, psychological need significance can be expected to vary between individuals, i.e. that the three needs would naturally differ in strength between people. Accordingly, they argue that the focus of SDT is not need satisfaction magnitude, and that the study of variations in motivational orientation and goal content is far more informative and useful in the understanding of human behaviour (Deci & Ryan, 2000). As stated above, numerous behaviours are not inherently interesting and enjoyable, and the energy motivating these behaviours is fuelled by psychological need satisfaction (Deci & Ryan, 2002). Accordingly, the satisfaction of basic psychological needs constitutes the fuel necessary for intrinsic

motivation and the internalization of extrinsic motivation to arise, and thus for well-being and optimal development. It is postulated that if need satisfaction is thwarted, negative consequences like overly external aspirations (e.g. for social recognition), risky health behaviours (e.g. smoking) and forestalled internalization could follow. In the long term, controlled motivation and amotivation are thought to cause negative conditions like learned helplessness and other self-protective behaviours (Ryan & Deci, 2002). Because internalization is a natural but not automatic process, it requires nutriments (e.g. feeling capable or affiliated) in order to progress; and all three needs are considered important for optimal development and for self-determined motivation to occur (Deci & Ryan, 2000). For example, competence is regarded as essential in all forms of motivation, while autonomy is required for intrinsic motivation. Relatedness is perceived as essential for the maintenance of intrinsic motivation, but since even solitary activities can be driven by intrinsic motivation, perhaps this need has a more "distal role" than the others (Deci & Ryan, 2000). In support of this view, previous studies have found competence and autonomy need satisfaction to be stronger than relatedness in exercise settings (Wilson, Longley, Muon, Rodgers, & Murray, 2006; Wilson, Rodgers, & Fraser, 2002), discussing differences in contexts and degree of internalization as possibly influencing the impact of the need for relatedness. Not surprisingly, then, the role of relatedness in exercise settings has been debated (e.g. McDonough & Crocker, 2007; Wilson et al., 2002) and the findings on relatedness are mixed (Teixeira et al., 2012). Another common trend in previous work is the strong intercorrelations between the needs, particularly competence and autonomy (e.g., Markland & Tobin, 2010), suggesting that the three needs may be captured by an underlying unidimensional factor. Supporting this view, Hagger and Chatzisarantis (2006) found that a single global need satisfaction factor could explain latent variables representing autonomy, competence and relatedness.

BMT and OIT are linked together, the former constituting a map of the origins of self-determined regulations in motivation and the latter seeking to explain how externally regulated behaviours can become incorporated in a person's self-determined way of life in order to satisfy basic needs (Hagger & Chatzisarantis, 2008). Hence, people's interest in (motivation to perform) a given activity will vary in relation to the degree of need satisfaction when doing it; and as long as the nutrimental needs are achievable, the organismic tendency to engage in activities supporting vitality, integration and health will be sustained (Deci & Ryan, 2000). To exemplify this, Edmunds et al. (2008) found that need satisfaction increased not only self-determined motivation towards exercise but also attendance rates; and another study by Edmunds et al. (2007) found that an increase in relatedness satisfaction also related to greater adherence.

Cognitive evaluation and causality orientation

The theoretical framework of SDT contains four sub-theories, sharing the same philosophical foundations and containing basic psychological needs (Ryan & Deci, 2002). OIT and BNT have already been mentioned and the two other sub-theories, *Cognitive evaluation theory* (CET) and *Causality orientations theory* (COT), will be described briefly here. Causality orientations concern individual differences regarding our general motivational tendencies, hence tapping the personality dimension of motivation. They are classified into an index consisting of three different orientations, depending on the amount of self-determination represented and our personal tendencies towards autonomy-supportive settings. These orientations are denoted as *autonomous* (i.e. driven by values, curiosity and interest); *controlled* (i.e. governed by demands and introjects); and *impersonal* (i.e. experienced ineffectance and amotivation). Cognitive evaluation refers to how intrinsic motivation can be affected by the social context, relative to the extent it supports or thwarts psychological need satisfaction through two primary processes: perceived locus of causality and perceived

competence. *Perceived locus of causality* denotes the need for autonomy and whether the situation prompts internal (enhancing intrinsic motivation) or external (hampering intrinsic motivation) locus. As the name implies, *perceived competence* refers to the need for competence and whether the situation facilitates (enhancing intrinsic motivation) or reduces (hampering intrinsic motivation) perceived competence (Ryan & Deci, 2002).

SDT-based interventions

SDT has a considerable amount of research supporting its notions in health behaviour change (Ng et al., 2012; Sheldon, Williams, & Joiner, 2003) and in the exercise field (Teixeira et al., 2012; Fortier et al., 2012; Hagger & Chatzisarantis, 2008). There is also emergent empirical evidence for its application in specific domains like exercise adherence (Patrick & Canavello, 2011; Williams, Niemiec, Patrick, & Deci, 2009) as well as in e-health (Pingree et al., 2010; Webber, Tate, Ward, & Bowling, 2010). Understanding the prerequisites for psychological need satisfaction (or thwarting) generates practical implications for constructing autonomy-supportive social environments facilitating self-determined motivation and subsequently improving psychological well-being (Deci & Ryan, 2000). Given that autonomous motivation can be modified through an intervention (Fortier, Sweet, O'Sullivan, & Williams, 2007) and that the proposed relationships between need satisfaction (BNT), motivational regulations (OIT) and behavioural outcomes are described in comprehensive process models (e.g. Williams et al., 2006; Pingree et al., 2010; Fortier et al., 2012), it is possible to study motivational sequence and specific mechanisms behind these processes and thereby help tailor successful interventions (e.g. Fortier et al., 2011).

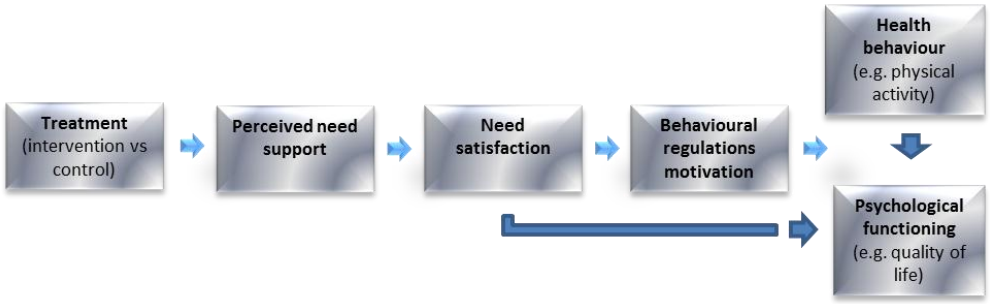

Figure 2. The SDT process model for health behaviour change in intervention research (adapted from Fortier et al., 2012, p 3)

In line with these propositions, this thesis is guided by a process model (Figure 2), illustrating the motivational sequence proposed by SDT. In short, the model describes the hypothesized causal mechanisms behind maintained health behaviour change and psychological well-being (Fortier et al., 2012). The SDT process model postulates that if an intervention (Steps 1 & 2) increases need satisfaction (Step 3), self-determined motivation will increase (Step 4), which in turn will predict the final steps into positive behavioural and psychological outcomes. The value of utilizing the SDT process model has substantial support (e.g. Williams et al., 2006; (Williams et al., 2002; Fortier et al., 2012; Pingree et al., 2010; Silva et al., 2011). An avenue less studied is the possibilty that there is reason to believe that the key associations in the SDT process model differ on the basis of demographical factors. Due to natural variations in personal values, health and goals, the individual motives for exercise and PA will possibly change at various points in life (Miller & Iris, 2002). For example, Wilson et al. (2006) found that psychological need satisfaction in an exercise setting

changed over time, as well as gender differences in the association between need satisfaction and well-being. Furthermore, Brunet and Sabiston (2011) found that introjected regulations correlated with PA among younger adults, while older adults seemed to be more internally regulated in terms of PA behaviour. Regarding gender differences in behavioural regulation level, current findings are inconsistent (Guérin, Fortier, & Sweet, 2012), demonstrating gender differences, for example, in introjected regulation (e.g. Gillison et al., 2009; Brunet & Sabiston, 2009) as well as similar patterns across gender (Duncan, Hall, Wilson, & Jenny, 2010; Guérin et al., 2012). Due to these findings of gender and age mean-level differences, it seems reasonable to progress by exploring these features through more sophisticated analyses of mediation and moderation. Recognizing such differences as potential moderators in the pathways between psychological need satisfaction, motivational regulations and outcomes might serve to improve exercise interventions for specific subgroups (Nigg & Geller, 2012).

From SDT to practice: autonomy support and motivational interviewing

By applying *autonomy support*, the SDT framework has proven to be a promising compass tool in intervention design (e.g. Ng et al., 2012; Cheon, Reeve, & Moon, 2012). Autonomy support is an interpersonal style that practitioners (e.g. teachers, counsellors, coaches, health-care providers etc.) can learn (Sheldon et al., 2003; Reeve & Halusic, 2009; Su & Reeve, 2010; Ntoumanis, 2012), and entails the things said and done in order to facilitate a person's locus of causality, volition and perceived options (Reeve et al., 2003). This is done by creating an environment promoting autonomy, competence and relatedness need satisfaction, facilitating internalization and minimizing control and pressure (Sheldon et al., 2003). In short, autonomy-supportive strategies would include *providing a meaningful rationale* (explaining utility and value of the target behaviour), *acknowledging negative feelings* (demonstrating empathy and understanding), *using non-controlling language* (avoiding terms like "must" and "should"), *offering choice* (informing about options) and *encouraging inner motivational resources* (stimulating interest, enjoyment and curiosity) (Su & Reeves, 2010; Fortier et al., 2011).

A growing amount of research also highlights the practical implications of the commonalities of SDT and the clinical method motivational interviewing (MI, Miller & Rollnick, 2002) regarding the significance of autonomy support for successful health behaviour change (Deci & Ryan, 2012; Patrick & Williams, 2012) suggesting that an applied combination of the two frameworks would be prosperous in intervention design. MI is a method developed from practice in treating addictive behaviours, defined as a "*collaborative, person-centred form of guiding to elicit and strengthen motivation for change*" (Miller & Rollnick, 2009, *p.* 137). Hence, MI aims to change a certain behaviour by exploring and solving ambivalence (Miller & Rollnick, 2002), e.g. through building rapport and considering readiness for change (Burke, Arkowitz, & Menchola, 2003) using four basic principles: a) expressing empathy, b) developing discrepancy, c) rolling with resistance, and d) supporting self-efficacy (Miller & Rollnick, 2002). MI is receiving growing empirical support for promoting health behaviour change (Miller & Rollnick, 2012; Lundahl, Kunz, Brownell, Tollefson, & Burke, 2010; Burke et al., 2003) in the PA domain (e.g. van Keulen et al., 2011) as well. The main weakness of MI, however, is that since it is a "bottom-up" model developed from practice it lacks coherent theoretical foundations, which makes it difficult to explain and understand the behavioural effects of MI-based interventions (Patrick & Williams, 2012). Interestingly, there seems to be a natural fit between the model of MI and the theoretical frame of SDT (e.g. Markland, Ryan, Tobin, & Rollnick, 2005; Vansteenkiste & Sheldon, 2006; Deci & Ryan, 2012), and it has been suggested that SDT could back up the theory deficiency in MI, while MI could provide SDT with guidelines in terms of practical

implications and methods (e.g. Patrick & Williams, 2012). Supporting autonomy and volition are basic fundaments in both MI and SDT, and they share a person-centred approach as well as human needs awareness (Miller & Rollnick, 2012; Deci & Ryan, 2012). In addition, both SDT and MI are process-oriented (Teixeira, Palmeira, & Vansteenkiste, 2012) and the needs of BNT are an essential part of MI (Miller & Rollnick, 2012).

Current research also recommends interventions combining SDT with other frameworks of health behaviour, like the Transtheoretical model of behaviour change (see Fortier & Kowal, 2007) and the Relapse prevention model (see Gustafson et al., 2011), and with methods like Cognitive behavioural therapy (see Khazaal et al., 2008). In brief, the Transtheoretical model of behaviour change (TTM; Prochaska, DiClemente & Norcross, 1994; Marcus & Simkin, 1994) integrates cognitive theory (e.g. Self-efficacy theory and the Relapse prevention model) and behavioural strategies. It describes and explains the gradual process by which people change their behaviour through various stages of attitudes, motivation and behaviour, as well as how behaviour maintenance can be promoted. The basic idea in applying the model is timing; that is, to provide the accurate advice at the right moment based on the stage in the model at which the target person is located. The proposed stages in TTM are *Precontemplation, Contemplation, Preparation, Action* and *Maintenance* (Prochaska et al., 1994). The Relapse prevention model (RPM, Marlatt & Gordon, 1985; Larimer et al., 1999) involves cognitive and behavioural strategies for effective coping in certain high-risk situations that could tempt people to regress and return to an earlier stage of change. Like other health behaviours, exercise adherence entails embarking on a journey for life; therefore maintenance cannot be expected to be a linear process, and slips, lapses and relapses are thus a natural part of it (Stetson et al., 2005). As an example of TTM and RPM utility, reviews have demonstrated that PA intervention programmes personally customized to readiness of change (Kahn et al., 2002; Ogilvie et al., 2007) and containing goal setting and relapse-prevention strategies (Kahn et al. 2002) are useful and effective. Cognitive behavioural therapy (CBT) is an evidence-based psychological therapy method (Robertson, 2010) sprung from the behaviouristic tradition and encompassing a variety of treatment principles (O'Donohue & Fisher, 2012) such as *goal setting* (support in adequate goal-setting procedures; see Linton & Flink, 2011), *psychoeducation* (increasing knowledge and insight by exchanging information; see Lukens & McFarlane, 2004), *behaviour chain analysis* (description of behaviour foundations and resolvement; see Sudak, 2011), *rationale* (theory-based descriptions of a proposed working model/intervention, see Sudak, 2011), and many more.

Person-centred perspectives

Mounting literature proposes applying a *person-centred* approach in different areas like counselling and therapy (e.g. Casemore, 2011; Quinn, 2013), management (Dai & De Meuse, 2013), sport (Gucciardi, Mahoney, Jalleh, Donovan, & Parkes, 2012; Yi, Smith, & Vitaliano, 2005) and health and social care (e.g. Thompson, Kilbane, & Sanderson, 2008). Person-centredness has been expressed in terms of counselling style or guiding philosophy/ethics (Price, 2006), while others have referred to it by using person-centred analyses and studying patterns in cluster analysis (Maarten Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009) in favour of, and in opposition to, a variable-centred approach (DeFruyt, 2002). In the literature there seems to be little or no consensus on the definition of person-centredness across domains, yet some of those focusing on interactive guidance share substructures which will be discussed in this thesis. In the field of psychology, the person-centred approach is held to stem from perspectives of humanism and existentialism, originating from Carl Rogers, who in the 1940s strongly challenged prevailing behaviouristic and psychoanalytic perspectives on

counselling with his *client-centred therapy* (Casemore, 2011). In health-care, a similar but perhaps more ethical-philosophical view has recently been conveyed in the area of Person-centred care (PCC; see Lindseth, Olsson, Liden, & Ohlen, 2011), mainly founded in the hermeneutics of Paul Riceur (see Kristensson-Uggla, 2011) and the psychology of personhood (Harré, 1998), stating that patients should be treated like persons (Entwistle & Watt, 2013).

When examining the philosophy behind PCC (i.e. personalism, see Ekman et al., 2014; Smith, 2010), the stipulations of SDT seem to go hand-in-hand with the basic outlooks of PCC. In both perspectives the person's subjective experiences are fundamental (cf. *person narrative,* see Lindseth et al., 2011); both consider the person an active, thinking and capable resource (cf. *homo capax,* see Smith, 2010 and Kristensson-Uggla, 2011); and both views encourage participative planning, discussion, problem-solving and decision-making (cf. *working partnership,* see Lindseth et al., 2011). In contrast to individualistic perspectives like personalized medicine (see e.g. Taegtmeyer, 2007 for description) that mainly focus on an individual's genetic or phenotype variations (Lindseth et al., 2011), both PCC and SDT are highly characterized by centring around the person per se and on social relations. In PCC the social environment and the relationship between caregiver and receiver are markedly stressed (e.g. Lindseth et al., 2011; Ekman et al., 2014), and similarly, SDT highlights the significance of social context for self-determination and well-being through autonomy-supportive environments (Deci & Ryan, 2000; Ryan & Deci, 2002). It is important to note that the concept of autonomy in SDT is not considered individualistic (as in independence) but rather analogous to the person-environment relationship in PCC, and could therefore also be conceived through the PCC concepts *volition* and *interest* discussed by Smith (2010). Furthermore, supporting autonomy and personal control is a pronounced goal in PCC (Beadle-Brown, 2006), along with identifying what is important to a patient (McCormack, 2010), hence clearly tapping fundamental elements of SDT. Also, when addressing issues of adherence, the SDT-related concept *self-concordance* (see Sheldon & Elliot, 1999; Sheldon & Kasser, 1998) appears to be better aligned with the philosophy of person-centredness than the controlling term *compliance*, traditionally used in health care (see Aronson, 2007 for concept discussion) in PCC as well (Munthe, Sandman, & Cutas, 2012). Finally, due to a current lack of valid and reliable measures in perceived person-centeredness across services and contexts (Nilsson, Lindkvist, Rasmussen, & Edvardsson, 2013), PCC assessment development is highly warranted (Price, 2006; Steenbergen et al., 2013). Given the above-mentioned commonalities between SDT and PCC foundations, and as SDT-related components like self-determination and need satisfaction can be reliably measured (Teixeira et al., 2012), perhaps conceptualizations of SDT could operate as complementary measures of person-centredness as an outcome. Altogether, there seems to be a prosperous outlook in combining SDT and PCC, possibly even regarding progressing the theoretical understanding and operationalization of PCC and thereby progressing matters of measurement.

To sum up, although regular PA and exercise can evidently offer positive physical and psychological health effects, these benefits will only be reaped through appropriate dose-response interactions. While establishing sustainable exercise routines have proven to be challenging, understanding the motivational prerequisites of exercise and PA behaviour could help disentangle the complex foundations of exercise and PA engagement. In this area, SDT has received substantive support for its application in both research and practice, even in combination with other theoretical approaches and methods. Based on previous research, it seems fruitful to further explore and advance the knowledge of motivational foundations, conditions and mechanisms. It would be of particular importance to progress the practical implications for successful and cost-effective intervention design, promoting exercise adherence and long-term maintenance.

Purpose

The main purpose of the thesis was to explore the motivational processes underlying exercise behaviours, using Self-determination theory and a person-centred approach as frameworks. This was done in two studies related to different steps of the SDT process model (Figure 2). The aim of the first study was to examine theoretically derived hypotheses on a) the relationships between the latent constructs of psychological needs, self-determined motivation and the manifest variable of exercise behaviour, b) the mediational role of self-determined motivation in the association of psychological needs with exercise behaviour, and c) gender and age differences in the aforementioned associations. The purpose of the second study was to examine the effects of an exercise intervention, informed by SDT with added elements of CBT, MI and relapse prevention strategies, regarding a) exercise level, b) motivation quality, and c) need satisfaction in autonomy and competence, respectively. A secondary aim was to test the indirect (mediating) effects of self-determined motivation and need satisfaction in the effect of the intervention on exercise behaviour.

Method

Participants

Study 1

The participants (N = 1,091) – 286 men and 805 women, aged 18-78 years (M=45.0; SD=11.7) – were all active Swedish members of an exercise programme created by a Swedish company in the e-health industry offering web-based health-care services (e.g. pedometer step contests, weight-loss programmes, etc.) mainly in the private sector. Since customers could join the web service either by purchasing a private membership (n= 251) or by joining a group package provided by their employer (n=840), the sample was expected to be diverse in aspects such as fitness level, age and gender, as well as motivational aspects.

Study 2

The participants were 64 undergraduate university students (49 women and 15 men) aged 19-49 years (M = 27.3; SD = 7.4). The inclusion criterion for this convenience sample was that the participants were not currently engaging in exercise activities more than once a week.

Measures

Psychological need satisfaction

Several SDT-driven instruments have been developed to asses psychological needs in exercise, and two different measures were utilized in this thesis. In Study 1, the Basic psychological needs in exercise scale (BPNES, Vlachopoulos & Michailidou, 2006) was used to measure satisfaction of the three needs autonomy, competence and relatedness. It consists of 12 items and a five-point Likert scale, where 1 = "I don't agree at all" and 5 = "I completely agree". Cronbach's alpha for the BPNES ranged from α 0.81 to 0.92. In Study 2, 12 items representing the factors of autonomy and competence in the Psychological needs in exercise scale (PNSE, Wilson, Rogers, Rodgers, & Wild, 2006) were used to measure psychological need satisfaction through statements assessed on a six-point Likert scale ranging from 1 (*false*) to 6 (*true*). Cronbach's alpha for both PNSE subscales was > 0.7. The BPNES has been successfully validated as supporting the theoretically based three-factor model and the needs hypothesis of SDT (Vlachopoulos & Michailidou, 2006). It has also demonstrated gender invariance (Vlachopoulos, 2008) and cross-cultural validity (Vlachopoulos, Ntoumanis, & Smith, 2010).

The PNSE scale has supporting evidence of structural and convergent validity (Wilson et al., 2006), and has shown stability coefficients from .52 to .69 and higher scores on PNSE to be associated with more internalized exercise motivation (Wilson & Rogers, 2008).

Behavioural regulations

The most widely used measure of behavioural regulations in the exercise domain is the Behavioural regulations in exercise questionnaire-2 (BREQ2, Markland & Tobin, 2004). It has been validated in several studies and has been found to be stable in a number of translated versions (Moreno Murcia, Gimeno, & Camacho, 2007; Moustaka, Vlachopoulos, Vazou, Kaperoni, & Markland, 2010; Palmeira, Teixeira, Silva, & Markland, 2007), and was chosen for both studies in this thesis. The scale comprises 19 items on a five-point Likert scale, where 0 = "not true for me and" 4 = "very true for me". Unlike the original scale, the BREQ (Mullan, Markland, & Ingledew, 1997), the BREQ-2 measures amotivation in addition to external, introjected, identified and intrinsic regulations. Using the Relative Autonomy Index

(RAI), a single score derived from the subscales provides an index of the degree of self-determination. Higher scores (over zero) reflect more self-determined motivation. Cronbach's alpha for the BREQ-2 was 0.73 to 0.86.

Self-reported exercise

Both studies also used the Leisure time exercise questionnaire (LTEQ; Godin & Shephard, 1985) to measure self-reported exercise. The LTEQ contains three questions measuring the frequency of performing a) strenuous, b) moderate and c) light exercise during a regular week. By multiplying the scores of strenuous exercise by 9, the scores of moderate exercise by 5 and the scores of light exercise by 3, the total exercise score is calculated and transformed into scores of metabolic equivalent of exercise (MET). The LTEQ is a frequently used self-reported measure of exercise, has sound test-retest reliability (Godin & Shepherd, 1985; Jacobs, Ainsworth, Hartman, & Leon, 1993) as well as construct validity (Wilson et al., 2010), and its scores have a confirmed relation to accelerometer motion scores (e.g. Jacobs et al., 1993). The rationale for using the LTEQ is that compared to other popular and more detailed self-report measures (like the IPAQ), it is user-friendly while also providing useful information, and due to its frequent use study comparisons are possible.

Procedure

Study 1

In the first study, the BPNES and BREQ-2 were translated from English into Swedish according to the back-translation method (Brislin, 1986). A bilingual (English and Swedish) expert first translated the tests from English into Swedish, and then another bilingual expert translated them back into English. Differences in the translated versions and the originals were discussed in the research group and formed the foundation of the final versions. A pilot study was then conducted, in which ten persons selected through convenience sample tested the comprehension and design of the test battery, using the think-aloud method (Ericsson & Simon, 1993). The pilot study resulted in the clarification and remodelling of parts of the test battery for the final version. Following a list of members provided by the e-health service company, potential participants for Study 1 were contacted by e-mail, with information on the aim of the study, ethical concerns and practical issues. When logging in to the questionnaire, the participants had to tick a box for informed concent in order to access the questionnaire. The collected data were stored in a certain web account accessible only by the researchers. Participation was anonymous, and no personal data were requested; hence, no personal register was created. The study was approved by the regional ethical board.

Study 2

In Study 2, the PNSE underwent the same translation technique as the instruments in Study 1, described above (i.e. back-translation and think-aloud pilot testing). Participants were enrolled by convenience sample and were initially informed of the study's aim and procedure. After completing baseline measures, the 64 voluntary participants were randomly matched to either an experimental group (n = 32) or a control group (n = 32). Members of the experimental group were contacted by telephone to schedule a time for the intervention. The intervention was implemented individually following a semi-structured intervention template. Mid-intervention (after three weeks), members of the experimental group received a follow-up telephone call and were offered support and exercise goal modification if needed. Control group members received no intervention. Six weeks after the intervention, both the experimental and the control group were assembled to complete the post-intervention measures. All participants received cinema tickets (value approx. €10). The study was

conducted according to the guidelines of the regional ethics board. An outline of the intervention is depicted in Figure 3.

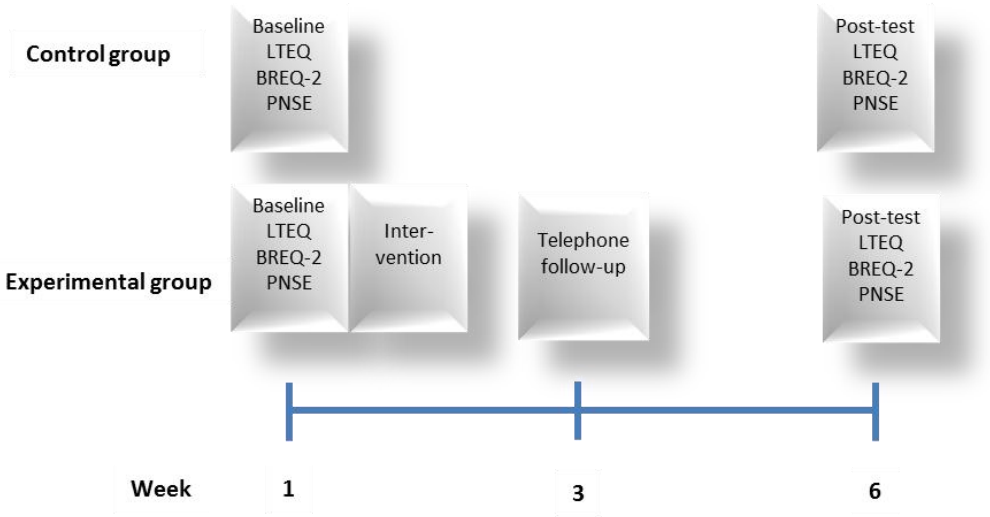

Figure 3. Intervention design

Intervention

The intervention in Study 2 was led by trained psychologists and consisted of a selection of MI, CBT and RPM strategies in terms of exercise-related participant narratives, decision balance, health-related exercise rationale, exercise-barrier identification, chain analyses and goal setting. According to recommendations advanced in previous research on SDT (e.g., Fortier et al., 2012; Sheldon et al., 2003; Su & Reeve, 2010) as well as SDT in combination with MI (e.g. Patrick & Williams, 2012; Markland et al., 2005), the intervention was conducted in an autonomy-supportive manner, using non-controlling language and conveying an empathic and non-judgmental approach, allowing participants to decide on potential behaviour change themselves without attempting to force any decisions. Taken together, the intervention provided vital elements of the working partnership in PCC (Ekman et al., 2014) as well as an SDT-informed interpersonal style with structure and involvement.

In order to allow personalized support and counselling, the trial leaders (TL) met all experimental group members individually. Initially, the participant's current relation to exercise as well as previous experiences were discussed, followed by a decision balance procedure whereby participants listed exercise pros and cons. The listings were transferred to a whiteboard, where pros and cons could be compared in order to display whether one outweighed the other. Then the TL provided a CBT-based rationale for the potential positive effects of exercise on physical and mental health. The rationale was followed by an inventory of experienced exercise barriers and potential approaches to overcome such barriers using relapse-prevention strategies (Marlatt & Gordon, 1985; Larimer et al., 1999), discussing potential drop-out situations and prevention strategies respectively. The TL described the differences between a slip, lapse, relapse and collapse, emphasizing the importance of participants not being self-judgmental when facing these difficulties but instead trying to regain their exercise routines. CBT-based barrier chain analysis was conducted in order to increase awareness of the long- and short-term consequences of different actions, and the participant was instructed to reflect on possible factors that facilitated exercise. Next, a basic SDT description was presented through CBT-based psychoeducation. Finally, potential interest in exercise initiation and prospective exercise activities were discussed based on the initial narrative. When the appropriate activities were established, participants were guided in exercise goal setting, employing specific, realistic and challenging goals based on CBT

guidelines as well as SDT-informed intrinsic goal orientation. The agreed-on goal formulation was subsequently compiled and distributed to each participant after the meeting. Three weeks after the first meeting, members of the experimental group were contacted by telephone for a follow-up, aiming to support participants by giving them an opportunity to discuss their exercise progress or any additional need for support in exercise initiation, ask questions, modify their goals if needed, etc.

Mediation and moderation

As mentioned above, a substantial amount of research strongly advocates adequate application of theory in order to explore and understand the mechanisms of intervention efficacy (e.g. Baranowski et al., 1998; Bauman et al., 2002; Noar & Zimmerman, 2005; Cerin & Mackinnon, 2008; Lubans, Foster, & Biddle, 2008), or simply put – clarify why any given exercise intervention succeeds or fails in changing behavioural outcome. Such knowledge would provide a recipe for how to construct interventions that will bring about certain changes in behaviour, which turns the query into a matter of causality (Bauman et al., 2002). When discussing cause and effect, it is important to note that all human behaviour involves multi-causal influences and reciprocal determinism (i.e. bidirectional correlations). Furthermore, since no factor can guarantee a behavioural outcome, only those assumed to increase the probability of behavioural outcome can be considered for study, and potential *confounders* (i.e. biasing factors that hinder discovery of the true level of observed effects) should be recognized in order to improve interpretation (Bauman et al., 2002). The relationship between the dependent (outcome) and independent (intervention) variables could hypothetically be affected by such factors, thereby forming the warranted mechanisms. This process is based on the assumption of *mediation effects* (Cerin & MacKinnon, 2008), also called mediators of change (Rhodes & Pfaeffli, 2010) and tested by mediation analyses (MacKinnon, Fairchild, & Fritz, 2007), also known as Mediating Variable Analysis (MVA; Cerin & MacKinnon, 2008). With adequate study design and proper analysis, MVA can not only inform practice by displaying whether an intervention changes the suggested mediators (the alpha-coefficient, or a-path), but also evaluate theory efficacy by demonstrating conceptual theory links (the beta-coefficient, or b-path), i.e. whether a change in mediators also changes outcome (MacKinnon et al., 2007; Cerin & MacKinnon, 2008).

The basic mediation model (see Figure 4) also contains the c-path, depicting the direct effect between the dependent and independent variables. The gold standard for testing these processes is randomized controlled trials (RCT; Kramer, Wilson, Fairburn, & Agras, 2002), but mediators can also be observed in other designs (even in cross-sectional studies, see MacKinnon, 2008; Kline, 1998), albeit with weaker value of evidence due to, e.g., factors of temporal and controlling character (Shadish, Cook, & Campbell, 2002).

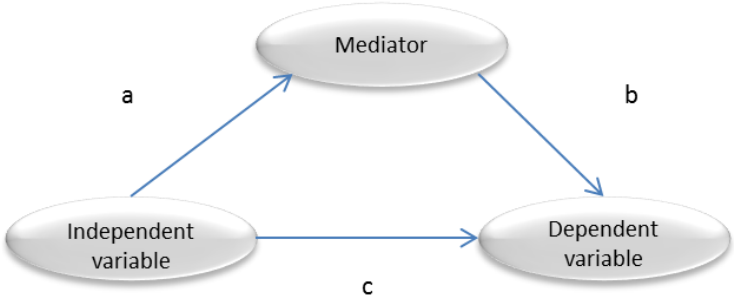

Figure 4. Basic mediation model outline

Mediators are variables required for an independent variable (x) to cause an effect in the dependent variable (y), and this relationship (i.e. indirect effects) can in turn be affected by a third variable, called *moderators* (Hayes, 2009). As an example, an intervention effect could be stronger or weaker in different age groups. Moderated mediation means that the mediation effect between x and y varies as a function of this third variable (m), impacting the strength of the relationship in different groups (Cerin, 2010). In conclusion, it is suggested that the deficiency of proper MVA studies is an important reason numerous exercise and PA interventions fail to change targeted behaviours (Rhodes & Pfaeffli, 2010; Baranowski & Jago, 2005) Baranowski et al., 1998). Moreover, Bauman et al. (2002) have stated that public health can be systematically improved only by understanding why interventions succeed or not. MVA provides a systematic evaluation of how theory works in an intervention, and reveals and explains the contribution of mediating and moderating factors, thereby allowing a focus on effective mechanisms and – perhaps more importantly – the removal of ineffective components (Baranowski et al., 1998; Cerin & MacKinnon, 2008). In regard to SDT research, this will entail a beneficial progression from dealing with first-generation research questions (whether need satisfaction is related to motivation and exercise behaviour), to second- (whether relationships between need satisfaction, motivation and exercise are stronger or weaker in different subgroups) and third-generation questions (what mechanisms can explain and/or predict the relationship between need satisfaction and exercise). If, on the other hand, mediation is not examined, it will remain uncertain whether theoretical constructs have caused observed intervention outcomes, and the potential to understand behaviour change will be restrained (Lubans et al., 2008). Even small-scale studies can yield knowledge for effective intervention designs if proper MVA is used, diminishing the practical limitations of heavy and expensive interventions and programmes (Cerin, Taylor, Leslie, & Owen, 2006). By focusing on changing mediators rather than behaviours, intervention magnitude (e.g. in terms of time and participants) could be condensed and yield more cost-effective programmes. In this way, not only successful but also economically sound intervention design for behaviour change could be facilitated (Baranowski et al., 1998; Cerin & MacKinnon, 2008).

Data analysis

Study 1

In the first study, analyses were done through structural equation modelling (SEM) and mediation analysis using a bootstrapping resampling approach (Preacher & Hayes, 2008; Cerin, 2010), enabling the examination of measurement-free associations between constructs and more robust mediational paths. Mplus version 7.1 (Muthen & Muthen, 1998–2009) was used to analyse the data with the maximum likelihood (ML) and robust maximum likelihood (MLR) estimators. Missing data were handled using a full maximum likelihood (FIML) estimator, which is default in Mplus. Therefore, data from all (N=1,091) participants (i.e., including those who had missing data on some items or variables) were used in the Mplus analyses. Based on recommendations by Hu and Bentler (1999), the following fit indexes were used: (a) Satorra-Bentler chi-square statistics, (b) Bentler's comparative fit index (CFI; Bentler, 1990), and (c) the root mean square error of approximation (RMSEA; Browne & Cudeck, 1993). For the CFI, values close to or greater than 0.95 indicate a well-fitting model (Hu & Bentler, 1999). For the RMSEA, values less than .05 indicate a good fit, whereas values up to .08 represent a reasonable fit (Browne & Cudeck, 1993). In the invariance testing, the recommendations by Cheung and Rensvold (2002) were used. Because the chi-square difference test is sensitive to the sample size, they recommend using a decline in the CFI of 0.01 or less as indicative of invariance. Moderation analyses were conducted through

multi-group analyses, whereby model fit for models with no constraints between groups (e.g., men vs. women) in terms of paths was compared with model fit in models in which certain paths were constrained to be equal between groups. Multiple mediator models with a bootstrapping resampling approach for calculating product-of-coefficients and asymmetric 95% confidence intervals based on 1,000 resamples (Preacher & Hayes, 2004; 2008) were used to test indirect effects. In the analyses, indirect effects of the independent variable (in the present study, psychological need satisfaction) on the outcome variable (exercise) through a proposed mediator variable (self-determined motivation) were estimated. Moreover, bias-corrected and accelerated bootstrap confidence intervals for the indirect effects were used (Hayes, 2013). Bootstrap confidence intervals are recommended because they do not make unrealistic assumptions about the shape of the sampling distribution of the indirect effect like, for example, the Sobel test does (Preacher and Hayes, 2008). All mediation analyses were performed through the SPSS macro PROCESS, described by Hayes (2013). The mediation analyses only included participants who had complete data on all included variables (n=672).

Study 2

Since analyses using structural equation modelling are not recommended for small samples (Kline, 1998), alternative methods were used in the second study. Independent t-tests were performed using the LTEQ (MET, strenuous, moderate, and light exercise), the BREQ-2 (amotivation, external, introjected, identified and intrinisic regulation, respectively; and RAI) and the PNSE (autonomy and competence) in order to detect any primary differences between the two groups from the baseline measurements. Instrument reliability was tested using Cronbach's alpha, and changes between pre- and post-test measures were analysed using repeated measures ANOVA. According to recommendations for two-pointed MVA (Cole & Maxwell, 2003; Senn, 2006), intervention effects were tested through analyses of covariance (ANCOVA), whereby the post-intervention scores on exercise, need satisfaction and motivational quality were compared in the control and intervention groups, controlling for baseline scores. The significance level for all tests was set to $p < .05$. To test whether need satisfaction and motivational quality mediated the effect of the intervention on physical activity, indirect effects were tested using multiple mediator models with a bootstrapping resampling approach to calculate product-of-coefficients and asymmetric 95% confidence intervals based on 1,000 resamples (Preacher & Hayes, 2004; 2008). All mediation analyses were performed through the SPSS macro PROCESS, described by Hayes (2013).

Results

Study 1

The data did not display multivariate normality for either of the two instruments. The critical values, as estimated using AMOS 20, ranged from 48.65 for the BPNES to 209.13 for the BREQ-2, indicating non-normality in the sample (Byrne, 2010). Therefore, all the analyses (except for the mediation analyses, which used bootstrapping through the SPSS macro PROCESS, Hayes, 2013) were done using the robust MLR estimator in Mplus. Descriptive data divided into gender and age groups are presented in Table 1.

Table 1. *Descriptives (Means and Standard Deviations) of psychological need satisfaction, behavioural regulations, and exercise last six months (PA), divided across gender and age groups*

	Gender		Age		
	Men (*n*=286)	Women (*n*=805)	Younger (*n*=539) (18-45 years)	Older (*n*=501) (46-78 years)	Total sample (N=1,091)
BPNES					
Autonomy	4.0 (.84)	4.1 (.80)	4.0 (.81)	4.1 (.81)	4.1 (.81)
Competence	3.8 (.84)	3.8 (.82)	3.8 (.82)	3.8 (.83)	3.7 (.82)
Relatedness	3.9 (1.1)	3.8 (1.0)	3.8 (1.0)	3.8 (1.1)	3.8 (1.0)
BREQ-2					
Amotivation	1.1 (.30)	1.1 (.24)	1.1 (.28)	1.1 (.23)	1.1 (.25)
External reg.	1.2 (.39)	1.1 (.34)	1.2 (.38)	1.1 (.32)	1.1 (.35)
Introjected reg.	2.1 (.73)	2.2 (.78)	2.3 (.75)	2.0 (.77)	2.2 (.77)
Identified reg.	3.2 (.66)	3.2 (.63)	3.2 (.65)	3.2 (.62)	3.2 (.63)
Intrinsic reg.	3.2 (.70)	3.3 (.69)	3.3 (.70)	3.3 (.67)	3.3 (.70)
GLTEQ					
Strenuous Exrc.	2.2 (1.8)	1.8 (1.6)	2.1 (1.9)	1.6 (1.5)	1.9 (1.7)
Moderate Exrc.	2.9 (3.5)	3.7 (2.6)	3.3 (2.4)	3.7 (3.3)	3.5 (2.9)
Light Exrc.	3.6 (4.1)	3.8 (2.9)	3.8 (3.2)	3.6 (3.3)	3.7 (3.3)

* Range of scores: BPNES scores range from 1-5. BREQ-2 scores range from 0-4. GLTEQ scores reflect number of times per week performed longer than 15 minutes at each occasion. (Exrc. = Exercise)

Factor validity of instruments and invariance testing

The theoretical a priori models displayed adequate-to-good fit with data. For the BPNES, the theoretical a priori three-factor model demonstrated good fit with data: Satorra-Bentler $\chi2$= 246.45 (51df), CFI=0.96; RMSEA: 0.059 (0.052-0.067). The five-factor model of the BREQ-2 demonstrated acceptable fit to data: $\chi2$= 408.60 (142df), CFI=0.94; RMSEA: 0.044 (0.039-0.049). All standardized factor loadings were significant and generally over .60. The

three-factor measurement model of the BPNES displayed strict invariance (i.e. invariant residuals in addition to invariant factor loadings and intercepts) across gender and age, as the CFI did not decrease more than .01 in model fit when factor loadings, intercepts, and residuals were constrained to be equal across groups of gender (men and women) and different ages (18–45 years, and 46–78 years). The BREQ-2 measurement model demonstrated strong invariance (i.e. invariant factor loadings and intercepts) across gender and across age groups. The correlations between the eight latent factors of the two instruments are displayed in Table 2. Correlations within the behavioural regulations generally followed the proposed simplex-like pattern, demonstrating that regulations close to each other had stronger and more positive connections to each other than to more distal regulations.

Psychological need satisfaction and self-determined motivation predicting exercise

In the first step, a model including the three psychological need satisfaction factors predicting the RAI score (reflecting the degree of self-determined motivation), which in turn predicted exercise behaviour (METS), was tested. The results from the model are presented in Table 3. The model demonstrated acceptable fit with data for the full group: Satorra-Bentler $\chi^2(145) = 691.16$, $p < .001$; CFI = .95; RMSEA = .060 (90% CI = .056 to .065). The paths from the two psychological needs, competence and relatedness, to self-determined motivation (RAI) were as expected, positive in direction and significant. The path between competence and self-determined motivation was stronger, however ($\beta = .71$, $p < .01$), compared with that between relatedness and self-determined motivation ($\beta = .19$, $p < .01$). Also according to expectations, self-determined motivation predicted exercise ($\beta = .25$, $p < .01$).

Table 2. *Intercorrelations among the latent factors of psychological need satisfaction (BPNES) and self-determined motivation (BREQ-2)*

Factors	F1	F2	F3	F4	F5	F6	F7	F8
BPNES								
F1Competence	-							
F2 Autonomy	.86	-						
F3 Relatedness	.63	.53	-					
BREQ-2								
F4 Amotivation	-.31	-.18	-.27	-				
F5 External	-.26	-.21	-.17	.26	-			
F6 Introjected	*-.01*	-.09	*-.06*	-.16	.28	-		
F7 Identified	.65	.45	.47	-.51	-.18	.44	-	
F8 Intrinsic	.68	.50	.53	-.46	-.22	.12	.82	-

Note: Non-significant correlations in italics

Contrary to expectations, the path between autonomy and self-determined motivation was negative and significant ($\beta = -.20$, $p < .01$). Given that the correlations between autonomy and the latent factors of the BREQ-2 were according to expectations (i.e., positive correlations with identified and intrinsic regulation but negative correlations with amotivation and external regulation), the negative path displayed in the model between autonomy and motivation most probably signals a suppressor effect rather than a conceptually meaningful result.

The three psychological needs were moderately to strongly associated in a positive direction (r=.86-.53, ps<.01), with competence and autonomy demonstrating the strongest association (r=.86, p<.01) (see Table 2). Due to these correlations, the three psychological need satisfaction factors were collapsed into one total psychological need factor, using a second-order (higher-order) model. This model, with one higher-order need factor predicting motivation, also demonstrated acceptable fit to data: Satorra-Bentler $\chi^2(75) = 410.37$, $p < .001$; CFI = .93; RMSEA = .066 (90% CI = .060 to .072). The path between the single latent

factor of total psychological need satisfaction and self-determined motivation was moderately strong and in a positive direction (β = .65, p > .01) for the full sample.

In the next step, the RAI was replaced with the five factors of the BREQ-2, to offer more specific insight into how various types of motivation were associated with total need satisfaction and exercise behaviour. For the full sample (see Table 4, last column to the right), total need satisfaction, as modelled by the higher-order factor, significantly and inversely predicted amotivation (β = -.44, p <.01) and external regulation (β = -.26, p > .01) but not introjected regulation.

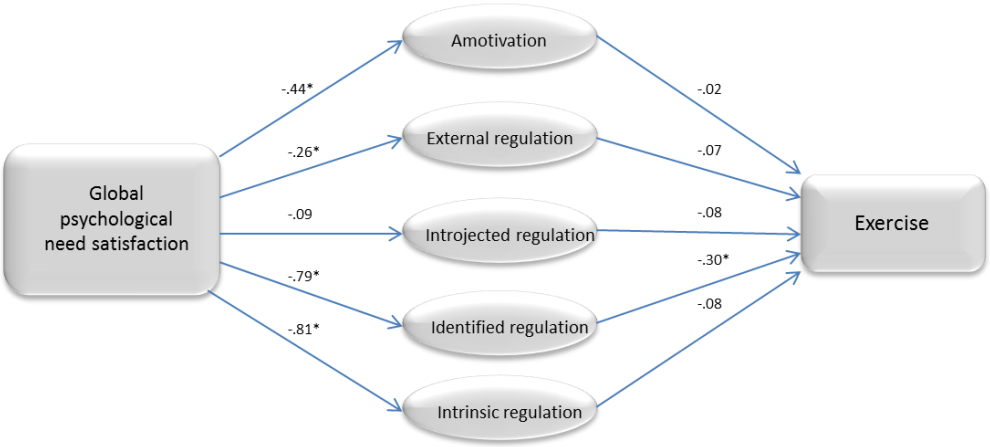

Figure 5. Mediation model for the full sample (= p >.05, see also Table 4)*

Moreover, total need satisfaction predicted both identified regulation (β = .79, p < .01) and intrinsic motivation (β = .81, p < .01). In terms of the paths from type of motivation to exercise, only identified regulation significantly (β = .30, p < .01) predicted exercise behaviour for the full sample (see Figure 5).

Moderating effects of gender and age

Only one significant difference across age groups or gender was found in the model using the RAI as a total measure of self-determined motivation (see Table 5). Self-determined motivation predicted exercise for women (β = .34, p < .01) but not for men, mirrored by a significant decrement in model fit ($\Delta \chi^2$=8.12/ 1 df) when these paths were constrained to be equal across men and women. When including the five BREQ-2 factors instead of the RAI in the model, a number of significant differences in strength and direction of paths between men and women appeared (see Table 4). Model fit decreased significantly (reflecting a significant difference between men and women) when the following paths were constrained to be equal: total need satisfaction to introjected regulation ($\Delta \chi^2$=24.06/ 1 df); total need satisfaction to identified regulation ($\Delta \chi^2$=4.09/ 1 df); external regulation to exercise ($\Delta \chi^2$=9.84/ 1 df); introjected regulation to exercise ($\Delta \chi^2$=11.67/ 1 df); and identified regulation to exercise ($\Delta \chi^2$=28.02/ 1 df).

Table 3. *Psychological need satisfaction and self-determined motivation (RAI) predicting exercise across gender and age groups*

Regression weights	Men (*n*=286)	Women (*n*=805)	Younger (*n*=539) (18-45)	Older (*n*=501) (46-78)	Full sample (N=1,091)
Competence → Motivation[a]	.63 (.18)**	.71 (.10)**	.75 (.12)**	.73 (.14)**	.71 (.09)**
Autonomy → Motivation	-.17 (.16)	-.18 (.09)*	-.27 (.11)*	-.18 (.13)	-.20 (.08)**
Relatedness → Motivation	.27 (.08)*	.17 (.05)**	.18 (.06)**	.21 (.05)**	.19 (.04)**
Total need → Motivation	.65 (.04)**	.66 (.02)**	.65 (.03)**	.72 (.03)**	.68 (.02)**
Motivation → Exercise	.03 (.08)	.34 (.04)**	.32 (.04)**	.23 (.05)**	.27 (.03)**
Correlations					
Competence ↔ Autonomy	.86 (.03)**	.86 (.02)**	.84 (.02)**	.88 (.02)**	.86 (.02)*
Competence ↔ Relatedness	.59 (.05)**	.64 (.03)**	.68 (.03)**	.59 (.04)**	.63 (.02)*
Autonomy ↔ Relatedness	.45 (.06)**	.55 (.03)**	.57 (.04)**	.50 (.04)**	.51 (.03)*

Note:[a] Relative Autonomy Index (RAI) *p<.05; **p<.01

Looking more specifically into these differences, the path between total need satisfaction and introjected regulation was positive and significant for men (β = .41, p < .01) but negative and non-significant for women, and total need satisfaction was more strongly related to identified regulation for men (β = .88, p < .01) than for women (β = .75, p < .01). Moreover, external regulation predicted exercise for men in a positive direction (β = .26, p < .01) but was not related to exercise for women, and introjected regulation was positively but non-significantly associated with exercise for men but negatively and significantly associated with exercise for women (β = -.14, p < .05). Finally, identified regulation predicted exercise for women (β = .40, p < .01) but not for men. When differences in paths between age groups were examined, significant differences were noted in the two paths: identified regulation to exercise ($\Delta \chi^2$=7.19/ 1 df), where the path was stronger and significant for the younger age group (β = -.52 p <> .01) compared to the older one (β = .11, p> .05), and intrinsic motivation to exercise ($\Delta \chi^2$=5.87/ 2 df), where the path was negative and non-significant (β = -.06, p >.05) for the young group but positive and significant (β = .24, p <.05) for the older one.

Table 4. *Total psychological need satisfaction and self-determined motivation (all five BREQ-2 factors) predicting exercise across gender and age groups*

	Men *n*=286	Women *n*=805	Younger (18-45) *n*=539	Older (46-78) *n*=501	Full sample N=1,091
Need → Amot.[a]	-.44 (.07)**	-.44 (.04)**	-.46 (.05)**	-.43 (.05)**	-.44 (.06)*
Need → Ext. reg.	-.14 (.07)*	-.30 (.04)**	-.24 (.05)**	-.29 (.05)**	-.26 (.04)*
Need → Introj. reg.	.41 (.07)**	-.03 (.05)	.11 (.06)*	.08 (.06)	.09 (.06)
Need → Ident. reg.	.88 (.04)**	.75 (.03)**	.78 (.03)**	.81 (.03)**	.79 (.06)*
Need → Intr. mot.	.84 (.03)**	.79 (.02)**	.76 (.03)**	.86 (.02)**	.81 (.06)*
Amot. → Exercise	-.10 (.09)	.00 (.05)	-.02 (.06)	-.02 (.07)	-.02 (.04)
Ext. reg. → Exercise	.26 (.08)**	-.00 (.04)	.04 (.05)	.12 (.06)*	.07 (.05)
Introj. reg. → Exercise	.12 (.10)	-.14 (.05)*	-.15 (.06)**	-.06 (.06)	-.08 (.05)
Ident. reg. → Exercise	-.06 (.16)	.40 (.07)**	.52 (.08)**	.11 (.11)	.30 (.11)*
Intr. mot. → Exercise	.16 (.14)	.04 (.07)	-.06 (.08)	.24 (.10)*	.08 (.06)

Note: Amot. = Amotivation; Ext. reg. = External regulation; Introj. reg. = Introjected regulation; Ident. reg. = Identified regulation; Intr. mot. = Intrinsic motivation. * $p<.05$; ** $p<.01$.

Mediation in self-determined motivation, psychological need satisfaction and exercise

The mediating (indirect) effects of the RAI and the separate BREQ-2 factors are presented in Table 5. In the full sample there was a significant indirect effect of the RAI ($\alpha\beta$=2.69, 95% CI = 0.39-4.40), indicating that self-determined motivation acted as a mediating variable in the relationship between psychological need satisfaction and exercise. Looking at the multivariate mediating effects of the BREQ-2 factors, the only significant indirect effect was found for identified regulation ($\alpha\beta$ = 3.60, 95% CI = 1.56-5.84). Gender moderated the indirect effect of the RAI, as it was significant for women ($\alpha\beta$ = 3.53, 95% CI = 1.72-5.32) but not for men. Also, the indirect effect of external regulation was significant for men ($\alpha\beta$ = 2.69, 95% CI = 0.39-4.40) but not for women, whereas the effect of identified regulation was significant only for women ($\alpha\beta$ = 3.78, 95% CI = 1.95-5.80).

Table 5. *The mediating effects of self-determined motivation in the relationship between psychological need satisfaction and exercise across gender and age groups*

Indirect effects	Men	Women	Younger (18-45)	Older (46-78)	Full sample
	$\alpha\beta^1$ (95%CI)	$\alpha\beta^1$ (95%CI)	$\alpha\beta^1$ (95%CI)	$\alpha\beta^1$ (95%CI)	$\alpha\beta^1$ (95%CI)
RAI	-0.55 (-15.90-3.84)	3.53* (1.72-5.32)	1.37 (-1.67-5.42)	2.22 (-4.60-4.48)	2.69* (0.39-4.40)
Amot.	0.74 (-0.22-3.73)	0.21 (-0.24-0.77)	0.35 (-0.35-1.23)	0.30 (-0.05-1.60)	0.30 (-0.13-0.86)
Ext. reg.	-1.80* (-6.83--0.10)	-0.03 (-0.50-0.46)	-0.13 (-0.83-0.36)	-1.25 (-4.86-0.07)	-0.48 (-1.44-0.07)
Introj. reg.	0.44 (-0.62-3.19)	0.34 (-0.17-1.04)	0.34 (-0.02-1.25)	0.03 (-0.26-0.57)	0.15 (-0.11-0.56)
Ident. reg.	1.33 (4.80--10.50)	3.78* (1.95-5.80)	6.14* (3.58-9.09)	1.14 (-3.01-3.88)	3.60* (1.56-5.84)
Intr. mot.	2.36 (-2.08-7.67)	-0.08 (-2.07-2.00)	-1.22 (-3.87-1.18)	2.97* (0.20-6.50)	0.68 (-1.45-2.88)

[1] Product-of-coefficient estimate (95% CI based on 1,000 bootstrap resamples). Note: RAI = Relative Autonomy Index; Amot. = Amotivation; Ext. reg. = External regulation; Introj. reg. = Introjected regulation; Ident. reg. = Identified regulation; Intr. mot. = Intrinsic motivation * p<.05

The patterns of indirect effects of the BREQ-2 factors also differed across age groups. Identified regulation was the only significant mediating variable in the younger age group (αβ = 6.14, 95% CI = 3.58-9.09), whereas intrinsic motivation was the only significant indirect effect for the older age group (αβ=2.97, 95% CI=0.20-6.50).

Study 2

No statistical differences between the experimental group and control group were found in the LTEQ, BREQ-2, or PNSE at the baseline measurement. Cronbach's alpha for the BREQ-2 and PNSE was > 0.70. Because the drop-out rate was low (n = 3), no drop-out analysis was done.

Differences between groups post-intervention

The experimental group (M = 38.8, SD = 23.8) reported significantly higher total exercise [$F(1,58) = 12.14$, $p < .01$] post-intervention than the control group did (M = 26.0, SD = 14.9), with a large (see Pierce, Block & Aguinis, 2004; Cohen, 1988) effect size (partial $\eta^2 = .17$). In addition, participants in the experimental group (M = 15.0, SD = 11.7) also showed significantly higher levels of strenuous exercise [$F(1,58) = 13.66$, $p < .01$] post-intervention than participants in the control group did (M = 7.7, SD = 10.6), and this effect size was also large (partial $\eta^2 = .19$). Further, participants in the control group displayed more external regulation than members of the intervention group did post-intervention [$F(1,58) = 4.41$, $p < .05$, partial $\eta^2 = 0.07$]. No statistical differences were found in autonomy need satisfaction [$F(1,58) = 1.53$, $p > .22$], competence need satisfaction [$F(1,58) = 0.70$, $p < .41$] or RAI score (i.e., weighted motivational profile [$F(1,58) = 2.01$, $p < .16$]) between the experimental and control conditions post-intervention (see Table 6).

Table 6. *Means (SD) of study variables at baseline and post-intervention; within-group changes post-intervention and Interaction effects (time*group)*

	Experimental group (*n*=30)				Control group (*n*=31)				Time*group interaction	
		Within-change				Within-change				
	M (SD)	t	*df*	*p*	*M (SD)*	*t*	*df*	*p*	*F*	*p*
PNSE – Autonomy	-	-	29	-	-	-	30	-	1.8	(.18)
Baseline	28.5 (5.3)	-	-	-	30.4 (5.3)	-	-	-	-	
Post-intervention	29.5 (6.8)	-1.8	-	.08	32.1 (4.1)	-2.9	-	.01	-	
PNSE – Competence	-	-	29	-	-	-	30	-	0.3	(.61)
Baseline	25.4 (7.5)	-	-	-	23.2 (7.4)	-	-	-	-	
Post-intervention	26.2 (6.8)	-1.1	-	.27	25.5 (6.2)	-2.6	-	.02	-	
BREQ2 – RAI[a]	-	-	29	-	-	-	30	-	1.0	(.32)
Baseline	8.9 (4.0)	-	-	-	7.8 (6.3)	-	-	-	-	
Post-intervention	10.7 (3.5)	-3.4	-	.01	8.5 (6.4)	-1.8	-	.09	-	
BREQ2 – Amotivation	-	-	29	-	-	-	30	-	1.6	(.21)
Baseline	0.2 (0.3)	-	-	-	0.5 (0.7)	-	-	-	-	
Post-intervention	0.2 (0.3)	.33	-	.08	0.4 (0.7)	1.8	-	.08	-	
BREQ2 – External reg.	-	-	29	-	-	-	30	-	4.2	(.04)
Baseline	0.6 (0.6)	-	-	-	0.5 (0.6)	-	-	-	-	
Post-intervention	0.5 (0.5)	1.5	-	.14	0.6 (0.7)	-1.4	-	.18	-	
BREQ2 – Introjected reg.	-	-	29	-	-	-	30	-	0.2	(.67)
Baseline	1.7 (1.1)	-	-	-	1.7 (1.0)	-	-	-	-	
Post-intervention	1.9 (1.0)	-.98	-	.34	1.7 (1.0)	-.58	-	.57	-	
BREQ2 – Identified reg.	-	-	29	-	-	-	30	-	0.2	(.68)
Baseline	2.4 (0.6)	-	-	-	2.3 (0.9)	-	-	-	-	
Post-intervention	2.9 (0.6)	-4.6	-	.01	2.6 (0.8)	-3.6	-	.01	-	
BREQ2 – Intrinsic reg.	-	-	29	-	-	-	30	-	1.6	(.22)
Baseline	2.5 (0.9)	-	-	-	2.5 (1.0)	-	-	-	-	
Post-intervention	2.7 (0.9)	-2.2	-	.04	2.5 (1.1)	-.25	-	.81	-	
LTEQ –Total Exercise[b]	-	-	29	-	-	-	30	-	12.4	(.01)
Baseline	19.0 (13.9)	-	-	-	19.0 (14.8)	-	-	-	-	
Post-intervention	38.8 (23.8)	-5.9	-	.01	26.0 (14.9)	-3.9	-	.01	-	
LTEQ –Strenuous Exercise	-	-	29	-	-	-	30	-	13.5	(.01)
Baseline	4.4 (4.8)	-	-	-	5.3 (8.5)	-	-	-	-	
Post-intervention	15.0 (11.7)	-3.5	-	.01	7.7 (10.6)	-2.3	-	.03	-	
LTEQ –Moderate Exercise	-	-	29	-	-	-	30	-	1.3	(.26)
Baseline	7.9 (9.3)	-	-	-	7.2 (7.4)	-	-	-	-	
Post-intervention	13.8 (11.8)	-2.2	-	.04	10.6 (7.8)	-2.7	-	.01	-	
LTEQ –Light Exercise	-	-	29	-	-	-	30	-	0.3	(.61)
Baseline	6.7 (6.0)	-	-	-	6.5 (5.8)	-	-	-	-	
Post-intervention	10.4 (9.8)	-2.2	-	.04	7.7 (6.3)	-1.5	-	.15	-	

[a]Relative Autonomy Index; [b]LTEQ – total exercise/MET.

The mediating effect of need satisfaction and motivation quality

Mirroring the results from the ANCOVAs, the total effect (c path) of the intervention on exercise post-test was significant (12.77, SE: 5.06, $p < .05$). Moreover, the direct effect (c prime path) of the intervention on exercise, when the mediators were controlled for, was significant in all analyses ($p < .05$). Total RAI score post-test mediated the effect of the intervention on exercise post-test. The 95% confidence intervals did not include zero, and were estimated to be between 0.30 and 6.57. When considering all the BREQ-2 variables as mediators in the same model, the only significant indirect effect was found for identified regulation, with the bootstrap 95% confidence intervals estimated to be between 0.12 and 11.58. Individuals in the intervention group had non-significantly ($p = .09$) higher total RAI scores and identified regulation post-test (a paths), and higher total RAI scores and identified regulation at post-test were significantly ($p<.05$) related to higher exercise at post-test (b paths). The indirect effects of the other BREQ-2 variables and of the needs competence and autonomy were not significant, indicated by the fact that zero was included in the 95% confidence bootstrap intervals for these variables.

Discussion

In order to enhance the knowledge of how interventions promoting exercise behaviour change and adherence can be designed, theoretical understanding of the mechanisms behind these actions is of great importance. The overall aim of the two studies was therefore to explore the motivational processes behind exercise behaviours, with Self-determination theory (SDT) as a person-centred guiding framework. The findings will first be discussed separately, followed by a general discussion. A brief summary of the contributions of the two studies is presented in Table 7 (page 44).

Study 1

To begin with, the translated versions of the BPNES (Vlachopoulos & Michailidou, 2006) and the BREQ-2 (Markland & Tobin, 2004) displayed acceptable factorial validity, reflected by a good fit between data and theoretical models in the confirmatory factor analyses. Hence, it seems proper to suggest that these instruments constitute robust and valid measurements of psychological needs and self-determined motivation not only in their original language versions, but also in translated versions across languages and cultural contexts, in this case Swedish.

Relationships between the basic psychological needs

The participants in Study 1 can generally be described as relatively self-determined exercisers with high need satisfaction. The respective satisfaction of the three psychological needs was, as expected, strongly and positively associated, generally supporting the trend in previous work (Hagger & Chatzisarantis, 2008; Wilson & Rodgers, 2007). In fact, the need-satisfaction correlations in Study 1 were stronger compared to what has been reported in most previous studies describing manifest variables (e.g. Edmunds et al., 2006; McDonough & Crocker, 2007). Nevertheless, other studies using structural equation modelling and reporting correlations between measurement-free latent factors (e.g. Hagger et al., 2006; Wilson & Rodgers, 2008) tend to report stronger correlations, more similar to those in Study 1. In terms of the specific pattern of associations between the needs, strong correlations were found between autonomy and competence, followed by the correlation between relatedness and competence and that between relatedness and autonomy. The slightly weaker correlation between the need for relatedness and the other two needs has been noted in several previous studies (Wilson & Rodgers, 2007; Wilson et al., 2006; Wilson et al., 2002), perhaps indicating that feeling related to others is not as essential in exercise settings as is feeling autonomous and efficacious. Still, though, the fact that all three needs were also significantly correlated to autonomous motivation (see below), the results of Study 1 support the findings of McDonough and Crocker (2007), who found relatedness to be a relatively strong predictor of autonomous motivation in an adult population of dragon boaters, emphasizing the potential importance of relatedness in motivational processes. As dragon boating is a team activity likely to entail group support and cohesion, and as the workplace-enrolled members in Study 1 take part in step contests as teams, both settings clearly tap the relatedness dimension. In this view, it is important to further explore whether the difference in need associations would be dependent on contextual, personal or demographic circumstances like stage of change, type of activity, group versus solitary activities, etc. For instance, considering that the sample in Study 1 consists of two types of members (i.e. private members and those who joined via their employer), it would be interesting to examine possible differences regarding psychological needs and motivational regulations between the two groups, a question not included in the objectives of Study 1.

Moreover, this pattern of the strongest association being found between competence and autonomy, could also be a probable cause of the observed suppressor effect in Study 1. The suppressor effect exposed a negative association between autonomy and self-determined motivation (RAI), which is evidently inconsistent with expectations from an SDT perspective. However, previous studies (Hagger et al., 2006; Markland & Tobin, 2010) have found that a single global need satisfaction factor explains latent variables representing autonomy, competence and relatedness. When the three needs were collapsed into one global latent need satisfaction factor, this was proven to fit the present data well. Since the respective satisfaction of the three needs is suggested to be complementary, denoting that the satisfaction of one need can only happen if the other needs are also satisfied (Deci & Ryan, 2002; Wilson & Rodgers, 2007), the global need factor seems to be a reasonable solution. Altogether, this might indicate that the observed suppression is not caused by conceptual theory or mediator measurement problems, issues otherwise suggested as probable causes of this particular phenomenon (Cerin and MacKinnon, 2008).

Correlations within the behavioural regulations are hypothesized to follow a simplex-like pattern, with stronger and more positive connections between regulations close to each other than between more distal regulations (Ryan & Deci, 2002), a notion supported in previous studies (Markland & Tobin, 2010; McDonough & Crocker, 2007). The results of Study 1 follow this pattern, thus supporting the use of the RAI . Moreover, the three needs had a significant positive relation to self-determined motivation (identified and intrinsic regulation) and a significant negative relation to external regulation and amotivation, which is also consistent with theory and previous research (Wilson & Rodgers, 2004; McDonough & Crocker, 2007; Hagger & Chatzisarantis, 2008). In addition, it could be argued that these results also provide some support for motivational profiling (Vansteenkiste et al., 2009) and the concepts of "mustivation" and "wantivation" suggested by Vansteenkiste (2013), although examination of these conceptualizations was not part of the current objectives. The relations for introjected regulation, on the other hand, were non-significant for competence and relatedness, which is quite interesting since SDT postulates that one has to feel both competence and relatedness (or at least a desire for relatedness) in order to be introjected (Ryan & Deci, 2007). McDonough and Crocker (2007) found that competence and introjection were significantly (albeit weakly) correlated, but also found non-significance between relatedness and introjection. Conceivably, this correspondence between their study and the results of Study 1 could be viewed in the light of the sample similarities outlined above, but it should be kept in mind that inconsistencies regarding the role of relatedness in exercise settings are well-known and could in part be attributed to measurement differences and operationalization (Markland & Tobin, 2010; Teixeira et al., 2012). For example, Markland and Tobin (2010) suggested that relatedness might be more properly measured by distinguishing between general (broader social and cultural relations) and specific dimensions (intimate relations with significant others), while Wilson et al. (2002) proposed that relatedness could perhaps be more important in extrinsic than intrinsic regulations.

Another possibility could be that relatedness support may have somewhat different bearing in different relationships (e.g. friends and family versus health-care providers or exercise instructors) and originate from multiple sources. This would be especially true in solitary activities, which makes the use of BREQ-2 slightly problematic since most items tapping relatedness concern the relation to other exercisers. These speculations emphasize the question raised by McDonough and Crocker (2007) regarding the need for further exploration of what circumstances under which relatedness is most prominent. For example, the strong endorsement of relatedness in Study 1 could perhaps be linked to the specific web service conditions regarding the team-based competitive components in workplace settings. This could be an example of when competition is need-supportive rather than thwarting, by

facilitating strong group cohesion and thereby also increasing the magnitude of relatedness satisfaction. Since different dimensions and sources of relatedness are not captured in the current measures, measurement refinement would be an interesting avenue to progress and explore.

Relationships between psychological needs, regulations and exercise behaviour

Following the recommendations of previous research (e.g. Rhodes & Pfaeffli, 2010; Cerin & MacKinnon, 2008; Baranowski et al., 1998) Study 1 examined relationships between the latent constructs of psychological needs, self-determined motivation and exercise behaviour. The main analyses in the full sample showed that higher need satisfaction predicts a more self-determined motivation (using RAI), which in turn predicted behavioural outcomes in terms of more exercise. Furthermore, for the full sample, total need satisfaction predicted identified regulation, which in turn also predicted exercise. These results are not only in line with theory, but also support previous suggestions that more internalized regulations (like identified regulation) are of greater importance for behaviours that are not inherently rewarding or enjoyable as exercise (e.g. Deci & Ryan, 2000; Edmunds et al., 2006), and especially the suggestion that identified regulation could actually be the most salient regulation in exercise behaviour (Teixeira et al., 2012). In sum, the results for the full sample support the stipulations of SDT (Deci & Ryan, 2000; Ryan & Deci, 2002) and the related steps of the process model by demonstrating self-determined motivation (especially identified regulation) to mediate the link between psychological need fulfilment and exercise behaviour. In confirming these conceptual theory links, this study contributes to the growing amount of evidence of SDT efficacy (Ng et al., 2012; Teixeira et al., 2012; Fortier et al., 2012).

Moderated mediation of gender and age

Based on SDT stipulations we would expect the connection between psychological needs and motivation to be universal across populations, and rather assume that the relationship between motivation and behaviour differs between subgroups (Deci & Ryan, 2000). Furthermore, since factors like age, gender and culture could influence how basic psychological needs are met (Ryan & Deci, 2002), such factors could also be expected to impact the development of behavioural regulations. This would be especially true considering the importance of social contexts in SDT. Bearing in mind that exercise-related values and goals are likely to differ between people in different demographical groups (e.g. gender, age, culture), the mechanisms within the SDT process model are also likely to vary as a function of such influences. This is a valuable research topic, not necessarily contradicting the proposed universality of SDT constructs (Guérin et al., 2012), and previous research has strongly advocated the examination of gender differences instead of grouping these data together (Teixeira et al., 2012). Accordingly, and extending previous research, the results of Study 1 revealed self-determined motivation as a stronger predictor of exercise for women than for men, advancing the knowledge of moderated mediation and possible mechanisms between hypothesized SDT constructs and exercise behaviour.

Using the RAI is quite common (Fortier et al., 2011), and in order to obtain more specific details on the above-mentioned mechanisms, the index was replaced with the specific regulations of the BREQ-2 in the following analyses, revealing some intriguing results. External regulation was found to mediate the relation between need satisfaction and exercise behaviour only for men, while identified regulation served as the corresponding mediator for women. In interpreting these results, it should be noted that the literature on gender differences in motivational regulations (as well as the RAI) is inconsistent (Guèrin et al., 2012) and mainly concerns mean level of motivation or direct effects, not (as in this study) indirect effects and moderated mediation. This, in combination with the exploratory ambition

of this thesis, implies that possible extrapolations from these results would be rather speculative and crude. Regarding the effects of identified regulation, the present results might not be surprising considering the sample constitution (mainly women) and the fact that this regulation also predicted exercise in the full sample. This could in turn also be linked to women seemingly being more prone than men to join web-based PA programmes (see Brouwer et al., 2010; Dawson, Tracey & Berry, 2008; Napolitano et al., 2003), and could therefore be expected to be more self-determined users of the web service in Study 1. Furthermore, since competition can generally be expected to have extrinsic connotations, the predictive value of external regulation of men's exercise behaviour could perhaps be referred to the competitive features of the web service.

Regarding age, it should firstly be noted that when splitting the sample into three age groups (younger, middle-aged and older adults) the findings on age differences remained essentially similar to those based on two age groups. The analyses based on age showed that identified regulation mediated the relation between need satisfaction and exercise behaviour for younger adults only, whereas intrinsic motivation mediated this link for older adults. To begin with, both identified and intrinsic regulations represent autonomous forms of motivation that are integrated to the self, and considering the proposed simplex pattern of regulations (Ryan & Deci, 2002) they are likely to interrelate. Although significant, these circumstances should be kept in mind when observed results are interpreted. In addition, the literature on moderated mediation concerning age in behavioural regulations is as scarce as in gender, and even if earlier findings on mean level for different age groups are more consistent than those regarding gender, rational interpretations of the current results still appear rather complicated. Generally, previous research has shown that older adults have more intrinsically oriented exercise goals and motives, while younger adults tends to have less self-determined ones (e.g. Brunet & Sabiston, 2011; Beck et al., 2010), explaining why older adults could perhaps be expected to be generally more autonomously regulated and younger adults to be more controlled. Applying these arguments to the present study this could reflect that older adults, at least in this sample, might have more internalized goals, e.g. mainly related to aspects of health and not as much to appearance. Again, these speculations should be considered in relation to the proposed simplex pattern, and at this stage it is clearly challenging (and probably premature) to generate sensible explanations for these mechanisms. In order to extend these exploratory moderating mediation analyses, the investigation of cross-study differences in SDT-related relationships regarding gender as well as age and other potential moderating factors highlighted in previous research (Guérin et al., 2012; Teixeira et al., 2012) needs to be addressed in future studies. Based on the universality stipulations of SDT, an alternative explanation more in line with theory would be that observed differences of gender and age could be influenced by the extent to which the social context supports (or thwarts) need satisfaction for a given subgroup. As an example, the general (stereotypic) gym culture and social context at fitness clubs might generate different opportunities for optimal psychological need fulfilment for men and women, respectively, as well as at different stages of life. Furthermore, older adults might be assumed to have more leisure time and better opportunities to choose interesting and stimulating exercise activities and/or be more prone to engage in and seek out need-supportive contexts. It is also possible that this particular sample of older adults is different than the archetypal/general person in this age group, for instance regarding the use of web-based exercise services.

Finally, there are some limitations that need to be reflected on. Due to the cross-sectional design the outcomes of this study should be interpreted with caution, but having used proper and modern recommended MVA (Hayes, 2009; Cerin & MacKinnon, 2008), the results could still be considered useful in informing practice (MacKinnon, 2008; Kline, 1998). As discussed above, interpretation should also consider the specific sample consisting mainly of

middle-aged women, the majority of whom had joined the web-based exercise service via step-contest packages provided by an employer, factors that may have influenced the concepts measured. Future studies should therefore further examine whether the current results generalize across populations. In addition, although the LTEQ can be considered relatively reliable (e.g. Jacobs et al., 1993) and valid (Wilson et al., 2010), self-reported measures of exercise levels are undeniably problematic and thus some caution is called for regarding exercise as an outcome. On the other hand, Study 1 contributes to previous studies in several aspects, e.g. providing a large e-health-based sample of middle-aged adults with assumed variance in studied variables. To sum up, Study 1 represents a first indication that intervention design might benefit from slightly different approaches for different subgroups based on age and gender, and perhaps also on contextual influences likely to modify vital prerequisites of certain subgroups. As pointed out by Teixeira et al. (2012), exploring motivational profiles based on (demographic) group level, stage of change or causality orientation would also be a valuable contribution to research and practice.

Study 2

Having examined the mechanisms of basic psychological needs and motivational regulations in relation to exercise behaviour, Study 1 covered the last three steps of the SDT process model (see Figure 2), adding to the understanding of potential mediating and moderating variables impacting exercise behaviour. Although the recommended analyses for cross-sectional data (MacKinnon, 2008; Kline 1998) were used, causal inference is limited and the reciprocal influences assumed to be present in exercise behaviour remain elusive. Study designs containing repeated measures provide better insight into mediational processes by adding a temporal aspect, allowing sequential observation (Cerin, 2010). In Study 2 an important step was added by including an intervention representing the first step of the described process model. Since PA and exercise behaviour have been suggested to be multifaceted behaviours difficult to cover with one specific theory (Bauman et al., 2002), and polytheoretical approaches are advocated (Baranowski et al., 1998; Ntoumanis, 2012), elements of MI, CBT and RPM were included, mainly utilized as intervention methods to apply and deliver the SDT-informed content in a structured manner. From an SDT perspective, the underlying intention was to impact participants' exercise behaviour by manipulating the suggested causal mechanisms described in the process model, i.e. facilitate internalization through an interpersonal style providing autonomy support, structure and involvement. Results from the second study displayed intervention effects on exercise level, exercise intensity and motivation quality, as well as mediating effects of RAI and identified regulation in relation to exercise behaviour. The experimental group also demonstrated significantly lower levels of extrinsic motivation than the control group post-intervention.

Intervention effects

The experimental group had increased levels of both total and strenuous exercise post-intervention, demonstrating that the intervention had a positive effect on exercise behaviour. In addition, the intervention effect was mediated by RAI and identified regulation, in agreement with SDT postulations (Deci & Ryan, 2000; Ryan & Deci, 2002) and previous research (Fortier et al., 2012; Teixeira et al., 2012) as well as the results of Study 1. Identified regulation predicted strenuous exercise in the study by Edmunds et al. (2006) as well, and its proposed value for demanding activities like PA and exercise (e.g. Teixiera et al., 2012; Ryan & Deci, 2002) is thereby reinforced by the results of Study 2. Since PA and exercise interventions in general have been shown to be ineffective in changing both proposed mediators and behaviour, and since few studies have demonstrated that a change in the mediators in turn changes behavioural outcome (Rhodes & Pfaeffli, 2010), the results of this

study provide conceptual theory links supporting SDT stipulations and capacity. The results also highlight the potential value of utilizing a polytheoretical approach in exercise interventions, in this case by providing support for previously suggested combinations of SDT with MI (Patrick & Williams, 2012; Markland, Ryan, Tobin & Rollnick, 2005; Vansteenkiste & Sheldon, 2006; Deci & Ryan, 2012), CBT (Khazaal et al., 2008) and RPM (Gustafson et al., 2011). Measuring the above-mentioned frameworks as outcomes was not included in the Study 2 objectives, so interpretations of how mediating effects of SDT-related constructs relate to specific constructs of MI, CBT or RPM cannot be made. In speculation, the post-intervention effects on exercise behaviour may indicate, for example, support for using MI guidelines in applying the theoretical foundations of SDT as encouraged by, e.g., Patrick and Williams (2012). Furthermore, besides providing structure, the RPM strategies like managing barriers and elements like goal setting and chain analyses from CBT may have supported participants' feelings of control and self-regulation. Together with the overall ambition to convey an autonomy-supportive approach, these conditions may have facilitated self-determined motivation (especially identified regulation) and diminished the prominence of external regulations, which in turn may have contributed to increased exercise level and intensity.

The lack of mediating effects regarding competence and autonomy need satisfaction is not in line with theory expectations and harder to explain. It seems that the mechanisms of self-determined motivation could be operative and generate increased exercise as an outcome even in the absence of statistically significant mechanisms of need satisfaction. Yet, this does not necessarily rule out the impact of the need for autonomy and competence on participants' autonomous motivation. The baseline measures could, for instance, be biased by an initial social desirability effect (Fortier et al., 2012). It is also possible that the voluntary involvement could imply higher baseline levels of motivation, perhaps even self-determined forms due to self-regulatory processes (Rhodes & Pfaeffli, 2010). This might be reflected in the behaviours regulated by identified motivation (which was a strong mediator of the intervention effect in Study 2) being considered more self-determined and volitional (Deci & Ryan, 2000). Moreover, participants had already acted autonomously by choosing to take part in the study (Fortier et al., 2012), and since inclusion criteria allowed some exercise once a week (although once was the maximum), some participants were likely already active to some degree, which may have influenced their feelings of competence and autonomy at baseline. Controlling for stage of change might therefore also have provided additional information. Taken together these matters could have affected the results, e.g., by making intervention effects on psychological needs undetectable. Furthermore, many SDT studies differ in terms of the number of needs assessed (Teixeira et al., 2012), and the decision to exclude the need for relatedness from PNSE was based on its supposedly more "distal" (Deci & Ryan, 2000) and, in exercise settings, debated role (McDonough & Crocker, 2007; Wilson, Rodgers & Fraser, 2002; Wilson et al., 2006). Since the three needs are considered interdependent and highly interrelated on a general level (Deci & Ryan, 2000), as was the case in Study 1, including relatedness in Study 2 might have generated more interpretable results in relation to theory. It is therefore recommended that future studies include all three needs (perhaps in a global need factor) in order to make adequate interpretations of the mechanisms between psychological needs and behavioural regulations in exercise settings.

Intervention concerns

Despite the small sample, the use of statistical methods with high power allows inferences of the mediating mechanisms impacting exercise behaviour (Cerin et al., 2006). In addition, the use of reliable measures (Teixeira et al., 2012; Rhodes & Pfaeffli, 2010), the random assignment and the theory-informed intervention design are all strengths that make

Study 2 a potentially valuable contribution to the field. The use of matching and multivariate analyses could to some extent also have reduced confounder bias incidence (Rothman, Lash & Greenland, 2013). Moreover, it is encouraging to note that even relatively short-term interventions like this one could have a positive impact on behaviour and mediators. As the intervention was conducted in the participants' real-world setting (i.e. not in a restricted or controlled environment), its expected practical utility regarding resources in terms of time, facilities and staff is proliferated. Most behaviour changes take place within the close environments of a person's private sphere, and although this will include incalculable confounders and uncontrollable factors, tailoring interventions applicable to where the person actually lives is surely far more useful than the controlled environments used in most interventions and RCT studies. The intervention in Study 2 has the potential to be applied in almost any context (e.g. gyms, workplaces, schools), and possibly even to be altered to fit in a digital context. Since the digital world now puts the person in the middle (in contrast to when people had no choice but to actually go to the library, bank or physician, for example, many of these errands can now be handled online), this would be increasingly valuable. Also, many previous studies have involved very specific samples, like clinical settings and overweight/obese women (Fortier et al. 2012), making this more heterogeneous sample a valuable contribution. Taken together, these conditions point to future opportunities to tailor more cost-effective interventions. Regarding limitations, the use of self-reported exercise measures is problematic, even when comparatively reliable ones like the LTEQ (Rhodes & Pfaeffli, 2010) are used, since effects of, e.g., social desirability cannot be ruled out. Including a direct measure of exercise would therefore have been ideal in order to permit the cross-reference of subjective and objective measures. An additional measure point would also have strengthened the study, allowing tests for within-person temporal change (Cole & Maxwell, 2003), and a post-intervention follow-up would have provided valuable information regarding maintenance and adherence; however, these concerns, as well as applying CONSORT guidelines and measuring intervention fidelity, were beyond the scope of this brief study.

In sum, Study 2 denotes a primary decent attempt, but future (RCT) studies would benefit from addressing these limitations and examining the above-mentioned mechanisms more thoroughly to provide more comprehensive information and explanation. Related to the findings in Study 1, regardless of what is considered the most plausible explanation (e.g. that observed age and gender differences are related to different motivational/need-support preferences; or that these age and gender differences are rather based on different opportunities in the social context), it would be especially interesting to consider intervention design tailored for these subgroups. Given that the population of older adults is growing, identifying and understanding the preferences of this group would be essential for facilitating the maintenance of health and physical as well as mental capacities during a long life. Finally, Study 2 could perhaps be considered an efficacy (rather than effectiveness) trial (Biddle, Mutrie, Gorely & Blamey, 2012), and due to aspects like this sample of convenience, it is essential to evaluate potential intervention effectiveness in terms of generalizability to various samples and settings.

General discussion

The big puzzle

As initially outlined, contemporary literature offers considerable evidence on the potential health benefits of regular PA and exercise (e.g. The European Health Report, 2013; YFA, 2010), but since modern society places little or no physical demands on people in order for them to survive, and since the "Palaeolithic rhythm" has encoded humans to take any opportunity to rest and save energy (Booth et al., 2002), people often have to take deliberate action regarding PA and exercise behaviours. Most Western countries have therefore developed guidelines and programmes to inform and promote PA and exercise behaviours in order for the population to gain desired health benefits. Unfortunately, health statistics show that many people do not reach these recommended activity levels (WHO, 2011). Research has also demonstrated that approximately half of those who actually try fail to maintain regular exercise habits (e.g. Nigg et al., 2008), and that only half of those getting PA on prescription actually increase their PA level (Kallings et al., 2009; Leijon et al., 2009). Apparently, few programmes generate sustainable changes in the long term (Cerin, 2010; Baranowski et al., 1998; Bauman et al., 2002), and since the targeted behaviours rely on multifaceted and complex relationships between various factors (e.g. Baranowski et al., 1998; Bauman et al., 2002; Nigg & Geller, 2012) there is a dire need for guidance in how to properly design successful programmes. As interventions operate through mediating processes, the study of indirect effects and clarifying mechanisms through MVA provide knowledge of how observed intervention effects could be interpreted and understood (MacKinnon et al., 2007). In addition, this would also endorse the evaluation of theory capacity and conceptual theory links (Cerin & MacKinnon, 2008), an important progression in this line of research (Nigg & Geller, 2012). In order to target the proposed mediators of behaviour change and create effective interventions, zooming in on moderating variables would also aid in adjusting the interventions for different groups/individuals or situations in which some methods have proven to be most effective (Cerin, 2010). Accordingly, focusing on known factors and mechanisms assumed to increase behavioural outcome (i.e. exercise) allows for systematic improvement and an understanding of how theory operates in successful interventions (Bauman et al., 2002). In turn, this allows for aiming at including effective components while removing ineffective ones, facilitating the design of more cost-effective programmes (Baranowski et al., 1998; Cerin & MacKinnon, 2008). Previous research and practice have generated ample knowledge of what works in exercise and PA promotion on a general level, but less is known more specifically about *why* it works, i.e. regarding the underlying mechanisms (Cerin & Mackinnon, 2008). Although several studies have supported the different individual paths of the proposed mediating model, few have fully tested the key assumption that self-determined motivation will mediate the association between need satisfaction and exercise outcome, especially considering possible moderating factors. By adding some new pieces to the puzzle, this thesis contributes to the understanding of how autonomy-supportive conditions facilitate self-determined motivation and subsequent outcomes in terms of exercise behaviour. Such knowledge constitutes a foundation for creating effective interventions and methods in public health programmes as well as in specific domains like schools, fitness centres and workplaces, or for instance addressing the modest PA adoption rates reported by Kallings et al. (2009) and Leijon et al. (2009) regarding Physical activity on prescription (PaP).

Overall, the results of the two studies correspond to the predictions from an SDT perspective and support the key assumption that a higher degree of psychological need satisfaction will be associated with increased exercise via more self-determined motivation (e.g. Deci & Ryan, 2000; Hagger & Chatzisarantis, 2008; Fortier et al., 2012; Vallerand &

Losier, 1999; Williams et al., 2006). In addition, by studying the motivational processes through mediation and indirect effects instead of focusing on direct or mean-level effects, this thesis represents a requested extension of previous studies in the field of exercise and PA (e.g. Biddle, et al., 2012; Nigg & Geller, 2012; Bauman et al., 2002; Fortier et al., 2012; Teixeira et al., 2012; Cerin, 2010). A key finding of this thesis is that Study 1 showed that self-determined motivation acted as a mediating variable in the relationship between psychological need satisfaction and exercise, and that these patterns of indirect effects differed across age and gender, indicating that mechanisms in the SDT process model can vary (qualitatively) in different subgroups. In line with the proposition that "one size may not fit all" (Gallagher et al., 2012), the current findings support the idea that no generic method will be successful in all situations and for all participants. It seems that one important key to success is personalization and timing, i.e. doing the right thing for the right person at the right time. Furthermore, the results of the second study also provide evidence that the mediating mechanisms of the process model can be manipulated in an intervention, e.g. by creating need-supportive environments facilitating internalization and subsequent exercise behaviour. A third key finding, which is in line with previous suggestions (Teixeira et al., 2012; Edmunds et al., 2006), is that both studies demonstrated that identified regulation plays a prominent role in the motivational processes, supporting the significance of internalizing the values behind a behaviour for the regulation of challenging activities like exercise (Deci & Ryan, 2000). Finally, the prospective value of combining SDT with other theoretical approaches and methods constitutes a fourth valuable outcome of this thesis. Implications of these main findings will be discussed below.

Putting the pieces together

Based on fundamental similarities outlined in the introduction, a complementary combination of the ideas of SDT and PCC is proposed. As the intervention design in Study 2 encompassed central parts of the working partnership (e.g. through person narrative, documentation, goal setting, follow-up, etc.), the overall intervention approach could be considered clearly person-centred. In the first study, the person-centred components seem somewhat more abstract, but in view of the apparent commonalities with PCC fundaments, SDT itself it could be regarded as the person-centred part of the study. When the aim is to facilitate motivation and engagement, involvement constitutes a fundamental element, i.e. the extent to which participants are involved in the processes and decisions concerning their health in a bottom-up manner, rather than receiving the traditional (more hierarchical) top-down approach. The bottom-up involvement approach represents the spirit of autonomy support in SDT (Deci & Ryan, 2000; Reeve et al., 2003; Sheldon et al., 2003) as well as the basic principles of PCC practice (Lindseth et al., 2011; Ekman et al., 2014; Sandman et al., 2011). Both frameworks thereby share an important philosophical foundation, forming the attitudinal value systems applied in research and practice. In essence, person-centredness can be expected to facilitate autonomy and vice versa.

The SDT assumption of people as organismic dialectic persons having an innate intrinsic motivational drive towards well-being (Deci & Ryan, 1985; 2000) is a belief that shapes interaction with clients and patients in the same way as PCC views patients as capable persons (Ekman et al., 2014; Lindseth et al., 2011). Essentially, this means that practitioners will not have to (and should not) force people to change, which is also in line with the fundamentals of MI practice (Miller & Rollnick, 2002; 2012) and represents a shift from traditional approaches involving more controlling and persuasive (or even threatening) interpersonal communication. Markedly, this also highlights a choice *not* to change, or *not* to prioritize health as autonomous and fully acceptable. It is very easy to presume that people see health as their first priority and really want to change, but the reality might look slightly different. For

instance, projecting personal values on others (like "Health is important", "This person should change", "I'm the expert here", "This person has a problem") and regarding no change as a personal failure are common traps in health counselling (Mason & Butler, 2010). Although many people have a desire to improve their health and/or to feel better in general, health is not always their first priority. Overlooking such an essential precondition could create an imbalance in the working partnership of PCC as well as impede the autonomy-supportive conditions of SDT. Volition (i.e. personal desires, goals and meaning) is considered a key capacity and a powerful human phenomenon in both SDT and PCC, and is expected to impact the emotional experience of behaviour as well as the subsequent behaviour itself. Being volitional (or autonomous), a person is able to feel creative and efficient in causing his/her own actions (Deci & Ryan, 2000; Ryan & Deci, 2002), and since this normally takes place within some social context, the social predispositions (e.g. value systems and interpersonal communication) are essential for the person to feel volitional. It therefore seems important for all involved parties (from policy-makers to researchers and practitioners) to truthfully question prevailing perceptions of human capacity in order to apply a more adaptable philosophical foundation. The culture and atmosphere conveyed through the adopted value system could indeed influence whether or not reaching out and stimulating motivation and engagement are successful. Autonomy support would be a valuable tool, and along with vital ingredients like involvement and responsibility (as in trust), the basics of a working partnership could mark the mutuality in such practices. All in all, such an approach could have a positive influence on the motivation and engagement for sustainable behaviour change and the subsequent self-regulation in different domains. This would be true not only for face-to-face interactions, but also in designing digital tools and services in e-health domains, placing high demands on the possibility for practical application and highlighting the need for an adequate theory base.

Strategies for the enhancement of exercise motivation

The implementation of regular exercise behaviour could be considered demanding in several ways. Obviously, it requires physical exertion to some degree, but also mental effort like planning and prioritizing (i.e. replacing other valued activities with exercise), reasoning with oneself in the face of boredom or stagnation, and sometimes even reasoning with others (perhaps questioning the new habit or feeling neglected in the process), and so on. Besides consciously planning logistic features (e.g. time, place, priorities), people also need to use cognitive and behavioural strategies to overcome perceived barriers both psychological (e.g. lack of time, energy, motivation or social support) and physical (e.g. somatic limitations like pain, overweight, fitness level and perceived exertion) in nature. In addition, practical skills and knowledge (e.g. adequate techniques, suitable exercise dosage and appropriate goal setting, etc.) as well as matters of facility proximity and access, resources and equipment need to be handled. Indeed, exercise initiation and maintenance can be quite challenging and for most people will most likely not happen automatically or through pure will power. When dealing with exercise promotion, practitioners and researchers need to not only recognize these challenges (and acknowledge the effort and ambivalence involved in persevering them), but also consider the pieces of the puzzle mentioned above, regarding for example the multifaceted origins of exercise engagement and mechanisms of motivational processes (i.e. the "why") and – perhaps most importantly – to consider the value system employed. As correlations between these aspects are likely to be bidirectional (Bauman et al., 2002) and no particular factor by itself can guarantee a desired outcome, a holistic view of exercise behaviour is of particular importance.

Bearing in mind that exercise initiation and adoption have the potential to generate health effects comparable to quitting smoking, there is a great deal to be won from creating successful exercise interventions based on the processes of motivation and engagement at

both an individual and a public health level. But general aims are perhaps too high, making people feel it is no use trying (amotivation) or experience pressures related to external and introjected regulations. Perceptions of "no pain-no gain" are commonly accepted, inflating the beliefs regarding the effort needed in order to gain desired benefits. Perhaps it could be stressed more clearly that the dose-response recommendations should be viewed in regard to the desired effects, i.e. more clearly differentiating between health and performance enhancement, since they denote quite different demands in terms of the time and effort needed. Dosage and perceived exertion can naturally be considered critical for the exercise and PA experience, and starting at too high a level could result in the inability to maintain ambitions, which in turn could have negative effects on feelings of competence (cf. effectance; White, 1959), thereby affecting motivation and increasing the risk for drop-out. Linking this to the tenets of relapse prevention (see Marlatt & Gordon, 1985; Larimer et al., 1999; Stetson et al., 2005), high initial ambitions would result in slips and lapses in the face of barriers, putting the person at risk of experiencing inconsequence between ambition and action (i.e. cognitive dissonance), generating feelings like guilt, failure and loss of control (thwarting the need for competence), which in turn leads to drop-out. In speculation, these arguments could in part contribute to explaining the stable drop-out rates observed in previous research (see Buckworth et al., 2013; Nigg et al., 2008; Lox et al., 2010) and the challenge of adherence (see Patrick & Canavello, 2011; Portnoy et al., 2008), as well as PA adoption rates in PaP (see Kallings et al., 2009; Leijon et al., 2009). It is possible that both health providers and people in general hold idealistic expectations regarding (particularly the initial) dosage recommendations, thereby hampering motivation for and engagement in exercise and PA behaviour by thwarting psychological need satisfaction and forestalling internalization. The importance of low-intensity PA is often neglected, and considering that this constitutes the main part of regular PA for most people (e.g. daily housework, short-distance indoor walking, etc.), these everyday activities could in fact have a greater impact on health than running or going to the gym three times a week. In fact, focusing on merely reducing daily sitting time (e.g. watching TV, working at the computer, etc.) could prompt substantial positive health impacts (Eklund-Bak et al., 2010), even by simply taking shorter breaks (i.e. standing up) from sitting down (Healy et al., 2010). In view of this, actually quite low effort is needed for relatively large health benefits, a notion quite contrary to the "no pain-no gain" notion. Hence, people actually do not need to start a jogging or gym routine, take their bike to work or even take brisk walks at lunch. This might sound nearly immoral to health professionals devoted to stimulating their clients/patients to improve their health by engaging in these behaviours. Quite on the contrary, though; this should be considered highly encouraging. First of all, it opens up numerous options for people to be physically active outside the conventional (and for many people dreadful) exercise activities like jogging, working out, doing aerobics, cycling, etc. Secondly, it allows people to feel more confident in trying, virtually regardless of fitness level, weight or other (perceived or real) somatic barriers, at least as long as one is able to stand up for a few minutes. Consequently, discouragement from anticipated physical exertion will be minimized. Thirdly, it also allows people to find time to actually do it. Numerous studies have shown that the perception of lack of time is one of the most prominent barriers to PA and exercise (e.g. Buckworth et al., 2013; Lox et al., 2010), and considering this, just regularly standing up during the TV commercials might sound like a much more attainable goal to a reluctant exercise initiator than going to spinning class. Hopefully, accomplishing such small steps could increase feelings of competence and create a foundation for autonomous progression. At the same time, it should not be forgotten that participants hold the key to change. Some people are really motivated to go from zero activity right into that spinning class, and some of them actually succeed in "starting their new life" and turning a more or less sedentary lifestyle into regular exercise behaviour in this way. Being true to the

values of SDT (and PCC), all motivational sparks should be professionally supported, e.g. by the exploration of choice and motivational aspirations. The social context and competing motives and values should also be considered, since these aspects are believed to affect a person's motivation for behaviour change.

In order to more accurately predict behaviour, it is essential that processes of "what" and "why" in motivation and goal orientations be separated (Deci & Ryan, 2000). Why a certain goal is pursued (e.g. intrinsic aspirations like affiliation versus extrinsic ones like image) is vital, since autonomous regulations involve higher need satisfaction. The effects of the goal content (e.g. in terms of well-being) could also be affected by why it is pursued, making the regulation process more important than the goal itself. When psychological need satisfaction is supported, internalization and self-determination will be promoted, which in turn is believed to encourage goals and aspirations involving need satisfaction. Focusing on individual differences in motivational orientations and goal content could thereby provide valuable knowledge about human behaviour (Deci & Ryan, 2000). The degree of self-determination could be captured by asking for whom the behaviour is carried out, why it is pursued and how it feels when being performed. If the answer encompasses experiences like curiosity and feelings of enjoyment and pleasure, the behaviour is likely intrinsically regulated, which according to SDT represents completely self-determined motivation. Due to its volitional and self-regulated nature, intrinsically motivated behaviours are expected to be self-maintained and therefore to have a strong predictive value for adherence and maintenance (Ryan & Deci, 2002; Deci & Ryan, 2000).

However, not all behaviours denote pleasure and enjoyment, and for any given behaviour there are most likely pieces of different types of motivation and goals, the phenomenon more recently known as "motivational soup" (Teixeira, 2013; Vansteenkiste, 2013). For instance, people might want to work out in order to improve their fitness and lose weight, and they can feel simultaneously both that it is fun and that they ought to do it. Bearing in mind the potential effort needed to adopt and maintain regular exercise behaviours mentioned above, intrinsic motivation may not be the most salient drive in this motivational soup in exercise settings, like more integrated/identified values. Identified regulation denotes partial internalization, whereby expected outcomes of pursuing the behaviour are highly valued even if the activity itself is not enjoyable (Ryan & Deci, 2000). In this case, internalization maintains the behaviour through perceived importance even in the absence of intrinsic appeal (Ryan, 1995), and this is why extrinsic motivation does not necessarily have to generate negative consequences. If a person identifies with the values and expected outcomes of the activity (or has integrated them into the self), he/she can indeed feel autonomous or self-determined. This means that promoting identified (and integrated) regulation as well intrinsic motivation could be prosperous in exercise settings (Edmunds et al., 2006; Teixeira et al., 2012), a belief visibly supported by the results of this thesis and the discussions above. Identified regulation could be expected to help people to exert effort in pursuing exercise activities, while intrinsic motivation would help them focus on enjoyment and well-being. It is important to keep in mind that intrinsic motivation is more than just fun; it is also about mastery, challenge, learning and creativity, which places the focus on the experience as an outcome. As Rhodes and Pfaeffli (2010) suggested, focusing on altering the behavioural experience in challenging behaviours like exercise has the potential to improve intervention fidelity and to have a positive impact on proposed mediators. This could in turn also be linked to the discussion above regarding exercise dosage and perceived exertion, highlighting the potential power of personalizing programmes. Furthermore, focusing on the experience could be signified by the feelings afterwards, like the smile, relief, accomplishment, etc., as well as feeling related to others in the process. In the exercise and PA domain, relatedness most likely centres on connecting with other people. Even when people exercise alone they can have

support from peers, either directly when exercising close to other people (e.g. relating with others in spinning classes due to shared suffering, the music energy, connecting with the instructor), or more distal when interacting via social media (posting exercise-related achievements on Facebook, tweeting on Twitter, participating in forum discussions, etc.). The significance of the need for relatedness in Study 1 is therefore an interesting finding, especially highlighted by the obvious problems interpreting the results of Study 2 facing the lack of data in the relatedness dimension.

Taken together, the arguments discussed above can readily be tied to the tenets of psychological need satisfaction, autonomy support and the internalization process. The suggestion to start on a smaller scale, with activities easy to incorporate into our daily routine without demanding too much sacrifice or prioritization, and with low prospective inconvenience in terms of physical exertion or discomfort, has the potential to have a positive impact on our feelings of competence and autonomy. The potential in connecting with (distal or proximal) others will fuel the need for relatedness, which in programmes and interventions can also be fuelled by a health-care provider conveying involvement and acknowledging feelings in the process (e.g. resignation or amotivation due to previous failure in exercise adoption). Embracing the proposition by Deci and Ryan (1985; 2000) to nurture all three needs (i.e. to feel capable, volitional and affiliated) in these ways has the potential to facilitate the progress of internalization, optimal development and self-determined motivation in the people we work with. Focusing on quality of motivation (i.e. the "why") will increase the understanding of factors influencing behaviour, and the OIT continuum shows how people gradually become more self-determined by internalizing extrinsic motives, which in turn is assumed to have a positive impact on maintenance of and commitment to the behaviour and to increase well-being (Ryan & Deci, 2002). Interventions that successfully satisfy the three psychological needs will thereby foster internalization and subsequent behaviour change. Furthermore, and as outlined above, there is reason to believe that the key associations in the hypothesized SDT process model, linking need satisfaction to behavioural and affective outcomes via self-determined motivation, will not be the same across gender and age. Accordingly, exercise interventions addressing the observed mechanisms of this thesis could be especially important since they seem to play an essential role in the motivational processes.

In the face of all these circumstances, the utility of employing a polytheoretical approach is clearly evident, and this thesis offers preliminary support for prosperous outlooks in combining the basic outlines of SDT with other theories and methods besides the parallel aspects of PCC discussed above. Also, MI has the potential to provide SDT with practical guidelines (Patrick & Williams, 2012; Markland et al., 2005), perhaps along with the structure and methods in CBT practice (see Khazaal et al., 2008). Also, previous evidence of the utility of programmes personally tailored to relapse-prevention strategies (Kahn et al., 2002),could in part be considered to be supported by Study 2. Moreover, several previous studies have recommended the application of stages of change (Teixeira et al., 2012; Fortier & Kowal, 2007; Fortier et al., 2012), which would probably have aided the interpretations of Study 1 and 2, since people can be expected to pay attention to different types of messages and supportive approaches depending on which stage they are at.

Future directions

One of the things missing in current research is an assessment of psychological need-support from multiple sources – i.e., tapping different dimensions of the needs (particularly relatedness), separating need support from health providers (physicians, instructors, health educators, etc.) and from significant others (friends, family, colleagues). In view of this, it would also be interesting to investigate whether the source of the support might matter as much, or even more, than the psychological need itself. Furthermore, it would also be

interesting to study whether having a need-supportive personal sphere (e.g. friends or family) might compensate for having a controlling health provider; i.e. whether there would be a statistical interaction between psychological need support (or perhaps thwarting) from the health provider and the psychological need support from family and friends.

Digital interventions are an important new direction of health promotion and intervention, but in the rapid advancement of the e-health industry regarding accessibility, quality and variety, somewhere the fundamentals of human needs and behaviour seem to have gotten lost. For example, it appears as if hardly any common digital services (e.g. apps, platforms, and programmes) are founded in behavioural theory but are rather based on short-term principles of maximizing turnover and consumer appeal. The digital world is mainly focused on extrinsic rewards and/or pressuring introjects, which from an SDT perspective could result in undermining (i.e. decrease in intrinsic motivation) and short-term effects (Deci & Ryan, 1985; 2000; Deci, Koestner & Ryan, 1999; Murayama, Matsumoto, Izuma & Matsumoto, 2010). Designing these e-health services is surely done for good reasons, but since such controlled processes can have negative consequences on personal growth and well-being (Ryan & Deci, 2002), besides having little or no effect in the long term, they potentially risk harming people. Consequently, it would probably be prosperous for future digital health promotion services to apply professionally devised services providing opportunities for autonomy support, structure and involvement, e.g. through providing educational health information along with a variety of options, instruments and tools; emphasizing volition, optimal goal orientation and values; facilitating feelings of connection, coherence and meaningful relationships, and so forth. Based on the summary of arguments above, embracing SDT and person-centred approaches in e-health design could be expected to facilitate positive effects in terms of targeted health behaviour outcomes and well-being. In this way, there would be potential to generate a win-win situation for both users and producers.

The current results also highlight possible implications of incorporating age and gender perspectives in designing effective exercise interventions, and given the previously observed female proneness to web-based exercise and PA programmes (e.g. Brouwer et al., 2010; Dawson et al., 2008; Napolitano et al., 2003), this might be even more important in Internet-based interventions and programmes. Future research can benefit practice by more thoroughly examining these notions (especially mediating and moderating effects) in order to be able to make adequate recommendations for how to address age and gender issues in digital intervention designs.

Finally, the possibilities offered by personalized interventions regarding aspects like motivational soup and subgroups based on different exercise activities or environments, along with longitudinal within-/between-group changes in these dimensions, would also be interesting objectives to study in order to better understand the elusive foundations of exercise and PA behaviour.

Conclusions & contributions

In summary, the results are generally in line with the theoretical expectations concerning the mechanisms in the SDT process model, demonstrating that self-determined motivation is promoted by need satisfaction and that self-determined motivation in turn can translate into increased levels of exercise. Furthermore, the results of the second study also provide evidence that these mechanisms can be manipulated in an intervention, e.g. by creating need-supportive environments facilitating internalization and subsequent exercise behaviour. Showing theory to predict behaviour by illuminating mediating effects allows a refinement of the intervention construction in order to increase its effectiveness. This thesis also extends previous research, breaking new ground by being one of the first studies to explore the sequential steps proposed by SDT in a full mediation model while also considering potential

moderators. The moderating effects of gender and age in the mechanisms of the SDT process model revealed complex patterns in the associations between SDT concepts and exercise, indicating that mechanisms in the SDT process model can vary depending on subgroup. Although some rudimentary attempts at inference have been made in the present thesis, the purpose has been to explore the presence of these mechanisms rather than to explain them. Future studies would therefore do well in further examining the moderating effects of gender and age in order to provide comprehensive and elaborate explanations to inform practice. Additionally, both studies demonstrated that identified regulation plays a prominent role in the motivational processes, supporting the significance of promoting internalization in potentially demanding activities like exercise. In this way exercise intervention efficacy could be more systematically improved, and more cost-effective and successful programmes could be tailored. Finally, the prospective value of using a polytheoretical approach in exercise promotion is discussed, more specifically regarding the prosperous outlooks offered by combining SDT with other theories and methods.

Table 7. *Study overview*

	Study 1	**Study 2**
Design	Cross-sectional	Two-wave RCT intervention
Theoretical foundation	SDT	SDT, MI, RPM CBT
Participants	N=1,091, web-based exercise service members, mean age 45 (SD=11.7)	N= 64, undergraduate students, mean age 27 (SD=7.4)
Measures	BPNSE, BREQ-2, LTEQ	PNSE, BREQ-2, LTEQ
Analyses	SEM, MVA	ANOVA, ANCOVA, MVA
Results	Self-determined exercise motivation (RAI and identified regulation) mediated the relationship between basic psychological need satisfaction and exercise in the full sample. This relation was also moderated by gender and age.	Post-intervention effects showed increased levels of total and strenuous exercise, and this effect was mediated by self-determined motivation (RAI and identified regulation).
Limitations	Cross-sectional design, sample constitution (mainly women, high mean age) and self-reported exercise.	Small sample of convenience, self-reported exercise, exclusion of the relatedness need dimension and only having two measure points.
Contributions	• Validation of Swedish translations of BPNES and BREQ-2 • Employing a large sample of middle-aged adults in an e-health context • Using SEM and advanced and modern recommended MVA • Generating a full mediation model of Steps 3-5 in the hypothesized SDT process model along with moderating effects of gender and age, hence not only examining general relationships between variables but also when, for whom, and why they are associated	• Short-term exercise intervention • Applying a polytheoretical-informed approach • Operating in a real-world setting • Using advanced and modern recommended MVA

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Study 1

Abstract

Objective: Based on propositions of the SDT process model, this study aimed to explore relationships between the latent constructs of psychological need satisfaction, self-determined motivation and exercise behaviour; the mediational role of self-determined motivation in the association of psychological need satisfaction with exercise behaviour; as well as gender and age differences in the aforementioned associations.

Design: Adult active members of an Internet-based exercise programme (n = 1,091) aged 18’78 years completed a test battery on motivational aspects based on Self-Determination Theory (SDT).

Main outcome measures: The Basic Psychological Needs in Exercise Scale (BPNES) and the Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) were used to measure SDT structures, and the Leisure Time Exercise Questionnaire (LTEQ) was used to measure self-reported exercise.

Results: Need satisfaction predicted self-determined motivation, which in turn predicted exercise, especially for women. Self-determined motivation was found to mediate the association between need satisfaction and exercise, but differences were found across gender and age in the mediating effect of motivation.

Conclusions: The results demonstrated gender and age differences in the proposed sequential mechanisms between self-determined motivation and exercise in the SDT process model. This study thus highlights a potential value in considering moderating factors in SDT intervention designs and the need to further examine the underlying mechanisms between needs, self-determined motivation, and exercise behaviour.

Key words: autonomy, competence, exercise, relatedness, mediation

Need satisfaction, Self-Determined Motivation and Exercise: Moderation and Mediation Effects

The positive effects of physical activity (PA) on health are well established, and it is generally accepted that regular PA and exercise can be used to prevent and treat a variety of physical and psychological diseases (see The European Health Reports, WHO, 2009, 2013). A decade ago, Bull et al. (2004) stated that the effective promotion of a more physically active lifestyle has the potential to prevent as many as two million premature deaths and nearly 20 million disability-adjusted life years (DALYs) worldwide. Still, almost ten years later, health statistics show discouragingly low levels of PA and exercise levels (see WHO, 2011), and many interventions promoting PA and exercise are considered ineffective (Baranowski & Jago, 2005; Rhodes & Pfaeffli, 2010). Mounting literature strongly advocates the use of sound theory application in order to improve intervention efficacy (e.g. Cerin & Mackinnon, 2009; Lubans, Foster, & Biddle, 2008), and a lack of studies explaining the underlying processes (i.e. mechanisms) of theoretically derived hypotheses may partially account for many intervention failures (Rhodes & Pfaeffli, 2010). In order to design successful interventions, an understanding of mediation models is fundamental for comprehending the complex interactions between theoretical constructs (e.g. motivation) and behaviour (Rhodes & Pfaeffli, 2010). A widely used theory in modern research on human motivation is Self-Determination Theory (SDT; Deci & Ryan, 1985, 2000), a framework that has received substantial support for its usefulness in health behaviour change (e.g. Ng et al., 2012) and in understanding exercise and PA behaviour (e.g. Martin S. Hagger & Chatzisarantis, 2008; Teixeira, Carraca, Markland, Silva, & Ryan, 2012), as well as regarding proposed mechanisms of health behaviour change (Fortier, Duda, Guérin, & Teixeira, 2012; Fortier et al., 2011).

Self-Determination Theory is a multidimensional theory based on the importance of people being self-determined in order to be motivated and engaged in certain behaviours (Deci & Ryan, 2000). A fundamental notion in SDT is that different types of motivation differ qualitatively along a continuum, in relation to the degree of self-determination or the extent to which the behaviour is regulated by controlling aspects. These relationships are described in a sub-theory called Organismic Integration Theory (OIT; Ryan & Deci, 2002). Amotivation represents one end of the continuum and is a lack of any intention to engage in the behaviour. At the other end of the continuum lies intrinsic motivation, the most self-determined form of motivation. When intrinsically motivated, a person performs the behaviour volitionally because it feels inherently interesting or enjoyable. Extrinsic motivation, situated between amotivation and intrinsic motivation on the continuum, instead regulates the behaviour in order to achieve outcomes separate from the behaviour itself. There are four types of extrinsic motivation (external, introjected, identified and integrated regulation), which denote progressively more self-determined motives in relation to the degree to which the behaviour has been internalized. With increased internalization the motivation becomes more self-determined, which enhances persistence and adherence (Deci & Ryan, 2000). Another sub-theory of SDT, the Basic Needs Theory (BNT), holds that self-determined motivation originates from individuals' innate tendency to satisfy three basic psychological needs: competence, relatedness, and autonomy (Ryan & Deci, 2002). The need for competence denotes the feeling of effectance and capability, while autonomy represents feelings of volition or self-determination and relatedness refers to feelings of social inclusion and closeness. According to SDT (Ryan & Deci, 2002, 2007) and extensions of the SDT model (Vallerand, 1997, 2007), self-determined motivation will be promoted when the three needs are satisfied. Also, it is proposed that self-determined motivation will lead to important behavioural, affective and cognitive outcomes, while the consequences are decreasingly

positive from introjected and external motivation to amotivation (Deci & Ryan, 2000). A common trend in previous work is the strong intercorrelations between the three needs; and between competence and autonomy in particular (e.g. Markland & Tobin, 2010), suggesting that the three needs may be captured by an underlying unidimensional factor. Supporting this view, Hagger, Chatzisarantis, and Harris (2006) found that a single global need satisfaction factor could explain latent variables representing autonomy, competence and relatedness.

A proposed key assumption (Vallerand & Losier, 1999) is that self-determined motivation mediates the association between need satisfaction and behavioural outcomes, also illustrated by the SDT process model proposed by Williams, McGregor, Zeldman, Freedman, and Deci (2004). Specifically linked to PA and exercise contexts, the model posits that a higher degree of satisfaction of needs (related to the behaviour) is suggested to be associated with increased exercise through a more self-determined motivation (Vallerand & Losier, 1999). This relationship is supported by a considerable amount of research (Fortier et al., 2012; Hagger & Chatzisarantis, 2008; Teixeira et al., 2012), but the literature on how this link between needs, self-determined motivation and behavioural outcomes such as PA and exercise actually operates is somewhat inconsistent. Some studies (Edmunds, Ntoumanis, & Duda, 2006) have found that need satisfaction and/or self-determined motivation is related to PA/exercise behaviour, whereas others (e.g. McDonough & Crocker, 2007) have found that self-determined motivation is unrelated to these behaviours. One reason for these different results could be the influence of various moderating factors (e.g., gender and age) on the associations between needs, motivation and behaviour. In addition, although several studies have supported the different individual paths of this proposed mediating model, few have fully tested the key assumption that self-determined motivation will mediate the association between need satisfaction and outcomes in the context of PA and exercise using recommended analyses and also considering moderating effects. Edmunds et al. (2006), for

example, found that the relationship between the need for competence and strenuous exercise was partially mediated by self-determined motivation (identified regulation). A limitation in their study, though, is that they used the simpler analytical regression strategy of Baron and Kenny (1986), a method not recommended in modern research (see Cerin, 2010; Preacher & Hayes, 2008), for example due to its conservative nature and low power (Cerin & MacKinnon, 2009). McDonough and Crocker (2007) used structural equation modelling (SEM), testing the mediation hypothesis, and found that the satisfaction of all three needs was related to self-determined motivation but that self-determined motivation only partially mediated the effect on positive and negative affect and was unrelated to the behavioural outcome.

In addition, neither of these two previous studies examined possible moderating factors such as gender or age, or the relationships between needs, motivation and outcomes, which may explain when and for whom need satisfaction and self-determined motivation may be related to outcomes and when and for whom self-determined motivation may mediate the proposed effect of need satisfaction on outcomes. This line of research questions has been raised as an important issue for future research (Cerin, 2010; Preacher & Hayes, 2008). In a review on SDT in exercise and PA (Teixeira et al., 2012), more sophisticated analyses were specifically requested in order to clarify the role of need satisfaction in the development of self-determined motivation and to study possible moderating factors like gender and age differences.

Following these recommendations, and considering that both age and gender could reasonably play an important role in the motivational processes within the SDT context, these moderating factors should be taken into account when studying these processes. Although basic psychological needs are thought to be universal and apply across genders, ages and cultures, it is likely that such factors could influence the means by which basic needs are met

(Ryan & Deci, 2002) as well as how behavioural regulations emerge. Over the course of a lifetime, people's reasons for engaging in exercise and PA may change along with aspects like natural variations in things like values, health and goals (Miller & Iris, 2002). For example, older adults tend to have more intrinsically oriented exercise goals and motives (Brunet & Sabiston, 2011), suggesting that they may have a more autonomous exercise motivation. Research findings regarding gender differences are mixed. Some studies imply that women have a general tendency towards more controlled regulations (mainly introjected) than men (Teixeira et al., 2012) while some suggest the opposite, that women are more autonomously regulated and men more externally regulated to exercise behaviour (Li, 1999). At the same time, a meta-analysis found only negligible gender differences in motivational regulations (Guérin, Fortier, & Sweet, 2012). These mean-level results suggest that there is reason to also expect possible moderators in the pathways between need satisfaction, regulation and outcomes (such as gender and age differences). The identification of such moderators would not only provide important information for the theoretical understanding of SDT-based models of exercise (Teixeira et al., 2012), but would also serve as an informative compass or guide in designing exercise and lifestyle interventions (e.g. Gallagher et al., 2012; Guérin et al., 2012), even for specific subgroups in the population (e.g., younger women, older adults).

The main aim of this study was to explore: (a) theoretically derived hypotheses about the relationships between the latent (free of measurement error) constructs of psychological needs, self-determined motivation, and the manifest variable of exercise behaviour; (b) the mediational role of self-determined motivation in the association of psychological needs with exercise behaviour; and (c) gender and age differences (moderating effects of gender and age groups) in the aforementioned associations.

Methods

Participants

The participants (N = 1,091) – 286 men and 805 women, aged 18-78 years (M=45.0; SD=11.7) – were all active Swedish members of an Internet-based exercise programme created by a Swedish company in the e-health industry offering web-based health-care services (e.g. pedometer step contests, weight-loss programmes, etc.) mainly in the private sector. Hence, the sample was expected to be diverse regarding, for instance, fitness level, age and gender, as well as motivational aspects.

Measures

The Basic Psychological Needs in Exercise Scale (BPNES; S.P. Vlachopoulos & Michailidou, 2006) measures satisfaction of the three needs autonomy, competence and relatedness in the exercise domain through 12 items (e.g. *"The way I exercise is in agreement with my choices and interests"*) and a five-point Likert scale, where 1 = "I don't agree at all" and 5 = "I completely agree". Cronbach's alpha for the BPNES was 0.81 to 0.92 in the present study. The BPNES has been successfully validated as supporting the theoretically based three-factor model and the needs hypothesis of SDT (S.P. Vlachopoulos & Michailidou, 2006). It has also demonstrated gender invariance (S. P. Vlachopoulos, 2008). Motivation quality was measured using the Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004) using 19 items (e.g. *"It's important to me to exercise regularly"*) and a five-point Likert scale, where 0 = "not true for me" and 4 = "very true for me". The scale measures behavioural regulations through five factors: extrinsic, introjected, identified and intrinsic motivation, and, unlike the original BREQ, the BREQ-2 also measures amotivation. Using the Relative Autonomy Index (RAI), a single weighted score derived from the subscales as recommended by, for example, Vallerand and Ratelle

(2002) provides an index of the degree of self-determination. Higher scores (over zero) reflect more self-determined motivation. Cronbach's alpha for the BREQ-2 was 0.73 to 0.86 in the present study. The Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) was used to measure self-reported exercise. The LTEQ consists of three questions regarding the frequency of performing strenuous, moderate and light exercise during a regular week. The total exercise score can be calculated and transformed into the metabolic equivalent of exercise (MET) scores.

The BPNES and BREQ-2 were translated from English into Swedish according to the back-translation Method (Brislin, 1986). A bilingual (English and Swedish) expert first translated the tests from English into Swedish, and then another bilingual expert translated them back into English. Differences in the translated versions and the originals were discussed in the research group and formed the foundation of the final versions. For the invariance and moderation analyses, mean age (45.0) was used to create two age groups: a younger (18-45 years) and an older (46-78 years) one.

Procedures

The study began with a pilot study including ten persons selected through convenience sampling to test the comprehension and design of the test battery, using the think-aloud method (Ericsson & Simon, 1993). The pilot study resulted in the clarification and remodelling of parts of the test battery for the final version. Following a list of members provided by the e-health service company, potential participants for Study 1 were contacted by e-mail, with information on the aim of the study, ethical concerns and practical issues. When logging in to the questionnaire, the participants had to tick a box for informed concent in order to access the questionnaire The collected data were stored in a certain web account accessible only by the researchers. Participation was anonymous, and no personal data were

requested; hence, no personal register was created. The study was approved by the regional ethical board.

Analysis

Modern recommended analytical approaches were used, such as structural equation modelling (SEM) and mediation analysis using a bootstrapping resampling approach (Preacher & Hayes, 2008; Cerin, 2010), enabling the examination of measurement-free associations between constructs and more robust mediational paths. Mplus version 7.1 (Muthen & Muthen, 1998–2009) was used to analyse the data with the robust maximum likelihood (MLR) estimators. Missing data were handled using a full maximum likelihood (FIML) estimator, which is default in Mplus. Therefore, data from all (N=1,091) participants (i.e., including those who had missing data on some items or variables) were used in the Mplus analyses. Based on recommendations by Hu and Bentler (1999), the following fit indexes were used: (a) Satorra-Bentler chi-square statistics, (b) Bentler's comparative fit index (CFI; Bentler, 1990), and (c) the root mean square error of approximation (RMSEA; Browne & Cudeck, 1993). For the CFI, values close to or greater than 0.95 indicate a well-fitting model (Hu & Bentler, 1999). For the RMSEA, values less than .05 indicate a good fit, whereas values up to .08 represent a reasonable fit (Browne & Cudeck, 1993). In the invariance testing, we used the recommendations by Cheung and Rensvold (2002). Because the chi-square difference test is sensitive to the sample size, they recommend using a decline in the CFI of 0.01 or less as indicative of invariance. Moderation analyses were conducted through multi-group analyses, whereby model fit for models with no constraints between groups (e.g., men vs. women) in terms of paths was compared with model fit in models in which certain paths were constrained to be equal between groups.

Multiple mediator models with a bootstrapping resampling approach for calculating product-of-coefficients and asymmetric 95% confidence intervals based on 1,000 resamples (Preacher & Hayes, 2004; 2008) were used to test indirect effects. In the analyses, indirect effects of the independent variable (in the present study, psychological need satisfaction) on the outcome variable (exercise) through a proposed mediator variable (self-determined motivation) were estimated. Moreover, bias-corrected and accelerated bootstrap confidence intervals for the indirect effects were used (Hayes, 2013). Bootstrap confidence intervals are recommended because they do not make unrealistic assumptions about the shape of the sampling distribution of the indirect effect like, for example, the Sobel test does (Preacher and Hayes, 2008). All mediation analyses were performed through the SPSS macro PROCESS, described by Hayes (2013). The mediation analyses only included participants who had complete data on all included variables (n=672).

Results

The data did not display multivariate normality for either of the two instruments. The critical values, as estimated using AMOS 20, ranged from 48.65 for the BPNES to 209.13 for the BREQ-2, indicating non-normality in the sample (Byrne, 2010). Therefore, all the analyses (except for the mediation analyses, which used bootstrapping) were done using the robust MLR estimator in Mplus. Descriptive data divided into gender and age groups are presented in Table 1.

[Table 1 near here]

Factor validity of instruments and invariance testing

The theoretical a priori models displayed adequate-to-good fit with data. For the BPNES, the theoretical a priori three-factor model demonstrated good fit with data: Satorra-Bentler $\chi 2$= 246.45 (51df), CFI=0.96; RMSEA: 0.059 (0.052-0.067). The five-factor model of the BREQ-

2 demonstrated acceptable fit to data: $\chi 2$= 408.60 (142df), CFI=0.94; RMSEA: 0.044 (0.039-0.049). All standardized factor loadings were significant and generally over .60.

The three-factor measurement model of the BPNES displayed strict invariance (i.e. invariant residuals in addition to invariant factor loadings and intercepts) across gender and age, as the CFI did not decrease more than .01 in model fit when factor loadings, intercepts, and residuals were constrained to be equal across groups of gender (men and women) and different ages (18–45 years, and 46–78 years). The BREQ-2 measurement model demonstrated strong invariance (i.e. invariant factor loadings and intercepts) across gender and across age groups.

[Table 2 near here]

Psychological need satisfaction and self-determined motivation predicting exercise

In the first step, a model including the three psychological need satisfaction factors predicting the RAI score (reflecting the degree of self-determined motivation), which in turn predicted exercise behaviour (METS), was tested. The results from the model are presented in Table 2. The model demonstrated acceptable fit with data for the full group: Satorra-Bentler $\chi 2(145) = 691.16$, $p < .001$; CFI = .95; RMSEA = .060 (90% CI = .056 to .065). The paths from the two psychological needs, competence and relatedness, to self-determined motivation (RAI) were as expected, positive in direction and significant. The path between competence and self-determined motivation was stronger ($\beta = .71$, $p < .01$) compared with that between relatedness and self-determined motivation ($\beta = .19$, $p < .01$). Also according to expectations, self-determined motivation predicted exercise ($\beta = .25$, $p < .01$). Contrary to expectations, the path between autonomy and self-determined motivation was negative and significant ($\beta = -.20$, $p < .01$). Given that the correlations between autonomy and the latent factors of the BREQ-2 were according to expectations (i.e., positive correlations with identified and

intrinsic regulation but negative correlations with amotivation and external regulation), the negative path displayed in the model between autonomy and motivation most probably signals a suppressor effect rather than a conceptually meaningful result.

Because the latent factors of competence, autonomy and relatedness correlated strongly to moderately, the three psychological need satisfaction factors were collapsed into one total psychological need factor, using a second-order (higher-order) model. This model, with one higher-order need factor predicting motivation, also demonstrated acceptable fit to data: Satorra-Bentler $\chi^2(75) = 410.37$, $p < .001$; CFI = .93; RMSEA = .066 (90% CI = .060 to .072). The path between the single latent factor of total psychological need satisfaction and self-determined motivation was moderately strong and in a positive direction ($\beta = .65$, $p > .01$) for the full sample.

[Figure 1 near here]

In the next step, the RAI was replaced with the five factors of the BREQ-2, to offer more specific insight into how various types of motivation were associated with total need satisfaction and exercise behaviour. For the full sample (see Table 3, last column to the right), total need satisfaction, as modelled by the higher-order factor, significantly and inversely predicted amotivation ($\beta = -.44$, $p < .01$) and external regulation ($\beta = -.26$, $p > .01$) but not introjected regulation. Moreover, total need satisfaction predicted both identified regulation ($\beta = .79$, $p < .01$) and intrinsic motivation ($\beta = .81$, $p < .01$). In terms of the paths from type of motivation to exercise, only identified regulation significantly ($\beta = .30$, $p < .01$) predicted exercise behaviour for the full sample.

[Table 3 near here]

Moderating effects of age and gender

Only one significant difference across age groups or gender was found in the model using the RAI as a total measure of self-determined motivation (see Table 2). Self-determined motivation predicted exercise for women (β = .34, p < .01) but not for men, mirrored by a significant decrement in model fit ($\Delta \chi^2$=8.12/ 1 df) when these paths were constrained to be equal across men and women.

When including the five BREQ-2 factors instead of the RAI in the model, a number of significant differences in strength and direction of paths between men and women appeared (see Table 3). Model fit decreased significantly (reflecting a significant difference between men and women) when the following paths were constrained to be equal: total need satisfaction to introjected regulation ($\Delta \chi^2$=24.06/ 1 df); total need satisfaction to identified regulation ($\Delta \chi^2$=4.09/ 1 df); external regulation to exercise ($\Delta \chi^2$=9.84/ 1 df); introjected regulation to exercise ($\Delta \chi^2$=11.67/ 1 df); and identified regulation to exercise ($\Delta \chi^2$=28.02/ 1 df). Looking more specifically into these differences, the path between total need satisfaction and introjected regulation was positive and significant for men (β = .41, p < .01) but negative and non-significant for women, and total need satisfaction was more strongly related to identified regulation for men (β = .88, p < .01) than for women (β = .75, p < .01). Moreover, external regulation predicted exercise for men in a positive direction (β = .26, p < .01) but was not related to exercise for women, and introjected regulation was positively but non-significantly associated with exercise for men but negatively and significantly associated with exercise for women (β = -.14, p < .05). Finally, identified regulation predicted exercise for women (β = .40, p < .01) but not for men.

When differences in paths between age groups were examined, significant differences were noted in the two paths: identified regulation to exercise ($\Delta \chi^2$=7.19/ 1 df), where the path was stronger and significant for the younger year group (β = -.52 p <> .01) compared to the older one (β = .11, p> .05), and intrinsic motivation to exercise ($\Delta \chi^2$=5.87/ 2 df), where the

path was negative and non-significant (β = -.06, p >.05) for the young group but positive and significant (β = .24, p <.05) for the older one.

[Table 4 near here]

The mediating effect of self-determined motivation in the association of psychological need satisfaction with exercise

The mediating (indirect) effects of the RAI and the separate BREQ-2 factors are presented in Table 4. In the full sample there was a significant indirect effect of the RAI (αβ=2.69, 95% CI = 0.39-4.40), indicating that self-determined motivation acted as a mediating variable in the relationship between psychological need satisfaction and exercise. Looking at the multivariate mediating effects of the BREQ-2 factors, the only significant indirect effect was found for identified regulation (αβ = 3.60, 95% CI = 1.56-5.84).

Gender moderated the indirect effect of the RAI, as it was significant for women (αβ = 3.53, 95% CI = 1.72-5.32) but not for men. Also, the indirect effect of external regulation was significant for men (αβ = 2.69, 95% CI = 0.39-4.40) but not for women, whereas the effect of identified regulation was significant only for women (αβ = 3.78, 95% CI = 1.95-5.80).

The patterns of indirect effects of the BREQ-2 factors also differed across age groups. Identified regulation was the only significant mediating variable in the younger age group (αβ = 6.14, 95% CI = 3.58-9.09), whereas intrinsic motivation was the only significant indirect effect for the older age group (αβ=2.97, 95% CI=0.20-6.50).

Discussion

The purpose of the present study was to examine key pathways in a self-determination-based model of motivation in exercise, linking satisfaction of psychological needs with self-determined motivation and exercise, and specifically to look at how gender and age may

moderate these pathways. Moving from first-generation research questions targeting whether relationships exist to second-generation research questions focusing on the conditions under which, and when, relationships exist and, finally, to third-generation questions targeting mechanisms of change (mediators) in relationships entails vital steps in the progress of knowledge development in any field (Zanna & Fazio, 1982). SDT-related exercise research has typically evolved around first- but not second- or third-generation research questions, resulting in a gap in the knowledge base regarding what factors moderate and mediate key relationships in the theory. Our main analyses in the full sample revealed that higher need satisfaction predicted a more self-determined motivational profile, and that more self-determined motivation in turn predicted behavioural outcomes in terms of more exercise. Thus, our results are well in line with general SDT stipulations and previous research (e.g., Williams et al., 2004; Hagger & Chatzisarantis, 2008; Ryan & Deci, 2007; Teixeira et al., 2012; Fortier et al., 2012). Moreover, our study advanced previous work by demonstrating that self-determined motivation was a stronger predictor of exercise for women compared with men, adding interesting information regarding moderated mediation and possible mechanisms between SDT constructs and exercise.

In essence, we found that self-determined motivation mediated the relationship between psychological need satisfaction and exercise, as well as age and gender differences regarding these mediating effects. Thus, this study further confirms previous suggestions that the relationship between psychological need satisfaction and outcomes is mediated by motivation (Deci & Ryan, 2007; Williams et al., 2004; Vallerand & Losier, 1999), adding to the understanding of the underlying mechanisms of SDT constructs and how they can influence behaviour. Because comparable previous studies have demonstrated only partial (Edmunds et al., 2006) or no mediating effects of self-determined motivation (McDonough & Crocker, 2007) using non-recommended mediation analysis (Cerin, 2010; Preacher & Hayes, 2008),

our study seems to be one of the first to demonstrate the mediating effect of self-determined motivation in the relationship between need satisfaction and outcomes in the context of exercise, while also considering moderating effects.

Offering simple explanations for the demonstrated moderating effects of age and gender is not easy, and due to the exploratory nature of the moderating mediation analyses such clarifications would seem quite premature. Previous research mainly concerns mean-level observations, and does not contribute a rich frame of reference for explaining the specific differences in paths between men and women and different age groups (e.g., Teixeira et al., 2012; Guérin et al., 2012). Nevertheless, the choice to examine these paths is based on some preliminary thoughts that should be expanded on. For example, there is reason to believe that factors like age and gender could influence the means by which, for example, basic needs are satisfied (Ryan & Deci, 2002; Deci & Ryan, 2000), and it is likely that people's reasons for exercise change over their lifespans (Miller & Iris, 2002). Although both identified regulation and intrinsic motivation are highly self-determined and integrated into the self, previous research has shown that older adults have more intrinsically oriented exercise goals and motives than younger adults do (e.g. Brunet & Sabiston, 2011; Beck et al., 2010). Accordingly, the current results (demonstrating that intrinsic regulation positively predicts exercise only for older adults, whereas identified regulation was a stronger exercise predictor among younger adults) might support these previous mean-level studies by indicating that the older adults in this sample were somewhat more autonomously regulated than the younger adults. Furthermore, these mediation effects might not be moderated by age per se, but perhaps age serves as a proxy in terms of different stages in life possibly offering different opportunities and barriers to choose between leisure time activities with various degrees of need support (or need thwarting). Such arguments imply that the moderated mediation effects found in this study merely represent a first step towards the exploration of possible underlying

mechanisms and other potential mediators. Further investigation of moderated mediation effects is needed in order to offer deeper knowledge of how to address these mechanisms in exercise intervention construction. It should be noted that when the sample was split into three age groups (younger, middle-aged and older adults) the findings on age differences remained essentially similar to those based on two age groups.

In regard to gender, the present results add to the inconsistency shown in previous studies on mean level by displaying more controlled (external and introjected) regulations predicting exercise for men, whereas more self-determined (identified) regulation predicted exercise for women, which is in line with the study by Li (1999) but quite the opposite of the conclusions in the review by Teixiera and colleagues (2012), and non-consistent with, for example, research by Guérin (2012). These inconsistencies point to a clear need to further examine gender-related differences in how regulations are associated with exercise; and the arguments above regarding other potential underlying dimensions of age moderating the mediation effects also apply to the discussion of gender (e.g. social-environmental factors).

In order to design effective exercise interventions, previous work has proposed that "one size may not fit all" (Gallagher et al., 2012) and that further investigation is needed concerning cross-study differences in SDT-related relationships regarding gender (Guérin et al., 2012) as well as age and other potential moderating factors (Teixeira et al., 2012). Most paths in the model were invariant according to SDT (e.g., Deci & Ryan, 2000), but at some points we found pathway differences between age and gender groups, not only using the RAI but also for the subscale regulations, which paints a slightly more complex picture of the mechanisms responsible for exercise behaviour. As stated by Hayes (2013), *"…an analysis that ignores the potential contingencies and boundary conditions of an effect is going to result in a greater oversimplification of complex processes relative to an analysis that acknowledges*

that complexity by formally modelling it…" (p. 327). In this way, our study represents a primary attempt to create a better understanding of how and for whom SDT interventions could be more effective in terms of behavioural outcome. Since the nuts and bolts of how this would inform intervention design more specifically still remain unclear, the results of this study highlight the need for further inquiry regarding possible moderating effects. Future research would therefore benefit practice by more thoroughly examining notions of both mediating and moderating effects in order to be able to make adequate recommendations for how to tailor more person-centred SDT intervention designs, e.g. by addressing age and gender issues.

The strong competence-autonomy association in our study most probably resulted in the suppressor effect, which was demonstrated by an unexpected and, from a theoretical viewpoint illogical, negative association in the model between autonomy and self-determined motivation. The suppressor effect was handled in our study by collapsing the three needs into one global latent need satisfaction factor. This modified model fit data well, which is in line with the findings in previous work (e.g., Hagger et al., 2006; Markland & Tobin, 2010) that a single global need satisfaction factor could explain latent variables representing autonomy, competence and relatedness. Moreover, these results are also in line with the assertion (Deci & Ryan, 2002; Wilson & Rodgers, 2007) that the satisfaction of the three needs is complementary; that is, that the satisfaction of one need (e.g., autonomy) can occur only if the other needs are also satisfied.

Limitations and future directions

The current results should be interpreted cautiously with regard to methodological differences in previous studies (i.e., traditional versus more advanced methods like SEM), and the somewhat contradictive results call for further inquiries concerning these moderators,

using advanced analysis and various samples. Interpretation should also consider the specific sample. First, the sample consists of members of a web-based exercise programme focused on step contests and weight loss, which might have impacted participative motives, regulations and preferences; second, the relatively high mean age (45 years) combined with the female dominance could also have affected the results (e.g., women being more self-determined due to higher age); and third, this specific population of older adults might not be representative of this age group in general (e.g. these web-based exercise services might attract older adults with certain capacities and/or characteristics). Furthermore, women seem be more inclined to join web-based PA interventions (see e.g. Brouwer, 2010; Dawson, 2008; Napolitano 2003), which might serve as a complementary reason why women were more autonomously motivated in this study than men were. The primary limitation of the study, however, is the cross-sectional design. Therefore, even though proper analyses were used (Cerin & MacKinnon, 2009) even for cross-sectional data (Kline, 1998), and even if a direction is implied in our analytical model (e.g., need satisfaction predicting motivation), we cannot rule out the possibility of reversed causation. Moreover, drawing conclusions about mediation analyses based on cross-sectional data may be misleading because mediation consists of processes that unfold over time (Maxwell & Cole, 2007); future studies should further examine whether the mediating role of self-determined motivation will hold longitudinally. Also, even though a comparatively reliable (Jacobs et al., 1993) and valid (Wilson et al., 2010) self-report measure of exercise was used, it is unquestionably less reliable than objective measures. On the other hand, we employed a large e-health-based sample of non-clinical middle-aged adults, who are more rarely studied in the context of motivation and exercise. In addition, we conducted age- and gender-specific analyses, contributing new information in terms of when and for whom the different paths in the SDT model exist or are stronger/weaker. Based on the mediation model, this study could add to the prospective value

of the application of SDT in exercise adherence intervention construction, contributing to the growing evidence of the utility of SDT (Hagger & Chatzisarantis, 2008; Teixeira et al., 2012 Ng et al., 2012). Making the best use of SDT as a kind of compass with regard to mediating and moderating effects and mechanisms in constructing exercise interventions could assist a transition from inactivity to activity that is smoother and more sustainable for inactive individuals. Hence, our results highlight the importance for researchers in the future to examine the effect of potentially relevant moderating factors that may influence the different paths in the SDT-based models, rather than controlling these variables (e.g., age and gender), as typically tends to be done.

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Table 1. *Descriptives (means and standard deviations) of psychological need satisfaction, behavioural regulations, and exercise last six months (PA), across gender and age groups*

	Gender		Age		
	Men (*n*=286)	Women (*n*=805)	Younger (18-45) (*n*=539)	Older (46-78) (*n*=501)	Total sample (N=1,091)
BPNES					
Autonomy	4.0 (.84)	4.1 (.80)	4.0 (.81)	4.1 (.81)	4.1 (.81)
Competence	3.8 (.84)	3.8 (.82)	3.8 (.82)	3.8 (.83)	3.7 (.82)
Relatedness	3.9 (1.1)	3.8 (1.0)	3.8 (1.00)	3.8 (1.09)	3.8 (1.0)
BREQ-2					
Amotivation	1.1 (.30)	1.1 (.24)	1.1 (.28)	1.1 (.23)	1.1 (.25)
External reg.	1.2 (.39)	1.1 (.34)	1.2 (.38)	1.1 (.32)	1.1 (.35)
Introjected reg.	2.1 (.73)	2.2 (.78)	2.3 (.75)	2.0 (.77)	2.2 (.77)
Identified reg.	3.2 (.66)	3.2 (.63)	3.2 (.65)	3.2 (.62)	3.2 (.63)
Intrinsic reg.	3.2 (.70)	3.3 (.69)	3.3 (.70)	3.3 (.67)	3.3 (.70)
GLTEQ					
Strenuous exrc.	2.2 (1.8)	1.8 (1.6)	2.1 (1.9)	1.6 (1.5)	1.9 (1.7)
Moderate exrc.	2.9 (3.5)	3.7 (2.6)	3.3 (2.4)	3.7 (3.3)	3.5 (2.9)
Light exrc.	3.6 (4.1)	3.8 (2.9)	3.8 (3.2)	3.6 (3.3)	3.7 (3.3)

* Range of scores: BPNES scores range from 1-5; BREQ-2 scores range from 0-4; GLTEQ scores reflect number of times per week performed longer than 15 minutes at each occasion. (exrc. = exercise; reg = regulation)

Table 2. *Psychological need satisfaction and self-determined motivation (RAI) predicting exercise across gender and age groups*

Regression weights	Men *n*=286	Women *n*=805	Younger (18-45) *n*=539	Older (46-78) *n*=501	Full sample N=1,091
Competence →	.63	.71	.75	.73	.71
Motivation[a]	(.18)**	(.10)**	(.12)**	(.14)**	(.09)**
Autonomy →	-.17	-.18	-.27	-.18	-.20
Motivation	(.16)	(.09)*	(.11)*	(.13)	(.08)**
Relatedness →	.27	.17	.18	.21	.19
Motivation	(.08)*	(.05)**	(.06)**	(.05)**	(.04)**
Total Need →	.65	.66	.65	.72	.68
Motivation	(.04)**	(.02)**	(.03)**	(.03)**	(.02)**
Motivation →	.03	.34	.32	.23	.27
Exercise	(.08)	(.04)**	(.04)**	(.05)**	(.03)**
Correlations					
Competence ↔	.86	.86	.84	.88	.86
Autonomy	(.03)**	(.02)**	(.02)**	(.02)**	(.02)*
Competence ↔	.59	.64	.68	.59	.63
Relatedness	(.05)**	(.03)**	(.03)**	(.04)**	(.02)*
Autonomy ↔	.45	.55	.57	.50	.51
Relatedness	(.06)**	(.03)**	(.04)**	(.04)**	(.03)*

Note:[a] Relative Autonomy Index (RAI) *p<.05; **p<.01

Table 3. *Total psychological need and self-determined motivation (All five BREQ-2 factors) predicting exercise across gender and age groups*

	Men *n*=286	Women *n*=805	Younger (18-45) *n*=539	Older (46-78) *n*=501	Full sample N=1,091
Need →	-.44	-.44	-.46	-.43	-.44
Amot.[a]	(.07)**	(.04)**	(.05)**	(.05)**	(.06)*
Need →	-.14	-.30	-.24	-.29	-.26
Ext. reg.	(.07)*	(.04)**	(.05)**	(.05)**	(.04)*
Need →	.41	-.03	.11	.08	.09
Introj. reg.	(.07)**	(.05)	(.06)*	(.06)	(.06)
Need →	.88	.75	.78	.81	.79
Ident. reg.	(.04)**	(.03)**	(.03)**	(.03)**	(.06)*
Need →	.84	.79	.76	.86	.81
Intr. mot.	(.03)**	(.02)**	(.03)**	(.02)**	(.06)*
Amot. →	-.10	.00	-.02	-.02	-.02
Exercise	(.09)	(.05)	(.06)	(.07)	(.04)
Ext. reg. →	.26	-.00	.04	.12	.07
Exercise	(.08)**	(.04)	(.05)	(.06)*	(.05)
Introj. reg. →	.12	-.14	-.15	-.06	-.08
Exercise	(.10)	(.05)*	(.06)**	(.06)	(.05)
Ident. reg. →	-.06	.40	.52	.11	.30
Exercise	(.16)	(.07)**	(.08)**	(.11)	(.11)*
Intr. mot. →	.16	.04	-.06	.24	.08
Exercise	(.14)	(.07)	(.08)	(.10)*	(.06)

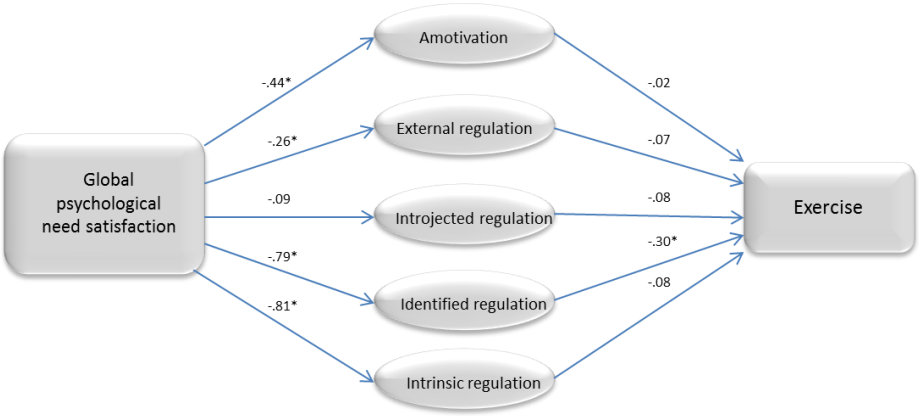
Note: Amot. = Amotivation; Ext. reg. = External regulation; Introj. reg. = Introjected regulation; Ident. reg. = Identified regulation; Intr. mot. = Intrinsic motivation. * $p<.05$; ** $p<.01$.

Table 4. *The mediating effects of self-determined motivation in the relationship between psychological need satisfaction and exercise across gender and age groups*

Indirect effects	Men $\alpha\beta^1$ (95%CI)	Women $\alpha\beta^1$ (95%CI)	Younger (18-45) $\alpha\beta^1$ (95%CI)	Older (46-78) $\alpha\beta^1$ (95%CI)	Full sample $\alpha\beta^1$ (95%CI)
RAI	-0.55 (-15.90-3.84)	3.53* (1.72-5.32)	1.37 (-1.67-5.42)	2.22 (-4.60-4.48)	2.69* (0.39-4.40)
Amot.	0.74 (-0.22-3.73)	0.21 (-0.24-0.77)	0.35 (-0.35-1.23)	0.30 (-0.05-1.60)	0.30 (-0.13-0.86)
Ext. reg.	-1.80* (-6.83--0.10)	-0.03 (-0.50-0.46)	-0.13 (-0.83-0.36)	-1.25 (-4.86-0.07)	-0.48 (-1.44-0.07)
Introj. reg.	0.44 (-0.62-3.19)	0.34 (-0.17-1.04)	0.34 (-0.02-1.25)	0.03 (-0.26-0.57)	0.15 (-0.11-0.56)
Ident. reg.	1.33 (4.80--10.50)	3.78* (1.95-5.80)	6.14* (3.58-9.09)	1.14 (-3.01-3.88)	3.60* (1.56-5.84)
Intr. mot.	2.36 (-2.08-7.67)	-0.08 (-2.07-2.00)	-1.22 (-3.87-1.18)	2.97* (0.20-6.50)	0.68 (-1.45-2.88)

[1] product-of-coefficient estimate (95% CI based on 1,000 bootstrap resamples);
Note: RAI = Relative Autonomy Index; Amot. = Amotivation; Ext. reg. = External regulation; Introj. reg. = Introjected regulation; Ident. reg. = Identified regulation; Intr. mot. = Intrinsic motivation
* $p<.05$

Figure 1. Results from structural equation modelling analyses linking psychological needs and self-determination to exercise for the full sample (*=p <.05)



Study 2

Abstract

The purpose of the present study was to examine the effects of a brief exercise intervention informed by Self-Determination Theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2002), combined with Cognitive Behavioural Therapy (CBT), Motivational Interviewing (MI) and relapse-prevention structures. The participants, 64 undergraduate university students, were randomized into either an experimental or a control group. The main question to be answered was whether the intervention would influence (a) exercise level, (b) motivation quality, and (c) need satisfaction (autonomy and competence). We also examined the indirect effects of self-determined motivation on exercise. Exercise level, need satisfaction and motivational quality were measured at baseline and after the six weeks of the intervention. Significant intervention effects were found regarding exercise level and motivation quality. In addition, exercise was found to be mediated by motivation quality and identified regulation. The results generally concur with expectations from an SDT perspective, and provide interesting information about the underlying mechanisms involved in exercise behaviour.

Key words: exercise, health behaviour, intervention, motivation

The effect of a six-week self-determination intervention on exercise

There is a strong need for adequately designed and well-delivered interventions that can increase physical activity and exercise (Biddle, Brehm, Verheijden, & Hopman-Rock, 2012). Theory-based interventions enable researchers to identify the potential mediators of change (Rhodes & Pfaeffli, 2010), and are more likely to successfully change behaviour. A growing body of evidence supports the application of Self-Determination Theory (SDT; Deci & Ryan, 1985, 2000; Ryan & Deci, 2002) in exercise and physical-activity promotion (Fortier, Duda, Guerin, & Teixeira, 2012; Teixeira, Carraca, Markland, Silva, & Ryan, 2012). This multidimensional theory emphasizes the social context and its ability to facilitate or thwart optimal motivation, as well as the extent to which behaviours are generally either self-determined or controlled in nature (i.e., motivation quality). In the Organismic integration sub-theory (OIT) of SDT, motivation quality is described on a continuum, with amotivation (non-regulation) and intrinsic motivation (self-determined regulation) at the ends and four types of extrinsic motivation (controlled regulations) in between, representing increasing degrees of self-determination (i.e. external, introjected, identified and integrated regulation). According to another sub-theory, Basic Needs Theory (BNT), self-determined motivation is based on the satisfaction of three basic psychological needs: competence, relatedness and autonomy (Ryan & Deci, 2002). In SDT, the term *internalization* describes the process whereby motivational regulation becomes more self-determined; and this process depends on the degree to which the social context supports or thwarts the satisfaction of the basic psychological needs (Deci & Ryan, 2000; Ryan & Deci 2002). Practical implications for internalization promotion include utilizing an interpersonal style and providing autonomy support, structure and involvement (Ntoumanis, 2012). The relationship between SDT concepts and behaviour has been described in a process model proposed by Williams et al. (2006), and specific mechanisms of the motivational sequence have been supported in several studies (e.g. Wilson & Rodgers, 2004; Teixeira et al., 2012) as well as in

interventions (e.g. Fortier et al., 2012; Edmunds, Ntoumanis & Duda, 2007; Edmunds, Ntoumanis & Duda, 2008). According to SDT, self-determined motivation has a positive impact on health-related behaviour (Deci & Ryan, 2000), a notion confirmed in physical activity and exercise interventions (Fortier et al., 2012) analysing the indirect effects (i.e., mediation) between SDT concepts and behavioural outcome. PA and exercise behaviour have been suggested to be multifaceted behaviours that are difficult to cover with just one theory (Bauman et al., 2002), and polytheoretical approaches are advocated (Baranowski et al., 1998). Recent research has also supported the combination of SDT with other theories of health behaviour, such as the relapse prevention model (RPM; Gustafson et al., 2011) and methods like Cognitive behavioural therapy (CBT; Khazaal et al., 2008) and Motivational interviewing (MI; Patrick & Williams, 2012). SDT-based interventions are still quite sparse, however, and differ greatly in terms of programme design and strategy (Teixeira et al., 2012). To our knowledge, few intervention studies combine SDT with methods like CBT and MI, especially outside health-care and clinical settings, and even fewer study indirect effects using mediation analyses (Cerin & MacKinnon, 2008; Rhodes & Pfaeffli, 2010).

The aim of this study was to examine the effects of an exercise intervention informed by SDT with added elements of CBT, MI, and relapse-prevention strategies regarding (a) exercise level, (b) motivation quality, and (c) need satisfaction for both autonomy and competence. A secondary aim was to test the indirect (mediating) effects of motivation quality and need satisfaction in relation to exercise behaviour.

Method

Participants

The sample was a convenience sample consisting of 64 undergraduate university students (49 women and 15 men) aged 19-49 years (M = 27.3; SD = 7.4). The inclusion criterion was that the participants were not currently engaging in exercise activities more than once a week.

Measures

Exercise level was measured using the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985), converting scale scores to metabolic activity relative to resting conditions (METs). The Behavioral Regulations in Exercise Questionnaire-2 (BREQ-2, Markland & Tobin, 2004) was used to measure motivation quality (i.e. regulations) and RAI scores (i.e. Relative Autonomy Index; a single weighted score of all the items, whereby higher scores (over zero) denote more self-determined motivation). The BREQ-2 contains 19 statements rated on a five-graded Likert scale, and has been validated and found to be stable in a number of translated versions (Moreno Murcia, Gimeno, & Camacho, 2007; Moustaka, Vlachopoulos, Vazou, Kaperoni, & Markland, 2010; Palmeira, Teixeira, Silva, & Markland, 2007). Finally, 12 items representing autonomy and competence on the Psychological Needs in Exercise Scale (PNSE; Wilson, Rogers, Rodgers, & Wild, 2006) were used to measure psychological need satisfaction. The PNSE originally contains 18 statements (for this study's purpose, the six items representing relatedness were removed) rated on a six-graded Likert scale. The PNSE scale has also has been found to be a valid measure of psychological need satisfaction (Wilson et al., 2006; Wilson & Rogers, 2008). Cronbach's alpha for both PNSE subscales was > 0.7.

Procedures

Participants were enrolled by convenience sample and were initially informed of the study's aim and procedure. After completing baseline measures, the 64 voluntary participants were randomly matched to either an experimental group (n = 32) or a control group (n = 32). Members of the experimental group were contacted by telephone to schedule a time for the intervention. The intervention was implemented individually following a semi-structured intervention template based on SDT (autonomy support) and combined with a selection of MI, CBT and RPM strategies. Mid-intervention (after three weeks), members of the experimental group received a follow-up telephone

call and were offered a modification of their exercise goals if needed. The control group received no intervention. Six weeks after the intervention, both the experimental and the control group were assembled to complete the post-intervention measures. All participants received cinema tickets (value approx. €10). The study was conducted according to the guidelines of the regional ethics board.

Intervention

The intervention in Study 2 was led by trained psychologists and consisted of a selection of MI, CBT and RPM strategies in terms of exercise-related participant narratives, decision balance, health-related exercise rationale, exercise-barrier identification, chain analyses and goal setting. According to recommendations advanced in previous research on SDT (e.g., Fortier et al., 2012; Sheldon et al., 2003) as well as SDT in combination with MI (e.g. Patrick & Williams, 2012; Markland et al., 2005), the intervention was conducted in an autonomy-supportive manner, using non-controlling language and conveying an empathic and non-judgmental approach, allowing participants to decide on potential behaviour change themselves without attempting to force any decisions. Taken together, the intervention provided vital elements of the working partnership in person-centred care (Lindseth, Olsson, Liden & Ohlen, 2011) as well as an SDT-informed interpersonal style with structure and involvement.

In order to allow personalized support and counselling, the trial leaders (TL) met all experimental group members individually. Initially, the participant's current relation to exercise as well as previous experiences were discussed based on a competence need rationale, followed by a decision balance procedure whereby participants listed exercise pros and cons. The listings were transferred to a whiteboard, where pros and cons could be compared in order to display whether one outweighed the other. Then the TL provided a CBT-based rationale for the potential positive effects of exercise on physical and mental health. The rationale was followed by an inventory of

experienced exercise barriers and potential approaches to overcome such barriers using relapse-prevention strategies (Marlatt & Gordon, 1985; Larimer et al., 1999), discussing potential drop-out situations and prevention strategies respectively. The TL described the differences between a slip, lapse, relapse and collapse, emphasizing the importance of participants not being self-judgmental when facing these difficulties but instead trying to regain their exercise routines. CBT-based barrier chain analysis was conducted in order to increase awareness of the long- and short-term consequences of different actions, and the participant was instructed to reflect on possible factors that facilitated exercise. Next, a basic SDT description was presented through CBT-based psychoeducation. Finally, potential interest in exercise initiation and prospective exercise activities were discussed based on the initial narrative. When the appropriate activities were established, participants were guided in exercise goal setting, employing specific, realistic and challenging goals based on CBT guidelines as well as SDT-informed intrinsic goal orientation. The agreed-on goal formulation was subsequently compiled and distributed to each participant after the meeting. Three weeks after the first meeting, members of the experimental group were contacted by telephone for a follow-up, aiming to support participants by giving them an opportunity to discuss their exercise progress or any additional need for support in exercise initiation, ask questions, modify their goals if needed, etc.

Analysis

From the baseline measurements, independent t-tests were performed using the LTEQ (MET, strenuous, moderate, and light exercise), the BREQ-2 (amotivation; external, introjected, identified, and intrinsic regulations, respectively; and RAI) and the PNSE (autonomy and competence) in order to detect any primary differences between the two groups. Instrument reliability was tested using Cronbach's alpha, and changes between pre- and post-test measures were analysed using repeated measures ANOVA. Between-group differences after the intervention were tested by analyses of

covariance (ANCOVA), whereby the post-intervention scores on exercise, need satisfaction and motivational quality were compared in the control and intervention groups; controlling for baseline scores and within-group differences was done though paired samples t-test. The significance level for all tests was set to $p < .05$. To test whether need satisfaction and motivational quality mediated the effect of the intervention on exercise, indirect effects were tested using multiple mediator models with a bootstrapping resampling approach to calculate product-of-coefficients and asymmetric 95% confidence intervals based on 1,000 resamples (Preacher & Hayes, 2004; 2008). All mediation analyses were performed through the SPSS macro PROCESS, described by Hayes (2013).

Results

No statistical differences between the experimental group and control group were found in the LTEQ, BREQ-2, or PNSE at the baseline measurement. Cronbach's alpha for the BREQ-2 and PNSE was > 0.70. Because the drop-out rate was low (n = 3) and displayed no extreme values, no drop-out analysis was done.

Post-intervention differences between groups

<Please insert Table 1 about here>

The experimental group ($M = 38.8$, $SD = 23.8$) reported significantly higher total exercise [$F(1,58) = 12.14$, $p < .01$] post-intervention than the control group did ($M = 26.0$, $SD = 14.9$), with a large effect size (partial $\eta^2 = .17$) (Pierce, Block & Aguinis, 2004; Cohen, 1988). In addition, experimental group participants ($M = 15.0$, $SD = 11.7$) also showed significantly higher levels of strenuous exercise [$F(1,58) = 13.66$, $p < .01$] post-intervention than participants in the control group did ($M = 7.7$, $SD = 10.6$), and this effect size was also large (partial $\eta^2 = .19$). Further, participants in the control group displayed more external regulation than members of the intervention group did post-intervention [$F(1,58) = 4.41$, $p < .05$, partial $\eta^2 = 0.07$]. No statistical differences were found in autonomy need

satisfaction [$F(1,58) = 1.53$, $p > .22$], competence need satisfaction [$F(1,58) = 0.70$, $p < .41$] or RAI score [$F(1,58) = 2.01$, $p < .16$] between the experimental and control conditions post-intervention (see Table 1).

The mediating effect of need satisfaction and motivation quality

Mirroring the results from the ANCOVAs, the total effect (c path) of the intervention on exercise post-test was significant (12.77, SE: 5.06, $p < .05$). Total RAI score post-test mediated the effect of the intervention on exercise post-test. The 95% confidence intervals did not include zero, and were estimated to be between 0.30 and 6.57. When considering all the BREQ-2 variables as mediators in the same model, the only significant indirect effect was found for identified regulation, with the bootstrap 95% confidence intervals estimated to be between 0.12 and 11.58. Explaining these paths, individuals in the intervention group had non-significantly ($p = .09$) higher total RAI scores and identified regulation post-test (a paths), and higher total RAI scores and identified regulation at post-test were significantly ($p<.05$) related to higher exercise at post-test (b paths). The indirect effects of the other BREQ-2 variables and of the needs competence and autonomy were not significant, indicated by the fact that zero was included in the 95% confidence bootstrap intervals for these variables.

Discussion

Our purpose was to study potential effects of an exercise intervention informed by SDT and using CBT, MI, and RPM structures as methods to apply the intervention content in a structured manner. The basic intention was to impact participants' exercise behaviour through manipulation of the OIT and BNT mechanisms of the process model; i.e., facilitate internalization through an interpersonal style providing autonomy support, structure and involvement. Significant post-intervention effects (experiment versus control group) were found regarding exercise level, exercise

intensity, and motivation quality. Both groups saw an increased total exercise level (i.e., total MET), but the experimental group had significantly higher total and strenuous exercise levels than the control group did post-test. Hence, the results generally align with SDT stipulations (e.g. Deci & Ryan, 2000) and previous research (e.g., Teixeira et al., 2012) as well as previous interventions (Fortier, et al., 2012), and suggest that SDT-informed interventions could have a positive effect on exercise behaviour. The study indicates the possibility that even brief interventions might yield effects similar to those of longer and more elaborate ones (e.g., Fortier et al., 2012), and the results also point to the potential benefits of combining SDT strategies with other theoretical components and methods such as MI, CBT and RPM, at least in short programmes. Since the objectives of this brief study only comprised measures of SDT-related constructs, interpretations of possible interrelations or interactions between the other frameworks cannot be made; thus future studies would do well to further explore these features.

The experimental group displayed lower levels of external regulation than the control group did post-test, indicating that the experimental group had become less regulated by external factors during the intervention. These results concur with expectations from an SDT perspective (Deci & Ryan, 2000; Teixeira et al., 2012), suggesting that the intervention may have influenced motivation quality by promoting internalization. Granted the explorative nature of this hybrid (polytheoretical) intervention approach, an initial speculation could be that the use of MI, RPM and CBT strategies might have supported participants' feelings of control and self-regulation, while the autonomy-supportive and person-centred interpersonal style might have lessened the prominence of external regulation. These circumstances together might have facilitated internalization (especially identified regulation), which in turn might have increased exercise level and intensity. It is also likely that the positive effects on exercise were affected by the social support of the TL; and even if the role of the need for relatedness is supposedly more distal than the other two needs in exercise settings (Deci &

Ryan, 2000) and has been debated in previous research (e.g. Wilson et, al. 2006; 2002), the inclusion of relatedness measures might have facilitated interpretation.

When examining the indirect effects of self-determined motivation suggested by theory (Ryan & Deci, 2002) and previous research (Fortier et al., 2012; Williams et al., 2006), the intervention effect (i.e., exercise) was found to be mediated by regulatory processes (RAI) and identified regulation. The prominence of identified regulation in exercise behaviour has previously been emphasized (e.g., Edmunds et al., 2006; Edmunds et al., 2007), and is in line with Deci and Ryan's (2000) suggestion that internalized controlled regulations are important in behaviours that are not instantly rewarding or enjoyable, such as exercise. A practical implication from this would therefore be to recognize the importance of facilitating internalization in exercise contexts, i.e. by providing autonomy support, structure and a person-centred approach. However, this needs to be further examined in more elaborate studies, since such information is important for a deeper understanding of the basic mechanisms at work in exercise behaviour, especially since identifying elements that influence behaviour (and excluding ineffective ones) is fundamental to constructing effective interventions (Fortier et al., 2011).

Limitations and contributions

Intervention effects should be considered with regard to the sample size (relatively small) and constitution (sample of convenience) as well as the self-reported exercise measure (probability of biases like social desirability). On the other hand, we engaged a non-clinical sample in a real-world setting, which proliferated the expected practical utility and lessened the resources needed in terms of time and facilities. The use of matching and randomization is expected to reduce confounder bias (Rothman et al., 2013), thereby strengthening the study and increasing the potential for assuming true intervention effects. The theory-informed content, in combination with advanced mediation analysis, provides conceptual theory links supporting SDT capacity. Since two measure points do not allow

for testing within-person temporal change in the way that designs with additional measure points do (Cole & Maxwell, 2003), a follow-up period would have provided further information on aspects of adherence and intervention effects over time. Applying CONSORT guidelines and measuring intervention fidelity were out of the scope of this brief study; and owing to practical constraints CBT, MI and RPM constructs were not measured, likely resulting in information loss. In addition, although many studies differ in the number of needs measured (Teixeira et al., 2012), including the relatedness need dimension from the PNSE might have added relevant information to facilitate interpretation, and it is therefore recommended that future studies include all three needs. Finally, it should be noted that the results may have been affected by the voluntary participation, since participants were perhaps already motivationally predisposed to increase their exercise levels.

To conclude, the main findings of this study are i) the positive effects on exercise behaviour from such a brief intervention; ii) the potential of a using a polytheoretical approach in SDT-informed interventions; iii) the significant decrease in external regulation; and iv) the mediating effects of motivation quality, especially the support for identified regulation being highly important in exercise settings. In order to facilitate the design of effective exercise interventions, it is recommended that future studies further examine interventions that combine SDT with other theoretical approaches (e.g., RPM) and methods (e.g., CBT, MI) in addition to the related mechanisms behind exercise motivation and behaviour. Such a path will surely advance our knowledge of the promising mediation processes in SDT.

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Table 1. *Means (SD) of study variables at baseline and post-intervention; Within-group changes post-intervention and interaction effects (time*group)*

	Experimental group (*n*=30)				Control group (*n*=31)				Time*group interaction	
		Within-change				Within-change				
	M (SD)	t	*df*	*p*	*M (SD)*	*t*	*df*	*p*	*F*	*p*
PNSE – Autonomy	-	-	29	-	-	-	30	-	1.8	(.18)
Baseline	28.5 (5.3)	-	-	-	30.4 (5.3)	-	-	-	-	
Post-intervention	29.5 (6.8)	-1.8	-	.08	32.1 (4.1)	-2.9	-	.01	-	
PNSE – Competence	-	-	29	-	-	-	30	-	0.3	(.61)
Baseline	25.4 (7.5)	-	-	-	23.2 (7.4)	-	-	-	-	
Post-intervention	26.2 (6.8)	-1.1	-	.27	25.5 (6.2)	-2.6	-	.02	-	
BREQ2 – RAI[a]	-	-	29	-	-	-	30	-	2.0	(.32)
Baseline	8.9 (4.0)	-	-	-	7.8 (6.3)	-	-	-	-	
Post-intervention	10.7 (3.5)	-3.4	-	.01	8.5 (6.4)	-1.8	-	.09	-	
BREQ2 – Amotivation	-	-	29	-	-	-	30	-	1.6	(.21)
Baseline	0.2 (0.3)	-	-	-	0.5 (0.7)	-	-	-	-	
Post-intervention	0.2 (0.3)	.33	-	.08	0.4 (0.7)	1.8	-	.08	-	
BREQ2 – External reg.	-	-	29	-	-	-	30	-	4.2	(.04)
Baseline	0.6 (0.6)	-	-	-	0.5 (0.6)	-	-	-	-	
Post-intervention	0.5 (0.5)	1.5	-	.14	0.6 (0.7)	-2.4	-	.01	-	
BREQ2 – Introjected reg.	-	-	29	-	-	-	30	-	0.2	(.67)
Baseline	1.7 (1.1)	-	-	-	1.7 (1.0)	-	-	-	-	
Post-intervention	1.9 (1.0)	-.98	-	.34	1.7 (1.0)	-.58	-	.57	-	
BREQ2 – Identified reg.	-	-	29	-	-	-	30	-	0.2	(.68)
Baseline	2.4 (0.6)	-	-	-	2.3 (0.9)	-	-	-	-	
Post-intervention	2.9 (0.6)	-4.6	-	.01	2.6 (0.8)	-3.6	-	.01	-	
BREQ2 – Intrinsic reg.	-	-	29	-	-	-	30	-	1.6	(.22)
Baseline	2.5 (0.9)	-	-	-	2.5 (1.0)	-	-	-	-	
Post-intervention	2.7 (0.9)	-2.2	-	.04	2.5 (1.1)	-.25	-	.81	-	
LTEQ –Total Exercise[b]	-	-	29	-	-	-	30	-	12.4	(.01)
Baseline	19.0 (13.9)	-	-	-	19.0 (14.8)	-	-	-	-	
Post-intervention	38.8 (23.8)	-6.9	-	.01	26.0 (14.9)	-3.9	-	.01	-	
LTEQ –Strenuous Exercise	-	-	29	-	-	-	30	-	13.5	(.01)
Baseline	4.4 (4.8)	-	-	-	5.3 (8.5)	-	-	-	-	
Post-intervention	15.0 (11.7)	-6.0	-	.01	7.7 (10.6)	-2.3	-	.03	-	
LTEQ –Moderate Exercise	-	-	29	-	-	-	30	-	1.3	(.26)
Baseline	7.9 (9.3)	-	-	-	7.2 (7.4)	-	-	-	-	
Post-intervention	13.8 (11.8)	-3.6	-	.01	10.6 (7.8)	-2.7	-	.01	-	
LTEQ –Light Exercise	-	-	29	-	-	-	30	-	0.3	(.61)
Baseline	6.7 (6.0)	-	-	-	6.5 (5.8)	-	-	-	-	
Post-intervention	10.4 (9.8)	-2.2	-	.04	7.7 (6.3)	-1.5	-	.15	-	

[a]Relative Autonomy Index, weighted score; [b]LTEQ – total exercise/MET.