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a self-determination theory approach**

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A mixed methods investigation of exercise motivation in adolescence:

A self-determination theory approach

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Thesis submitted for the degree of Doctor of Philosophy

University of Bath
Department of Health

September 2016

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~ For my Dad, Roger ~

List of Papers

The present thesis encompasses the following four empirical papers:

1. Emm-Collison, L. G., Gillison, F. B. & Standage, M. (In preparation). An exploration of how adolescents understand the term 'exercise'.
2. Emm-Collison, L. G., Standage, M. & Gillison, F. B. (2016). Development and Validation of the Adolescent Psychological Need Support in Exercise Questionnaire. *Journal of Sport & Exercise Psychology*, 38(5), 505-520. doi: 10.1123/jsep.2015-0220.
3. Emm-Collison, L.G., Standage, M. & Gillison, F. B. (Manuscript in preparation). Predicting objectively assessed estimates of adolescents' exercise and sedentary behaviour: A self-determination theory approach. *Journal of Sport & Exercise Psychology*
4. Emm-Collison, L. G., Curran, T., Gillison, F. B. & Standage, M. (Manuscript in preparation). The role of conscious and automatic self-regulation in translating motivation to behaviour: A self-determination theory perspective on adolescent exercise. *Journal of Sport & Exercise Psychology*.

The data from the current thesis resulted in the following conference abstract:

- Emm, L., Standage, M. & Gillison, F. (2013). Development and validation of the adolescent psychological need support for exercise scale. Paper presented at the 5th International Conference on Self-Determination Theory, Rochester: New York.

During the period of postgraduate study at The University of Bath, the following book chapters and papers were also published:

- Standage, M & Emm, L.G. (2014). Relationships within physical activity settings in Weinstein, N. (Ed.) *Human motivation and interpersonal relationships*, pp.239-262.
- Standage, M., Gillison, F., Emm, L. (2013) Self-Determination Theory. Sage
- Emm, L.G., Gillison, F.B. & Juszczak, D. (2013). Support for obesity-related policy and its association with motivation for weight-control. *Psychology, Public Policy and Law*, 19(3), 321-330. doi: 10.1037/a0033305

Abstract

The purpose of this thesis was to explore the motivational processes that underpin adolescent exercise and sedentary behaviour. Grounded in Self-determination theory (SDT; Deci & Ryan, 1985), a series of four studies sought to address key methodological pitfalls within the extant SDT literature and utilise these developments to explore how motivation and its related cognitive processes relate to adolescent exercise and sedentary behaviour. In Chapter 2, through focus groups with 39 adolescents, the participants' conceptualisation of exercise was explored to inform the interpretation of responses to exercise-related measures and the measurement of exercise behaviour. In Chapter 3, to facilitate the holistic measurement of need support, the Adolescent Psychological Need Support in Exercise Scale (APNSEQ) was developed and validated in two samples of adolescents (N=806). In Chapter 4, applying the new APNSEQ measure and the conceptual insight gained in Chapter 2, cross-sectional data from 388 adolescents supported the nomological network of variables proposed within SDT. However, the SDT model only explained a small amount of variance in behaviour. Thus, in Chapter 5 (N=257), a mediation model, where action planning, self-monitoring and habit mediate the relationship between autonomous motivation and behaviour was explored. Habit was a significant mediator of the relationship between autonomous motivation and exercise and sedentary behaviour, and need support was indirectly associated with self-regulation.

Collectively, the four studies address some key conceptual and methodological issues present in the extant SDT literature, and apply these developments to offer a comprehensive exploration of the motivational processes that underpin adolescent exercise and sedentary behaviour. Through holistically considering the antecedents of motivation (i.e., need support, need thwarting, need satisfaction, and need frustration), as well as exploring the processes through which motivation influences behaviour, this thesis offers exciting routes for theoretically robust future research, as well as potential insights for intervention.

Chapter 1

General Introduction

General Introduction

1.1. Introduction

The purpose of this chapter is to introduce the contextual, conceptual, and theoretical underpinnings that inform the primary aims of this thesis, and the four empirical chapters presented herein. Each of the empirical chapters (i.e., Chapters 2, 3, 4, & 5) are presented as individual papers and thus contain introductions offering a more specific review of evidence pertinent to the research questions of the paper.

With a view to introducing the context of adolescent exercise and sedentary behaviour, I first discuss global trends in these behaviours, and research pertaining to the benefits of exercise and health risks of physical inactivity during adolescence will be highlighted. This contextual overview provides justification for studying the antecedents of adolescent exercise and sedentary behaviour. Second, as the broad focus of this thesis is human motivation, I make a case for studying adolescent exercise motivation, introduce the concept of motivation, and provide a theoretical overview of Self-determination theory (SDT; Deci & Ryan, 1985) which forms the framework of the present thesis. I subsequently present an overview of the extant SDT literature in the context of adolescent exercise, specifically focusing on the role of need support and thwarting, need satisfaction and frustration, and autonomous and controlled motivation in determining motivational, behavioural, and psychological outcomes. Additionally, I highlight some key conceptual and methodological limitations of the extant SDT literature in the context of adolescent exercise behaviour. In light of these, I discuss the self-regulatory processes which may mediate the relationship between autonomous motivation for exercise, and subsequent behaviour.

1.2. Physical activity, exercise and sedentary behaviour: Trends and consequences

Adolescent physical inactivity is considered a global health problem (Hallal, Victoria, Azevedo, & Wells, 2012). Over and above the health benefits of being physically active, there are a number of health risks associated with physical inactivity, including higher body mass, lower cardiovascular fitness, raised cholesterol and increased allergy symptoms (Hancox, Milne, & Poulton, 2004; Mitchel, Beasley, Bjorksten, Crane, Garcia-Marcas, & Keil, 2013). Evidence also relates physical inactivity to increased risk of injury, potentially due to a negative influence on bone health (Bloemers, Collard, Paw, Van Mechelen, Twisk, & Verhagen, 2012; Yannakoulia, Keramapoulos, & Matalas,

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2004). Further, sedentary time has been shown to negatively influence health outcomes irrespective of physical activity level (Cliff et al., 2016; Ekelund, Luan, Sherar, Eslinger, Griew, & Cooper, 2012).

There are also a number of health benefits to engaging in regular physical activity during adolescence, both in the short and long-term. In the short term, a physically active lifestyle can lead to lower fat mass, lower systolic blood pressure, better bone health, and improvements in asthma symptoms (Jimenez-Pavon, Kelly, & Reilly, 2010; McMurray, Harrell, Bangdiwala, Bradley, Deng, & Levine, 2002; Mitchel et al. , 2013; Yannakoulia et al., 2004). Physical activity can also benefit adolescent psychological health, in terms of reducing symptoms of depression and increasing self-esteem (Crews, Lochnaum, & Landers, 2004; Motl, Dishman, Saunders, Dowda, & Pate, 2004). Being physically active during adolescence also has long term health benefits, including for bone density, cancer risk, and cardiovascular health (Boreham, Twisk, Neville, Savage, Murray, & Gallagher, 2002; Hasseltrom, Hansen, Frobergm & Andersen, 2002; Khan et al., 2000; Okasha, McCarron, Gunnell, & Smith, 2003). These findings demonstrate the importance of physical activity for the maintenance of health both in the short and long-term.

As part of government-led strategies to increase population health within western countries, including the United Kingdom (UK), as well as Canada and the United States (U.S.), there are formal, age-dependent guidelines for the optimal level of physical activity for promoting health (Canadian Society for Exercise Physiology, 2016; Department of Health, 2011; US Department of Health and Human Services, 2008). These recommendations propose that adolescents should engage in moderate intensity activity (i.e., activities that make your heart beat faster, cause you to get warmer, and breathe harder but still with the capacity to engage in conversation) for 60 minutes each day, with three of these days including some vigorous activity (i.e., where conversation is more difficult than in moderate activity), or strengthening activities (i.e., using body weight or resistance; Canadian Society for Exercise Physiology, 2016; Department of Health, 2011; US Department of Health and Human Services, 2008). Additionally, and in line with the evidence for the independence of physical activity and sedentary behaviours (Ekelund et al., 2012), the guidelines also suggest minimising time spent engaging in sedentary behaviours, such as watching television, computer use, video gaming and car or bus journeys (Canadian Society for Exercise Physiology, 2016; Department of Health, 2011; US Department of Health and Human Services, 2008).

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However, despite these recommendations being the focus of many health campaigns (e.g., Change4life in the UK, Go4life in the US, and ParticipACTION in Canada), adolescent physical activity levels in the UK, and in Canada and the U.S., are persistently low (Craig, Mindell, & Hirani, 2009; Colley, Garriguet, Janseen, Craig, Clarke, & Tremblay, 2011; Fakhouri, Hughes, Burt, Song, Fulton, & Ogden, 2014).

The most recent objective measurement of physical activity in UK adolescents suggests that 7% boys and 0% girls aged 12-15 years obtain 60 minutes of moderate-to-vigorous physical activity (MVPA) on at least 6 days per week (Craig et al., 2009). Additionally, the evidence suggests that boys spend an average of 484 minutes, and girls 534 minutes, in sedentary activity per day, equating to 50.4% and 55.6% of wake time (based on an average of 8 hours sleep per day; Craig et al., 2009). These findings are consistent with more recent assessments in the U.S. and Canada that also show that the majority of adolescents do not meet the recommended levels of daily physical activity (Colley et al., 2011; Fakhouri et al., 2014). In addition to numerous studies documenting the low-levels of adolescent physical activity, there is also longitudinal evidence indicating that physical activity behaviours decrease, and sedentary behaviours increase throughout adolescence and into adulthood (Brodersen, Steptoe, Boniface & Wardle, 2007; Gordon-Larsen, Nelson & Popkin, 2004). Further to this, evidence suggests that physical activity patterns established in adolescence persist into adulthood (Telama, Yang, Viikari, Valimaki, Wanne & Raitakari, 2005).

The low levels of physical activity and high levels of sedentary behaviour in UK adolescents are a major health concern due to the associated health consequences of a physically inactive lifestyle. Adolescence provides a key opportunity to intervene and promote good exercise behaviour patterns that persist through to adulthood (Biddle, Gorley & Stensel, 2004; Flodmark, Marcus & Britton, 2006). Evidence revealing the low levels of physical activity, high levels of physical inactivity and the health consequences of these behavioural patterns has instigated an abundance of research investigating the motivational processes that underpin physical activity related behaviours.

1.3. A case for studying exercise motivation

Physical activity is defined by the World Health Organisation (2010) as '*any bodily movement produced by skeletal muscles that requires energy expenditure*' (p. 53). The broad concept of physical activity can be broken down into a number of subcategories,

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including sport, exercise, and active transport. This is beneficial for research due to the differing purposes and underlying motivational processes of each the subcategories of physical activity (Kilpatrick, Hebert, & Bartholomew, 2005; Monteiro, Conde, Matsudo, Matsudo, Bonsenor, Lotufo, 2003). From a health promotion perspective, exercise (i.e., *'a subcategory of physical activity that is planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective'*; WHO, 2010, p. 52) presents a useful category of physical activity to promote during adolescence, as motives associated with exercise (e.g., health and social) predict higher levels of physical activity than other motives (e.g., competition and affiliation; Kilpatrick et al., 2005; Monteiro et al., 2003). Whilst exercise can be conducted via a number of different activities, and in various environments (e.g., in school, through sports teams, in leisure time), the planned and structured elements of exercise, accompanied by the primary purpose of improving fitness, may provide the skills necessary to maintain lifelong physical activity that is not dependent on the structure provided through a school or sports club. Due to the purposeful nature of exercise (i.e., to improve or maintain physical fitness and health) it is also more likely to be influenced by underlying motivational and self-regulatory processes than the broader concept of physical activity which can be largely incidental (e.g., walking up the stairs at home, or walking between classrooms at school).

1.4. Motivation

Motivation is broadly concerned with the factors that drive people to think, act and behave (Ryan & Deci, 2000). Due to its underlying role in all human behaviour, motivation has been the focus of much research within the field of psychology for several decades (Deci & Ryan, 1985). In accordance with public health strategies to develop evidence-led interventions to increase physical activity, motivation has become a prominent feature of much sport and exercise psychology research.

Traditionally, motivation was conceptualised as a dichotomy of intrinsic versus extrinsic motivation (e.g., Bandura, 1996; deCharms, 1968). Whilst the distinction between intrinsic and extrinsic motivation has value, it is too simplified and presenting the two entities as opposite ends of a dichotomy is misleading (Deci & Ryan, 2002). Rather, developments in motivation theory have led to an interest in the quality of motivation, over and above the proposed extremes of intrinsic and extrinsic motivation (Deci & Ryan, 1985). In doing so, more recent theories of motivation have the capacity

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to account for the differing reasons why individuals engage in behaviour (Deci & Ryan, 1985; McClelland, 1985). One theory that addresses motivation in terms of quality, and accounts for the processes that facilitate motivational development is self-determination theory (SDT; Deci & Ryan, 1985).

1.5. Self-determination theory

SDT (Deci & Ryan, 1985; Deci & Ryan, 2000) offers a framework of motivation that has particular utility for explaining the motivational processes underpinning a range of behaviours, including in the context of health, sport, education, and exercise (e.g., Ryan & Deci, 2007; Ryan & Deci, 2009; Ryan, Patrick, Deci & Williams, 2008). SDT is an organismic-dialectical theory of human motivation that addresses the cognitive processes that facilitate or undermine behavioural initiation, behavioural regulation, and psychological functioning (Deci & Ryan, 2012). From an organismic perspective, it is assumed that humans are inherently active, with a desire to function at the optimal level (Deci & Ryan, 2012), and thus seek optimal challenges and new experiences to master and integrate (Deci & Ryan, 1991; Deci & Ryan, 2002). However, the dialectical component acknowledges that activities do not occur in isolation, and thus accounts for external and internal forces that conflict with innate drives and impact on growth, development, and functioning (Deci & Ryan, 1991). Additionally, within SDT it is posited that motivation is facilitated or undermined by the social environment (Deci & Ryan, 2000; Deci & Ryan, 2002). Specifically, the way in which our social environment satisfies or frustrates the three basic psychological needs of autonomy (feelings of volition and responsibility, inner endorsement of actions; Ryan, 1995), competence (feelings of efficacy and the ability to overcome challenges; Deci & Ryan, 2000), and relatedness (sense of belonging and being connected and cared for; Ryan, 1995) determines the extent to which regulation is internalised in our self-concept (Deci & Ryan, 2000). Thus our social interactions are central in determining motivational, behavioural and psychological outcomes. Here, we discuss the six mini theories that are encompassed within SDT: Cognitive Evaluation Theory (Deci, 1975), Organismic Integration Theory (Deci & Ryan, 1985), Basic Psychological Needs Theory (Ryan & Deci, 2002), Causality Orientations Theory (Deci & Ryan, 1985), Goal Content Theory (Kasser & Ryan, 1993, 1996) and Relationships Motivation Theory (Deci & Ryan, 2014).

1.5.1. Cognitive Evaluation Theory

The first mini-theory is Cognitive Evaluation Theory (CET; Deci, 1975). At its core, CET is concerned with the facilitation of the most optimal form of motivation that is referred to as intrinsic motivation (i.e. engagement in behaviour due to inherent enjoyment and interest derived from the activity; Ryan & Deci, 2008). It is posited that the satisfaction of the basic psychological needs of autonomy and competence is central to fostering and maintaining intrinsic motivation. When autonomy is satisfied, through the provision of choice and information, individuals may experience intrinsic motivation (e.g., Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Similarly, the presence of controlling factors such as rewards or punishments can frustrate the need for autonomy which may undermine intrinsic motivation (Deci & Ryan, 2000; Deci & Ryan 2008). Additionally, when the need for competence is satisfied, through the provision of structure and encouragement, intrinsic motivation may also be facilitated (Deci, Koestner, & Ryan, 1999). Understanding the antecedents of intrinsic motivation offers the most beneficial route through which to instigate healthy behaviours, as intrinsic motivation is associated with more adaptive behavioural and psychological outcomes (Deci & Ryan, 2000).

Much of the evidence for CET pertains to the effects of different rewards on intrinsic motivation, and a meta-analysis of 128 studies showed that contingent rewards (i.e., reliant on engagement, completion, or performance) undermine intrinsic motivation, whereas verbal rewards (e.g., positive feedback) enhance intrinsic motivation and behaviour (Deci et al., 1999). Looking further at the role of verbal communication in facilitating intrinsic motivation, an early experimental study in the context of physical education, showed that positive feedback (e.g., ‘It looks like you have natural ability’) increased, whilst negative feedback (e.g., ‘your improvement is quite slow’) decreased perceptions of competence and intrinsic motivation (Vallerand & Reid, 1984).

The role of perceived autonomy and competence in facilitating intrinsic motivation has been demonstrated in quantitative and qualitative studies (e.g., Goudas, Biddle, & Fox, 1994; Haerens, Aeltermna, Vansteenkiste, Soenens, & van Petegem, 2015; Hassandra, Goudas, & Chroni, 2003). In a qualitative study with adolescents regarding their intrinsic motivation for physical education, perceived competence and autonomy were found to influence motivation (Hassandra et al., 2003). This is supported in questionnaire-based studies, where findings suggest that an autonomy-supportive

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teaching style promotes intrinsic motivation for physical education by satisfying the basic psychological needs, and a controlling teaching style undermines intrinsic motivation by frustrating the basic psychological needs (Haerens et al., 2015).

1.5.2. Organismic Integration Theory

The second mini-theory, Organismic Integration Theory (OIT; Deci & Ryan, 1985) is concerned with extrinsic motivation and the facilitation of internalisation and integration. Extrinsic motivation is concerned with outcomes outside of the behaviour itself, and thus behaviour is performed due to a separable outcome (Deci & Ryan, 2008).

One implication for health behaviour research is that behavioural engagement is more likely when the behaviour is internalised within the self. Therefore, OIT offers a multi-dimensional approach to extrinsic motivation, whereby extrinsic motivation is not universally external, but rather differs in the extent to which it is autonomous and controlled. To this end, a continuum of different types of motivation is proposed that differ in the extent to which they are internalised (Deci & Ryan, 1985; Figure 1.1.). Fully internalized regulations are referred to as integrated (i.e., when the value placed on the behaviour assimilates with one's sense of self, such as for health reasons) and identified (i.e., identification of the activity as useful in fulfilling personally meaningful goals, such as losing weight), and are most similar in experience to intrinsic motivation. Introjected regulations (i.e., regulatory forces mandated by self-imposed contingencies, such as shame and guilt) are partially internalised, and non-internalised regulations are referred to as external regulation (i.e., regulatory forces mandated by factors external to the self, such as rewards and punishments). Collectively, all these regulation types can be referred to as extrinsic motivation, however their underlying drivers are vastly different. More frequently, and of value for research, is the distinction between these regulations in terms of being autonomous (identified and integrated regulations along with intrinsic motivation) and controlled (introjected and external regulations). Additionally, within SDT a lack of regulation is referred to as amotivation (i.e., lacking intention to act, value, competence and control of behaviour; Ryan & Deci, 2000).

A second implication for health behaviour research is that the internalisation process is dependent on the extent to which the basic psychological needs for autonomy, competence, and relatedness are satisfied or frustrated (Ryan, 1995; Vansteenkiste, Niemiec, & Soenens, 2010). Thus, to the degree that these needs are satisfied, behaviour



Figure 1.1 The self-determination continuum (Ryan & Deci, 2000)

is internalised within the self, leading to more intentional behaviour, and greater psychological well-being (Ryan, 1995; Vansteenkiste et al., 2010). Similarly, the degree to which the psychological needs are frustrated, behaviour is, at most, partially internalised, resulting in less intentional behaviour and greater psychological ill-being (Vansteenkiste & Ryan, 2013).

There is consistent evidence for the role of autonomous motivation in predicting behaviour and well-being outcomes across a number of domains, including education (e.g., Black & Deci, 2000), smoking cessation (e.g., Williams et al, 2006), diabetes self-control (e.g., Williams et al., 2004), and physical activity (e.g., Amorose & Anderson-Butcher, 2007). In the physical activity context, more autonomous motivation has been shown to predict exercise effort (e.g., Taylor, Ntoumanis, Standage, & Spray, 2010), MVPA (e.g., Standage, Gillison, Ntoumanis, & Treasure, 2012), and quality of life (e.g., Gillison, Standage, & Skevington, 2006) among other positive outcomes. Further to this, there is evidence in both experimental and field studies of the role of the basic psychological needs in facilitating the internalisation process (e.g., Deci, Eghari, Patrick, & Leone, 1994; Markland & Tobin, 2010). For instance, Markland and Tobin (2010) demonstrated the importance of each of the three basic psychological needs in determining the extent to which motivation was internalized in the context of an adult exercise referral scheme.

1.5.3. Basic Psychological Needs Theory

Basic Psychological Needs Theory (BPNT; Ryan & Deci, 2002) extends the idea of the psychological needs as the essential nutrients underlying motivation, and posits their centrality in determining psychological health and well-being (Deci & Ryan, 2008). Across all the mini-theories encompassed within SDT, a fundamental assumption is that the basic psychological needs are universal, existing across cultures, ages, and gender (Chirkov, Ryan, Kim, & Kaplan, 2003). Accordingly, and considering the organismic-dialectical approach that SDT takes, humans are driven to seek out environments that satisfy, rather than thwart, the basic psychological needs (Ryan & Deci, 2002). Commensurate with this assumption, social environments that support or thwart the basic psychological needs should incrementally influence health and well-being.

Evidence highlights the importance of the satisfaction of all three of the basic psychological needs for optimal human functioning (Reis, Sheldon, Gable, Roscoe, &

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Ryan, 2000) and similarly, the functional loss that ensues when the needs are frustrated (Deci, Ryan, Gagne, Leone, Usunov, & Kornazheva, 2000; Ryan & Deci, 2000).

With a focus on the social environment as a means to satisfy or frustrate the basic psychological needs, BPNT suggests specific factors that serve to support or thwart the psychological needs. Characteristics of need supportive environments include the provision of choice, assistance in overcoming challenges, and perceptions of feeling valued, whereas need thwarting environments include the limiting of choice, imposing of others opinions, and perceptions of not being cared about (Chen et al., 2015; Standage & Vallerand, 2014). In terms of application, BPNT provides a meaningful account of how the social environment influences motivational outcomes, and therefore offers a framework through which to target the motivational processes which underpin health behaviour and well-being (Deci & Ryan, 2008).

Across a number of life domains, and at both the general and daily level, there is evidence for the relationship between the basic psychological needs and well-being (e.g., Hodge, Lonsdale, & Ng, 2008; Reis et al., 2000; Ryan, Berstein, & Brown, 2010; Sheldon, Ryan, & Reis, 1996). In the physical activity domain, cross-sectional and longitudinal evidence supports the role of need satisfaction in predicting well-being, motivation, and behavioural outcomes (e.g., Gagne, Ryan, & Bargmann, 2003; Reinboth & Duda, 2006; Gunnell, Crocker, Mack, & Wilson, 2014). For example, need satisfaction experienced during a practice has been shown to predict self-esteem, affect, and vitality in adolescent gymnasts (Gagne et al., 2003). Evidence also supports the premise that the frustration of the basic psychological needs predicts ill-being (e.g., Bartholomew, Ntoumanis, Ryan, Bosch, & Thogersen-Ntoumani, 2011; Hodge et al., 2008). For example, the frustration of the basic psychological needs, particularly of autonomy and competence, has been shown to predict burnout in elite rugby players (Hodge et al., 2008).

In addition to the influence of each of the three needs on well-being and ill-being with a specific context, there is evidence to suggest that a balance of need satisfaction across life domains is predictive of optimal functioning (e.g., Milyavskaya et al., 2009; Sheldon & Filak, 2008). For example, in adolescents, a balance of need satisfaction across the school, family, friend, and work environment predicted well-being and school-adjustment (Milyavskaya et al., 2009a). There is also pervasive evidence for

the universality of need satisfaction and need frustration in predicting well-being across cultures (Chen et al., 2015).

1.5.4. Causality Orientations Theory

The three mini-theories outlined so far approach motivation from a largely situational perspective. In contrast, Causality Orientations Theory (COT; Deci & Ryan, 1985) outlines the processes that underlie trait-level regulation by addressing the way in which individuals perceive their own behaviour. Three orientations are proposed within COT that differ in the extent to which they represent self-determination; Autonomous orientation (i.e., a tendency to act out of interest and values their social environment), controlled orientation (i.e., driven by rewards, gains, and approval) and impersonal orientation (i.e., behaviour without intention; Ryan & Deci, 2002). A more autonomous orientation is posited to predict more favourable psychological and behavioural outcomes, whereas it is suggested that a controlled orientation predicts less-internalised regulations (e.g., introjected and external regulation) meaning less stable behavioural engagement. An impersonal orientation is the least desirable and can lead to the presentation of ill-being symptoms (Deci & Ryan, 2008). However, Deci & Ryan (1985) highlight that individuals can possess all of these orientations in differing quantities.

As with all the components of SDT, the three orientations are underpinned by the satisfaction and frustration of the basic psychological needs. However, rather than being context specific, they result from the continuous effect that the social environment has on one's need satisfaction. That is, the ongoing satisfaction of the needs of autonomy, competence, and relatedness leads to a more autonomous orientation (Deci & Ryan, 2008). When autonomy is continuously thwarted, a more controlled orientation is likely to emerge, and when all three of the basic psychological needs are thwarted, the orientation is likely to be impersonal (Deci & Ryan, 2008).

There is evidence to support the role of autonomous and controlled orientations in predicting motivation and behaviour (e.g., Hagger & Chatzsisarsantis, 2011; Kwan, Hooper, Magnan, & Bryan, 2011; Wong, 2000). In an education setting, an autonomous orientation has been shown to positively predict academic experience, and a controlled orientation to negatively predict academic experience, performance, and commitment (Wong, 2000). Evidence also suggests that an autonomous orientation

may have protective value on intrinsic motivation with regards to the undermining effects of rewards (Hagger & Chatzisarantis, 2011). While there has been limited application of the propositions within COT to the health context (Wilson, Mack, & Grattan, 2008), longitudinal evidence in exercise context shows a more autonomous orientation to predict more positive exercise-related affect, and more self-determined motivation for exercise (Kwan et al., 2011).

1.5.5. Goal Contents Theory

The fifth mini theory encompassed within SDT is Goal Contents Theory (GCT; Kasser & Ryan, 1993, 1996). GCT emerged out of empirical work examining the distinction between intrinsic and extrinsic goals, and their impact on motivation and wellness. Intrinsic goals such as a desire for community, close relationships, and personal growth are associated with greater well-being, whereas extrinsic goals such as financial success, appearance, and popularity are associated with greater ill-being (Vansteenkiste et al., 2004). It is proposed that the influence of intrinsic and extrinsic goals on motivation and behaviour can be accounted for through their influence on need satisfaction and need frustration (Deci & Ryan, 2000). Thus, extrinsic goals may undermine need satisfaction and foster need frustration, thus overriding the innate drive to satisfy the needs and failing to initiate the internalisation process (Deci & Ryan, 2008). In contrast, intrinsic goals may facilitate the internalisation process by fostering need satisfaction (Deci & Ryan, 2008). Consequently, the promotion of intrinsic goals in health behaviour is likely to be beneficial for motivational, behavioural, and psychological outcomes.

Evidence supports the theoretical proposition that intrinsic goals predict autonomous motivation, behaviour, and well-being (e.g., Sebire, Standage, & Vansteenkiste, 2009; Vansteenkiste, Timmermans, Lens, Soenens, & van den Broeck, 2008). Experimental evidence suggests that intrinsic goal framing is more effective than extrinsic goal framing for facilitating autonomous motivation (Vansteenkiste et al., 2008). In the physical activity domain, more intrinsic goals have been shown to positively predict physical self-worth, exercise behaviour and well-being, and negatively predict anxiety (Sebire et al., 2009). Further to this, evidence also supports the premise that intrinsic goals positively influence physical activity related outcomes through their effect on need satisfaction and autonomous motivation (Sebire et al., 2009; Sebire, Standage, & Vansteenkiste, 2011), and extrinsic goals negatively influence physical activity related

outcomes due to frustrating the basic psychological needs (e.g., Vansteenkiste, Neyrinck, Niemiec, Soenens, de Witte, & van den Broeck, 2007).

1.5.6. Relationships motivation theory

Underpinning all of the mini-theories that constitute SDT is the importance of relationships with significant others, and the extent to which these relationships satisfy, or frustrate, the basic psychological needs. Relationships Motivation Theory (RMT; Deci & Ryan, 2014) provides a motivational account of the dynamic processes underpinning high quality relationships, and within the theory it is suggested that high quality relationships are essential for optimal functioning (Deci & Ryan, 2000; Lavigne, Vallerand & Crevier-Braud, 2011). Specifically, it is proposed that whilst relatedness may be assumed to be the most important basic need for high quality relationships, satisfaction of all three basic psychological needs are necessary for relationships to be of the highest quality (Deci & Ryan, 2014; Standage & Emm, 2014). In a similar vein, if any of the needs are frustrated by the presence of need thwarting behaviours in a relationship, the relationships will be of a poorer quality (Deci & Ryan, 2013).

While RMT is a new theory, there is long-standing evidence supporting the impact of need supportive and need thwarting behaviours on relationships, but also on the functional outcomes associated with need satisfaction and frustration (e.g., La Guardia, Ryan, Couchman, & Deci, 2000; Reis et al., 2000). Relationships that support the needs of autonomy, competence and relatedness have been shown to be beneficial for outcomes in the context of health and physical activity (e.g., Lewis & Butterfield, 2007; Ntoumanis, 2012; Standage et al., 2012). There is particular evidence for the role of autonomy-supportive relationships in determining more autonomous motivation for physical activity, physical activity behaviour, and well-being (e.g., Hagger, Chatzisarantis, Hein, Soos, Karsai, Lintunen, & Leemans, 2009; McDavid, Cox, & Amorose, 2012; Standage et al., 2012), and some support for the role of competence-, and relatedness- support in determining physical activity-related outcomes (e.g., Markland & Tobin, 2010; Standage, Duda, & Ntoumanis, 2005).

1.5.7. Summary and critique of self-determination theory

Self-determination theory offers a useful framework through which to investigate behavioural motivation in a variety of different contexts (Ryan & Deci, 2000). The theoretical tenets within SDT have been supported through research in a variety of domains (such as education [Haerens, Aelterman, Vansteenkiste, Soenens, & Van Petegem, 2015] and healthcare [Ng, Ntoumanis, Thogersen-Ntoumani, Deci, Ryan, Duda, & Williams, 2012]), reflecting the wide applicability of SDT. One of the key strengths of the theory, and one of the main distinguishing factors of SDT from other theories of human motivation (e.g., Bandura, 1996; DeCharms, 1968) is the focus on quality of motivation rather than quantity. This perspective better explains the more complex and multifaceted role of motivation in determining behavioural and wellbeing outcomes (Deci & Ryan, 2002). Additionally, SDT also explicitly takes into consideration the role that the social environment and social interactions play in determining behavioural and well-being outcomes (Deci & Ryan, 2008). By focussing on social contextual factors rather than on the individual, SDT offers a useful framework through which to design and implement widespread interventions.

Notwithstanding the strengths of the theory, at this juncture it is necessary to consider some of the limitations, particularly in regards to the use of SDT as an intervention framework. First is the emphasis that SDT places on the social environment in terms of being need supportive, yet there is little evidence to show whether there is congruence between a groups perceptions of the social environment as such. Rather, there has been a focus on individuals' perceptions of the social environment as being need supportive or thwarting. Whilst the basic psychological needs are proposed as universal nutriments for optimal functioning (Ryan & Deci, 2000), there is little theoretical or empirical evidence for whether behaviours that are perceived as need supportive or thwartive are universal. This, therefore, has potential implications for interventions based on the SDT framework, as if behaviours are not universally perceived as being need supportive or thwarting, having a widespread positive behavioural impact through promoting need supportive behaviours is likely to be difficult (Standage & Vallerand, 2008). However, observational studies have highlighted teacher behaviours that are consistently perceived as supportive of autonomy, competence, and relatedness (e.g., Haerens, Aelterman, Van den Berghe, De Meyer, Soenens, & Vansteenkiste, 2013; Reeve, 2016), but similar research is required

in contexts other than schools to facilitate larger scale SDT based interventions (Ryan, Patrick, Deci, & Williams, 2008).

A second limitation is demonstrated through existing research showing that motivation explains just a small amount of variance in behavioural outcomes (e.g., Aelterman et al., 2012; Lonsdale et al., 2013; Standage et al., 2012; Stenling et al., 2015). At its core, SDT is a theory of human motivation, and this is reflected in its ability to explain the processes that are pertinent to facilitating good quality motivation, but not how motivation is translated to behaviour (Hagger & Chatzisarantis, 2009). In contrast, there are theoretical models that explain processes involved in initiating behaviour, but not how to foster motivation (e.g., The theory of planned behaviour; Ajzen, 1975). Therefore, drawing on other theoretical models (e.g., Hagger et al., 2009), may offer a more comprehensive method of behaviour change, and allow for more successful intervention within the SDT framework. However, it is also important to highlight that there has been little empirical focus on daily fluctuations in motivation and its related constructs and therefore the measurement of motivational constructs in existing literature is spurious. A focus on more regular fluctuations in these constructs (e.g., through ecological momentary assessments), may elicit stronger relationships between motivation and behavioural outcomes and provide further evidence for how SDT can be used to change behaviour.

1.6. Self-determination theory and adolescent physical activity, exercise and sedentary behaviour

The theoretical network specified within SDT is supported by evidence across a number of domains, including sport (e.g., Fenton, Duda, & Barrett, 2016), physical activity (e.g., Owen, Astell-Burt, & Lonsdale, 2013), and physical education (PE; e.g., Standage et al., 2005). Whilst all of the theoretical components of SDT have their utility with regards to predicting adolescent exercise behaviour, the mini-theories most pertinent to the objectives of this thesis are CET, OIT, and BPNT, as they explain how the social environment may impact on motivation and subsequent behaviour. Therefore, in the following section I provide an outline of the existing research regarding autonomous motivation and controlled motivation, need satisfaction and frustration, and need support and thwarting in the context of adolescent exercise and sedentary behaviour.

1.6.1 Autonomous motivation, controlled motivation and amotivation

In line with the theoretical propositions of SDT (Deci & Ryan, 1985; 2000), evidence consistently shows more autonomous motivation to predict higher levels of adolescent physical activity, less sedentary time, and more adaptive psychological outcomes (e.g., Cox & Ullrich-French, 2010; Cox, Ullrich-French, & Sabiston, 2013; Gillison et al., 2006). Evidence in the PE context has shown motivation for PE to positively predict self-reported physical activity both within the PE lesson (Cox et al., 2013) and in general (Cox & Ullrich-French, 2010). Additionally, motivation for exercise has been shown to positively predict self-reported leisure-time physical activity (Gillison et al., 2006).

Longitudinal research supports the premise that more autonomous motivation predicts long-term engagement in sport and exercise behaviours (e.g. Cox, Smith, & Williams, 2008; Papaioannou, Bebetos, Theodorakis, Christodoulidis, & Kouli, 2006; Taylor et al., 2010). For example, in the PE context, intrinsic motivation (specifically enjoyment) has been shown to predict self-reported sport and exercise engagement up to 14 months later (Papaioannou et al., 2006). There is also evidence for the role of within-person fluctuations in motivation in predicting behavioural outcomes. In their study with adolescents aged 11-16 years, Taylor et al. (2010) found that fluctuations in intrinsic motivation across a school term were positively associated with effort in PE and intention to exercise, and fluctuations in identified regulation were associated with changes in exercise behaviour across a school term. These findings offer support for the role of autonomous motivation in predicting exercise behaviour. However, the findings presented so far have relied on self-report measures of physical activity and behaviour, which have been shown to offer overestimations of activity levels (e.g., Chinapaw, Mokkink, van Poppel, van Mechelen, & Terwee, 2010; Hagstromer et al., 2008).

With a view to obtaining accurate behavioural measurement, more contemporary studies have adopted objective measures of physical activity and exercise behaviour (e.g., accelerometers), and evidence from studies using these devices also shows autonomous motivation to predict adaptive physical activity outcomes (e.g., Aelterman, Vansteenkiste, van Keer, Van den Berghe, De Meyer, & Haerens, 2012; Fenton, Duda, Quested, & Barrett, 2014; Lonsdale et al., 2013; Owen et al., 2013; Standage et al., 2012; Stenling, Lindwall, & Hassmen, 2015). For instance, in a study with adolescent boys aged 14-15 years, Owen et al. (2013) found that autonomous motivation predicted

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variance in MVPA during both PE and leisure time. Specifically, individual-level motivation was a significant predictor of leisure time MVPA, and class-level autonomous motivation was a significant predictor of MVPA during PE. This is consistent with another study that found class-level motivation to significantly predict MVPA during a PE lesson in adolescents aged 11-19 years (Aelterman et al., 2012). With regards to psychological outcomes, Standage et al. (2012) studied the influence of the PE motivational climate on physical activity and well-being in younger adolescents ($M_{age}=12.98$). They found more autonomous motivation for PE to predict more autonomous motivation for general exercise, and in turn this positively predicted pedometer step count, physical self-concept, and health-related quality of life. Outside of the PE context, evidence has shown autonomous motivation for sport to positively predict accelerometer-assessed MVPA and negatively predict sedentary time (Fenton et al., 2014).

There is less evidence for the role of controlled motivation in determining adolescent physical activity-related behaviours, however the limited evidence shows no relationship between controlled motivation and physical activity or sedentary time (e.g., Fenton et al., 2014; Taylor et al., 2010). In their study with young male footballers, Fenton and colleagues (2014) found that controlled motivation did not significantly predict accelerometer assessed MVPA or sedentary time. Studies that differentiate between the effects of introjected and external regulations also generally show no relationship with behavioural outcomes at both the between and within-person levels (e.g., Taylor et al., 2010). However, there is some evidence to suggest that introjected regulation for exercise in adolescence is a strong predictor of physical activity outcomes in both boys and girls (Gillison, Osborn, Skevington, & Standage, 2009). Theoretically, this could be explained through the process of internalization, and introjection represents the first stage in the assimilation of behaviour to the self (Deci & Ryan, 1994). Yet in the Gillison et al (2009) study, the strong relationship with behaviour may also be explained by a high presence of more autonomous regulation alongside introjection.

There is a growing body of evidence for the role of amotivation in predicting physical activity-related outcomes (e.g. Jackson-Kersey, & Spray, 2013; Standage, Duda, & Ntoumanis, 2003; Standage et al., 2005; Taylor et al., 2010). Amotivation has been shown to negatively predict effort within physical activity, (Taylor et al., 2010),

physical activity intentions (e.g. Standage et al., 2003; Lim & Wang, 2009), physical self-concept (Jackson-Kersey & Spray, 2013), happiness, and concentration (Standage et al., 2005). Despite the proposition within SDT that amotivation has negative implications for behaviour (Ryan & Deci, 2000), evidence suggests that amotivation is not associated with physical activity behaviour (Taylor et al., 2010). In future research, it may be of interest to researchers to further explore the role of amotivation in determining exercise and sedentary behaviour, and well-being outcomes.

Collectively, these findings provide support for the role of more autonomous motivation in determining adaptive behavioural and well-being outcomes (Deci & Ryan, 1985; 2000). Therefore, in order to promote engagement in physical activity and exercise behaviour, the facilitation of more autonomous motivation for exercise may be a useful route for interventions aiming to increase adolescent exercise behaviour, and decrease sedentary behaviour.

1.6.2 Basic Psychological Need Satisfaction and Frustration

Within SDT it is proposed that the primary antecedent of motivation and the process of internalisation is the satisfaction or frustration of the basic psychological needs of autonomy, competence, and relatedness (Deci & Ryan, 1985; Deci & Ryan, 2000). That is, that through the satisfaction of the basic psychological needs, more autonomous motivation is fostered, and thus behaviour is more intentional (Ryan, 1995; Vansteenkiste et al., 2010). In the same way, when the basic psychological needs are frustrated, autonomous motivation is undermined and behaviour is less intentional (Vansteenkiste & Ryan, 2013).

Evidence within the adolescent exercise context supports this theoretical proposition, with need satisfaction being shown to predict more autonomous exercise motivation (Barkoukis, Hagger, Lambropoulos, & Tsorbatzoudis, 2010; Standage et al., 2005; Standage et al., 2012; Taylor et al., 2010). For example, Barkoukis et al. (2010) found that autonomy and competence satisfaction within a PE lesson predicted autonomous motivation for PE, and competence and relatedness satisfaction in leisure time predicted autonomous motivation for leisure time physical activity. Further to this, Standage et al. (2012) found autonomy and competence satisfaction predicted autonomous motivation for PE and well-being outcomes (physical self-concept and health-related quality of life). Longitudinal research has also demonstrated the within-person effects of need satisfaction on physical activity effort and intention (Taylor et al.,

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2010), however evidence for the role of need satisfaction in predicting physical activity behaviour is inconsistent (Gunnell, Brunet, & Belanger, 2014; Taylor et al., 2010). Evidence using self-reported physical activity outcomes suggests that the satisfaction of any of the three basic psychological needs does not predict leisure-time physical activity (Taylor et al., 2010), however Gunnell et al (2014) found that the satisfaction of the three basic psychological needs of autonomy, competence, and relatedness each predict objectively assessed MVPA estimates to a similar degree ($r=.46-.48$; Gunnell et al., 2014). These conflicting findings indicate that further investigation into the individual contributions of the basic psychological needs in predicting exercise related outcomes. Whilst there has been limited investigation of the effects of need satisfaction on sedentary behaviours, evidence from an intervention study with Spanish adolescents aged 12-15 years suggests that autonomy satisfaction is negatively associated with sedentary behaviour (Pardo, Bengoechea, Clemente, & Lansapa, 2016). The same study found that whilst perceived competence in physical education was a predictor of sedentary time cross-sectionally, changes in perceived competence had no significant influence on behaviour longitudinally (Pardo et al., 2016).

Considering each of the basic psychological needs, there is some evidence demonstrating the independent importance of autonomy, competence, and relatedness satisfaction in determining motivation and behavioural outcomes (e.g., Balaguer, Gonzalez, Fabra, Castillo, Merce, & Duda, 2012; Barnett, Morgan, Van Beurden, & Beard, 2008; Edmunds, Ntoumanis, & Duda, 2006; Ntoumanis, 2005; Peddle, Plotnikoff, Wild, Au, & Courneya, 2007; Standage et al., 2003; Standage et al., 2012). In the PE context, satisfaction of both autonomy and relatedness have been shown to be important for facilitating more autonomous motivation and exercise behaviour both within the PE lesson and in leisure time (Cox et al., 2008; Shen, McCaughy, Martin, & Fahlman, 2009; Standage et al., 2003; Standage et al., 2012). Additionally, in longitudinal research, competence satisfaction has been shown to have no relationship with autonomous motivation for physical activity or physical activity outcomes (Cox et al., 2008). This is in contrast to findings outside of the PE context that have found competence in sport and exercise to predict long term physical activity engagement (e.g., Gunnell et al., 2014). Speculatively, this contextual difference could be due to a primary aim of the PE curriculum being to foster competence (Department for Education, 2013). Therefore, due to a primary aim of the secondary school PE

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curriculum is to instil exercise related competence through helping students to develop a range of physical skills and promoting capability and improvement in physical activity and sport (Department for Education, 2013), the variation in competence satisfaction within the context of a PE lesson may be smaller than in other physical-activity contexts.

Recent SDT literature has started to attend to the negative constructs within the theory, specifically how need frustration negatively impacts on motivation, behaviour and well-being outcomes. Whilst there has been limited investigation of the effects on need frustration on adolescent exercise behaviour, evidence with adults supports the notion that need frustration predicts less autonomous motivation (e.g., Bartholomew, Ntoumanis, Ryan, Bosch, & Thøgersen-Ntoumani, 2011; Gunnell et al., 2013). A key study with adolescents conducted by Haerens et al. (2015) in the PE context has shown need frustration to predict more controlled motivation and amotivation for PE. Research with adolescents has also shown need frustration to predict greater exercise-related ill-being (e.g., disordered eating, burnout, depression, negative affect; Curran, Hill, Hall & Jowett, 2014; Haerens et al., 2015).

Whilst the constructs of need satisfaction and, to a lesser extent need frustration, have been studied in contexts related to adolescent exercise, outside of the PE environment there has been no study of the two constructs simultaneously in the context of adolescent physical activity. Given evidence for the unique pathways through which need satisfaction and need frustration influence motivation and behaviour (i.e., Haerens et al., 2015), in future, efforts should be made to account for both constructs in a broader range of physical activity contexts (e.g., exercise behaviour) in order to obtain a more comprehensive overview of the antecedents of motivation.

1.6.3 Need support and need thwarting

Underpinning all of the mini-theories proposed within SDT are the socio-contextual environments that foster or undermine need satisfaction and frustration. Within the context of adolescent exercise behaviour, exercise-related interactions from family, friends, and PE teachers are important (Gagne et al., 2003; Hagger et al., 2009; Salvy, de la Haye, Bowker, & Hermans, 2012). Specifically, the extent to which these relationships support, or thwart, the basic psychological needs of autonomy, competence, and relatedness, is fundamental in determining need satisfaction and frustration, and autonomous motivation (Ryan & Deci, 2000).

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Whilst there has been limited application of the SDT framework in the context of adolescent exercise, the extant literature in the related contexts of PE, youth sport and leisure-time physical activity have shown that perceptions of need support contribute to less amotivation and more autonomous motivation, behavioural engagement, and psychological well-being (e.g., Amorose, Anderson-Butcher, Newman, Fraina, & Lachini, 2016; Curran, Hill, Ntoumanis, Jowett, & Hall, 2016; Fenton et al., 2014; Hagger et al., 2009; Jackson-Kersey & Spray, 2016; Standage et al., 2012). For instance, in the PE environment, Hagger et al. (2009) found that autonomy-support from PE teachers predicted autonomous motivation for PE and leisure-time physical activity in adolescents from four countries. Further to this, longitudinal evidence has shown perceptions of PE-teacher autonomy-support to predict both short and long term autonomous motivation for PE (Shen et al., 2009).

Beyond predicting more autonomous motivation, perceived need support from PE teachers has also been shown to negatively predict amotivation (e.g., Jackson-Kersey & Spray, 2016; Shen, Weidong, Haichun, & Rukavina, 2010). Both cross-sectional and longitudinal evidence suggests that PE-teacher afforded need-support negatively predicts aspects of amotivation (i.e., unappealing task characteristics and insufficient task values) in adolescent boys ($M_{\text{age}}=14$ years; Jackson-Kersey & Spray, 2016). Substantiating these findings is additional cross-sectional evidence showing that the lack of need-supportive PE environment, particularly support for competence and relatedness, is associated with higher levels of amotivation (Shen et al., 2010). These findings highlight the importance of a need-supportive PE climate in order to foster more autonomous motivation for PE, physical activity, and exercise.

The evidence supporting the theoretical proposition that perceptions of need support from a PE teacher predict more autonomous motivation, less amotivation, and more self-determined behaviour, raises the question of how PE teachers can cultivate a need supportive climate. Observational studies offer insight into PE teacher behaviours that students perceive as need supportive (Haerens, Aelterman, van den Berghe, de Meyer, & Soenens, 2013). Behaviours that foster perceptions of autonomy-support include asking students about their interests, problems, wishes, or values, offering choice to all students, and giving students the opportunity to practice independently, without interfering. Being enthusiastic and eager, empathetic, and physically near the students contribute towards perceptions of relatedness-support (Haerens et al., 2013).

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Evidence also suggests that a competence-supportive environment can be cultivated through behaviours at the start of a lesson, such as giving clear verbal instructions and personally demonstrating tasks, as well as during the lesson itself, such as through offering to help with exercises and providing positive feedback (Haerens et al., 2013). The identification of these behaviours is useful for intervention in terms of providing specific strategies that teachers can use to promote more autonomous motivation within their classes. Accordingly, interventions educating PE teachers in strategies to foster an autonomy-supportive class environment have been shown to have meaningful effects on students autonomous motivation (Cheon, Reeve, & Moon, 2012; Tessier, Sarrazin, & Ntoumanis, 2010).

In the leisure-time context, evidence suggests that autonomy-support from mothers and fathers is just as important as autonomy-support from a PE teacher in predicting autonomous motivation and physical activity (Hagger et al., 2009; McDavid et al., 2012). Similarly, parental need-support has been shown to predict autonomous motivation for sport in young gymnasts and athletes (e.g., Amorose et al., 2016; Gagne et al., 2003). In a recent study with high school athletes, Amorose and colleagues (2016) also found that autonomy-support from more than one social agent (i.e., coach, mother, or father) was more predictive of autonomous motivation for sport than autonomy-support from just one, suggesting that different social agents can incrementally influence motivation and behavioural outcomes. Whilst there is limited evidence for the role of peer need support in the physical activity context, assessments of peer support (specifically perceptions of relatedness) within the context of PE suggest that need supportive peer relationships may be advantageous for autonomous motivation and enjoyment of PE lessons (Cox & Ullrich-French, 2010). However, Hagger et al. (2009) found that peer afforded autonomy-support predicted autonomous motivation for leisure time physical activity in adolescents from Estonia, Finland, and Hungary, but not in Britain.

Despite the aforementioned studies, the literature has largely focussed on need support from authority figures (e.g., PE teacher, coaches, parents; Adie, Duda, & Ntoumanis, 2012; Gagne et al., 2003; Zhang, Solmon, Kosma, Carson, & Gu, 2011) or on autonomy support, not adequately accounting for competence and relatedness support (e.g., Curran et al., 2016; Gillison, Standage, & Skevington, 2013; Hagger et al., 2009; McDavid et al., 2012). This is a key measurement limitation with the extant

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SDT literature, and will be discussed in further detail in the section entitled ‘General limitations of the extant literature’. However, it is important to highlight that this limitation has been guided by the availability of validated need support measures, which are largely autonomy-centred and focused on need support from authoritative figures (e.g. Health Climate Questionnaire [HCCQ], Williams, Grow, Freedman, Ryan, & Deci, 1996; Learning Climate Questionnaire, [LCQ], Williams Wiener, Markakis, Reeve, & Deci, 1994; Perceived Autonomy Support Scale for Exercise Settings [PASSES], Hagger, Chatzisarantis, Hein, Pihu, Soos & Karsai, 2007). Given the evidence for the importance of multiple social agents in determining motivation and physical activity behaviors (e.g., Hagger et al., 2009; McDavid et al., 2012), by assessing need support from just one social agent researchers may be overlooking important motivational processes that underpin exercise behaviour. Also, given the theoretical importance of all three of the basic psychological needs in fostering of intrinsic motivation and the internalization process (Vansteenkiste et al., 2004; Vansteenkiste et al., 2010), not accounting for competence- and relatedness- support may limit understanding of the role of the basic psychological needs in determining physical activity and exercise related outcomes.

In conjunction with an increased interest in the role of need frustration in determining motivational, behavioural and psychological outcomes, and in line with evidence to suggest that need support and thwarting influence outcomes through different pathways (Haerens et al., 2015), in recent years the role of need thwarting behaviours in the context of adolescent physical activity behaviours has received some attention in the literature. Evidence in the PE and youth sport context shows positive relationships between autonomy thwarting, need frustration, controlled motivation, amotivation and ill-being (e.g., Balaguer et al., 2012; Haerens et al., 2015). For example, a longitudinal study with male Spanish youth football players demonstrated that perceptions of controlling coach behaviours predicted need frustration and subsequent athlete burnout across the football season (Balaguer et al., 2012). Similarly, Haerens et al., (2015) found perceptions of a controlling teaching style within a PE lesson to predict less autonomous motivation for PE and more controlled motivation and amotivation for PE in secondary school students. Observational studies highlight that PE teachers that exercise power, use commands, display irritation, and give destructive criticism are perceived by students to be autonomy-thwarting (De Meyer et

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al., 2014), however there has been little investigation into specific teacher behaviours that are considered to be competence-, and relatedness-thwarting.

As with the need support literature, need thwarting has largely focused on autonomy-thwarting from a PE teacher or coach. However, there is a distinct lack of evidence within the more general adolescent exercise context considering need thwarting from family and peers and accounting for competence- and relatedness-thwarting interactions. Recent developments in measures of perceptions of need thwarting, both in general contexts as well as specific contexts such as sport (e.g., Interpersonal Behaviours Questionnaire; Rocchi, Pelletier, Cheung, Baxter & Beaudry, 2016) reflect the call to investigate the effects of need thwarting over and above the influences of need support.

1.7. General limitations of the extant literature

Notwithstanding the strengths of the literature highlighted so far, there are a number of limitations with the existing literature. Here, I will highlight four limitations that provide the foundations for the work presented in the current thesis.

1.7.1. Adolescent conceptualisation of exercise

Evidence suggests that children do not understand physical activity related constructs (e.g., active play and physical activity) in the same way as adults (e.g., Burrows, Eves, & Cooper, 1999; Brockman, Fox, & Jago, 2011; Trost, Morgan, Saunders, Fetton, Ward, & Pate, 2002). For instance, Trost et al., (2002) found that children aged 9 and 10 years were unable to accurately categorise physical activity and sedentary behaviours without some degree of educational intervention. Drawing on this literature, it may be that adolescents also conceptualise physical activity behaviours in a different way to adults, meaning there could be fundamental differences between adolescents understanding of exercise and that of researchers. If this is the case, there are potential problems in the interpretation of responses to questionnaires referring to exercise (e.g., BREQ-2; Markland & Tobin, 2004).

The overview of the SDT literature presented so far offers consistent support for the theoretical proposition that more autonomous motivation predicts exercise outcomes (Dishman, McIver, Dowda, Saunders & Pate, 2015; Owen et al., 2013; Sebire, Jago, Fox, Edwards, & Thompson, 2013). Many of the studies discussed have adopted the existing measures, grounded within SDT, that refer to exercise-related constructs (e.g., Revised Behavioural Regulation in Exercise Questionnaire [BREQ-2]; Markland &

Tobin, 2004; Psychological Need Satisfaction in Exercise Scale [PNSE]; Wilson, Rogers, Rogers, & Wild, 2006; Perceived Autonomy Support Scale for Exercise Setting [PASSES]; Hagger et al., 2007) and many of these measures have been used in studies with adolescents (e.g., Hagger et al., 2007; Markland & Ingledew, 2007; Schneider & Kwan, 2013). Studies that use these measures with adolescents often rely on the WHO (2010) definition of exercise (e.g., Standage, Sebire, & Loney, 2008), despite little being known about whether adolescents' conceptualisation of exercise aligns with this definition.

Beyond questionnaire based research, an understanding of how adolescents conceptualise exercise, and the activities that contribute towards adolescent exercise will offer an insight into how best to measure adolescent exercise behaviour. For example, if adolescents identify discrete behaviours that contribute towards exercise, self-report measures or exercise diaries may be sufficient, however if their conceptualisation is based more on intensity and duration, objective measurement may provide a better estimation of adolescent exercise. Therefore, considering the issues of interpretation and measurement for research in the context of adolescent exercise behaviour, it is important to understand the activities that adolescents consider to be exercise (i.e., what range of activities do they have in mind when completing measures referring to exercise) and whether they understand exercise in the sense that it is planned, structured, repetitive and for the purpose of improving or maintaining health and fitness.

1.7.2. Measurement of need support

The extant SDT literature in the context of adolescent exercise behaviour has been limited by the lack of availability of a measure of need support that is contextually specific and encompassing of supports for all three of the basic psychological needs of autonomy, competence, and relatedness. The main limitations of existing measures pertain to their incapacity to assess support for all three basic psychological needs (i.e., rather than autonomy alone) and the focus on authority based relationships.

First, there are a number of measures that have been used to assess autonomy-support for exercise and physical activity (e.g., Teacher as Social Context Questionnaire [TASCQ]; Wellborn, Connell, Skinner & Pierson, 1988; Health Care Climate Questionnaire [HCCQ], Williams et al., 1996; Learning Climate Questionnaire [LCQ], Williams et al., 1994; PASSES; Hagger et al., 2007). Whilst labelled as measures of

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autonomy-support, many of these measures contain items that are conflated with aspects of support for the constructs of competence and relatedness (e.g., ‘they convey confidence in my ability to make changes regarding my physical activity’; HCCQ, Williams et al., 1996; ‘I feel that my teacher accepts me’; LCQ, Williams et al., 1994; ‘they provide me with positive feedback when I do physical activity’; PASSES, Hagger et al., 2007). From an analysis perspective, this may lead to overestimations of the importance of autonomy-support in determining outcomes, whilst not allowing for the disaggregation of autonomy-, competence-, and relatedness-support in order to examine their relative contributions to need satisfaction, motivation, behaviour and well-being. While the TASCQ (Wellborn et al., 1988) does explicitly incorporate items pertaining to support for all three of the basic psychological needs it refers only to need support from authoritative figures (i.e., teachers), whilst neglecting to account for support from peers.

Accordingly, the second limitation of existing need support measures is their focus on the ‘provider-recipient’ relationships, whilst not acknowledging the role of peer and family interactions that are pertinent to adolescent exercise behaviour (Salvy, et al., 2012). Many of the activities that contribute towards adolescents’ exercise behaviour take place within contexts outside of school and sports clubs (e.g., after school play with friends) and therefore much of adolescent exercise behaviour is likely to be influenced by other, more informal relationships (e.g., peers, family; Gage et al., 2003; Salvy et al., 2012). Therefore, considering need support from a variety of social agents would provide a more comprehensive insight into the social contextual precursors of motivation and behaviour.

In line with recent developments in measures for need thwarting to encompass autonomy-, competence-, and relatedness-thwarting behaviours (e.g., Rocchi et al., 2016), it seems timely that similar developments should occur with regard to need support measures. I therefore propose that the development of a measure of need support that sufficiently accounts for support for autonomy-, competence-, and relatedness-, and has the capacity to assess need support from a variety of social agents is a crucial step in order to further understanding of the socio-contextual determinants of motivation, behaviour. and well-being.

1.7.3. The measurement of exercise and sedentary behaviour

There are numerous expert opinions on the best way in to measure exercise and sedentary behaviours. The most accurate measurement procedures for assessing physical activity behaviour include direct observation and indirect calorimetry (Sirard & Pate, 2001). However, these methods are not appropriate for use in large-scale field studies as direct observation is very labour intensive, and it is not possible to control for all factors conducive to conducting accurate indirect calorimetry assessments (Sirard & Pate, 2001).

Generally, self-report measures of behavioural outcomes have been used in large-scale studies as they offer an easy way through which to collect large amounts of data quickly and without great cost (Montoye, Kemper, Saris, & Washburn, 1996). For the purpose of assessing exercise and sedentary behaviour, self-report measures also have the capacity to provide detailed information regarding the types of activity that participants engage in (Montoye et al., 1996), which objective measures are unable to do (Sallis & Saelens, 2000). However, there are a number of general issues with self-report measures of behaviour.

First, self-report measures of physical activity involve recall over a specific period of time (usually around one week, e.g., 8 days, The Activity Questionnaire for Adolescents & Adults; Sliotmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009; 7 days, The Adolescent Physical Activity Recall Questionnaire; Booth, Okely, Chey & Bauman, 2002), and therefore are subject to the limitations of human memory. This may be particularly problematic for behaviours such as physical activity and sedentary behaviour which are often conducted habitually (Shephard, 2003). Further, self-report measures are also susceptible to reporter bias, where the respondent answers in a way to meet what they perceive to be the researchers expectations rather than truthfully (Sallis & Saelens, 2000). Issues with social desirability bias such as this have been highlighted in research with adolescents, not only with regards to the researcher's expectations, but also with peers, where they respond in a way commensurate with what they believe to be acceptable to their friends (Troiano, Gabriel, Welk, Owen & Sternfeld, 2012), thus limiting the accuracy of responses. Finally, when assessing multiple constructs via self-report, there are potential issues of common method artefact (Dishman, 1994). Specifically, when having to report internal states that relate to the reported behaviour (e.g., motivation for exercise), it is likely that the observed correlations will be artefactually inflated (Lindell & Whitney, 2001). In line with these general limitations,

evidence comparing self-reported and objectively assessed exercise has shown self-report measures to overestimate behaviour (e.g., Hagstromer et al., 2008; Sliotmaker et al., 2009).

Considering the limitations of self-report measures, and the unsuitability of direct observation of indirect calorimetry for large scale studies, electronic devices, such as accelerometers may offer a reasonable compromise. Accelerometers are sophisticated electronic devices that assess accelerations produced by body movement. As such, they are able to assess both duration and intensity of activity through a relatively non-invasive method (Sirard & Pate, 2001). Estimates of behaviour based on accelerometer assessments also have a distinct advantage over subjective measures due to real time data storage meaning they are able to provide reliable estimates about physical activity and exercise patterns over a set time period and in large samples (Troost, Pate, Freedson, Sallis, & Taylor, 2000).

Much of the extant SDT literature in the context of adolescent exercise and physical activity behaviours has adopted self-reported measures of physical activity such as the physical activity questionnaire for older children (e.g., Cox et al., 2008; Taylor et al., 2010) and the leisure-time exercise questionnaire (e.g., Gillison, Standage, & Skevington, 2011; Shen, McCaughy, & Martin, 2007). However, there has been a contemporary move towards the use of objective measurements of adolescent physical activity, particularly the use of accelerometers (e.g., Aelterman et al., 2012; Fenton et al., 2014; Lonsdale et al., 2013; Owen et al., 2013; Stenling et al., 2015). Despite this move, there has to date been no application of a holistic SDT model, encompassing the brighter (i.e., need support, need satisfaction and autonomous motivation) and darker (i.e., need thwarting, need frustration and controlled motivation) aspects of the theory, to objectively assessed adolescent exercise and sedentary behaviour.

1.7.4. The processes through which exercise motivation influences behaviour

Despite empirical support for the SDT framework in the context of adolescent exercise behaviour, the associations between autonomous motivation and behavioural outcomes are typically small-to-moderate (e.g., Aelterman et al., 2012; Fenton et al., 2014; Lonsdale et al., 2013; Owen et al., 2013; Standage et al., 2012; Stenling et al., 2015). When behaviour has been assessed in a specific context, such as PE, evidence suggests that context-specific motivation is moderately associated with behavioural outcomes (e.g., Aelterman et al., 2012). For instance, Aelterman et al. (2012) found motivation

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for PE to explain 37% of the variance in MVPA during a PE class. However, when a longer study protocol is used, the relationship between autonomous motivation and behaviour has been shown to be weaker (e.g., Fenton et al., 2014). For example, in a study adopting a 7-day measurement protocol, a combination of coach autonomy-support and autonomous motivation for sport and active games was shown to predict 3.3% variance in accelerometer assessed MVPA and 1.6% in sedentary time (Fenton et al., 2014). The weak association between autonomous motivation and behavioural outcomes alludes to the possibility of processes that are rooted more proximally in the cognitions associated with the initiation of behaviour, which may be involved in translating motivation to behaviour (Hagger et al., 2009). In the same way, it has been acknowledged that self-regulatory mechanisms are important for translating motivation into action (Hagger, Wood, Stiff, & Chatzisarantis, 2010). Therefore, dual-process models that include both conscious self-regulatory and automatic self-regulatory processes offer a framework through which to investigate the intricacies of the relationship between motivation and behaviour.

A number of health behaviour models define behavioural action as a dual-stage process, through which a motivation stage leads to a volitional stage (e.g., Heckhausen & Gollwitzer, 1987; Schwarzer, 2008). These models consider both the social-contextual and cognitive processes involved in forming behavioural intentions and motivation, as well as the subsequent self-regulatory processes that translate this motivation to action (Heckhausen & Gollwitzer, 1987). Relating these processes to SDT, when people engage in behaviour for more autonomous reasons they are likely to self-regulate effectively as the behaviour is performed due to reasons central to the self (Hagger et al., 2010). Regulatory processes that may be particularly pertinent to translating autonomous motivation to exercise behaviour are habit, action planning, and self-monitoring.

Habit represents an automatic regulatory process where behaviour is enacted in response to a repeated stimulus in a particular context (e.g., school or work), and strengthened through recurrent engagement (Gardner, 2012). In adults, there is consistent evidence for the role of habit in predicting physical activity and exercise outcomes (e.g., Rhodes, de Bruijn, & Matheson, 2010), and a recent review highlighted the importance of habit for predicting physical activity outcomes (Rebar, Dimmock, Jackson, Rhodes, Kates, Starling, & Vandelanotte, 2016). Additionally, Gardner and Lally (2013) found that autonomous motivation for exercise predicted exercise habit

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strength independently from engagement in past behaviour. To our knowledge, there has been no investigation of the role of habit in mediating the relationship between autonomous motivation and exercise or sedentary behaviour in adolescents.

Action planning and self-monitoring are conscious self-regulatory strategies that encompass a range of cognitions through which to initiate behaviour (Abraham & Michie, 2008; de Bruijn, 2011; Gollwitzer & Branstatter, 1997). Action planning involves pairing contextual cues, such as a location, a time, or a person, with a specific behaviour to enhance the likelihood of behavioural initiation. Self-monitoring involves the constant reflection on the proposed action plan, and cognitive appraisal of whether these aims are being met (e.g., constantly keeping in mind the exercise that was planned for each day; Abraham & Michie, 2008). Both action planning and self-monitoring have been shown to be an especially strong predictors of physical activity in adolescents (e.g., Araujo-Soares, McIntyre, & Sniehotta, 2009; Dombrowski & Luszczynska, 2009; Luszczynska, Cao, Mallach, Pietron, Mazurkiewicz, & Schwarzer, 2010; Pangrazi, Beighle, Vehige & Vack, 2003; Pate, Wars, Saunders, Felton, Dishman & Dowda, 2005). For example, in their study with Portuguese adolescents aged 10-16 years, Araujo-Soares and colleagues, (2009) found planning strategies to predict self-reported physical activity. Interventions to increase adolescent physical activity that have a strong self-monitoring based component have also shown to be effective (e.g., Pangrazi et al., 2003; Pate et al., 2005). While there has been limited enquiry into how autonomous motivation relates to conscious self-regulation for physical activity and exercise, the data available suggest that action planning and self-monitoring partially mediate the relationship between autonomous motivation and self-reported physical activity (Brickell & Chatzisarantis, 2007; Li, Iannotti, Haynie, Perlus, & Simons-Morton, 2014; Nurmi, Hagger, Haukkalal, Araujo-Soares, & Hankonen, 2016). In a recent study with older adolescents, Nurmi and colleagues (2016) found the relationship between autonomous motivation and self-reported physical activity to be mediated by planning and self-monitoring, whereas controlled motivation did not have any significant influence on self-regulatory strategies.

While there is evidence of the role of both conscious and automatic regulatory processes in mediating the relationship between autonomous motivation and self-reported physical activity behaviours in adolescents, there has to date been no research simultaneously exploring the mediating role of habit, action planning, and self-monitoring in the relationship between autonomous motivation and objectively assessed

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adolescent exercise. There have also been no attempts to ascertain how the precursors of motivation (e.g., need support) may influence these mediators. Therefore, integrating self-regulatory processes within the SDT model may offer a comprehensive model to explain the motivational processes involved in effective self-regulation and exercise behaviour (Hagger et al., 2010).

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1.8. Overview of the current research

The purpose of this thesis was to explore the motivational processes that underpin adolescent exercise and sedentary behaviour. To maintain conceptual clarity, SDT is used as the framework through which to investigate behavioural motivation and the precursors of motivation. Further, and considering the four conceptual, methodological, and theoretical limitations with the extant SDT literature in the context of adolescent exercise behaviour that are highlighted in this Chapter, the purpose of the four empirical Chapters presented in this thesis is to address these limitations and, in doing so, to obtain more comprehensive understanding of the role of motivation in determining adolescent exercise engagement. In regards to this, the present thesis has four key aims: 1) to further understand adolescent's conceptualisation of exercise, 2) to develop a valid measurement tool for assessing need support in the context of adolescent exercise, 3) to assess the extent to which a more holistic model of SDT (i.e., incorporating both the positive and negative aspects of the theory) can predict objective estimates of exercise and sedentary time in adolescents, and 4) to explore the processes through which motivation predicts adolescent exercise and sedentary behaviour. Chapters 2, 3, 4, and 5 comprise four independent yet systematically sequenced empirical chapters that each address one of these aims.

First, in Chapter 2, the way in which adolescents conceptualise exercise will be addressed. To date, there has been no investigation of how adolescents conceptualise exercise, and this conceptualisation has implications for the interpretation of questionnaire responses, as well as how best to quantify exercise behaviour through accelerometers. Therefore obtaining an understanding of how adolescents conceptualise exercise is the logical first step in addressing existing limitations. Through focus groups, the activities that adolescents classify as exercise, as well as their understanding of the characteristics and purposes of exercise will be explored.

In Chapter 3 I address the existing limitations of current measures of need support in the context of adolescent exercise. In order to extend existing work, and align with the theoretical assumption that all three of the basic psychological needs must be supported for optimal functioning (Reis et al., 2000), a holistic measure of need support (the Adolescent Psychological Need Support in Exercise Questionnaire; APNSEQ) will be developed and validated. Three studies will be reported; 1) the development and refinement of an item pool, 2) the administration and further refinement of the item pool through categorical confirmatory factor analysis and item response theory, and 3) the

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further validation of the final measure of need support in an independent sample of adolescents. The APNSEQ will capture supports for autonomy, competence and relatedness, and be applicable to multiple social agents (family, friends and PE teachers).

The study presented in Chapter 4 will employ the new APNSEQ measure, as well as other recent measures of need thwarting, need satisfaction and need frustration (i.e., Interpersonal Behaviours Questionnaire; Rocchi et al., 2016; Basic Psychological Need Scale; Chen et al., 2015) in order to test a comprehensive model of SDT. This will capture the brighter (i.e., need support, need satisfaction and autonomous motivation) and darker (i.e., need thwarting, need frustration, and controlled motivation) aspects of the theory, in the context of accelerometer-assessed adolescent exercise and sedentary behaviour. The SDT model will be tested through structural equation modelling, and the mediation effects of the basic psychological needs examined.

In line with previous research (e.g., Aelterman et al., 2012; Fenton et al., 2014; Lonsdale et al., 2013; Owen et al., 2013; Standage et al., 2012; Stenling et al., 2015), the study presented in Chapter 5 will explore the mediators of the relationship between autonomous motivation and adolescent exercise and sedentary behaviours. Considering the importance of self-regulatory processes for translating motivation to action, and the role of autonomous motivation in facilitating effective self-regulation (Hagger et al., 2010), the roles of action planning, self-monitoring, and habit in mediating the relationship between autonomous motivation and behavioural outcomes will be explored through path analysis. Additionally, the social contextual factors (i.e., need support) that precede both autonomous motivation and self-regulatory processes will be explored.

Chapter 6 draws together the findings of the four empirical chapters, and discusses the contribution of the collective thesis to the literature. The general limitations of the empirical work are considered, and directions for future research that build upon the work presented in this these are proposed, in order to advance the evidence base for the motivational processes that underpin adolescent exercise behaviour. The potential practical insights afforded through this programme of research will also be discussed.

Chapter 2

An exploration of how adolescents understand the term ‘exercise’

An exploration of how adolescents understand the term 'exercise'

Pre-paper commentary

Within the general introduction, the lack of knowledge of adolescents' conceptualization of exercise was highlighted as a key limitation of the existing SDT literature in the context of adolescent exercise. Therefore, as a means to further understand the motivational processes that underpin adolescent exercise engagement, it is first necessary to ascertain how adolescents understand the term 'exercise'. In this chapter, a qualitative exploration of how adolescents understand the term exercise is presented. First, through a combination of a written task and verbal discussion, the types of activity that the adolescents classified as exercise, and those that they did not, were identified. Second, using the participants written responses to guide the discussion, the reasons why the activities were classed as exercise, or not, were explored with the aim of identifying the common features of exercise activities. Supplementing the paper, this commentary offers a detailed overview of the methodological decisions that were made during the process of designing and implementing the study.

As the primary aim of this study was an exploration of how adolescents understand and conceptualise the term 'exercise', qualitative methodology was adopted. Qualitative methods are recommended for the exploration of ideas and concepts (e.g., Darbyshire, MacDougall & Schiller, 2005; Denzin & Lincoln, 1998; Porcellato, Dughill & Springett, 2002; Powell & Single, 1996), and have been extensively used in other conceptualisation studies (e.g., Fattore, Mason & Watson, 2007; Jones, Andrews & Berry, 2016; Madiba & Ntuli, 2015; Porcellato et al., 2002). Due to the effects that researcher bias can have on the interpretation of interview data (Fine & Sandstrom, 1988), and how this bias may be detrimental when trying to comprehend participants' perspectives on a subject matter (Horner, 2000), focus groups were chosen as the study design. Focus groups offer a methodological framework that may provide greater access to the target population's world-view (e.g., Horowitz, Vessey, Carlson, Bradley, Montoya, & McCullough, 2003; Shucksmith & Hendry, 1998) by allowing them to verbalise their thoughts, feelings and ideas in the context of a group discussion (Horner, 2000; Krueger & Casey, 2000; Mahon, Glendinning, Clarke, & Craig, 1996). By centring on the participant discussions, as opposed to the researcher-participant interactions, researcher bias is likely to be minimised, and thus the findings will be

grounded more in the participants' views, rather than the researcher's personal experiences.

Focus groups have successfully been used in studies exploring adolescent understanding and perception of other health behaviours, including smoking, alcohol consumption and contraceptive use (e.g., Jones et al., 2016; Madiba & Ntuli, 2015; Porcellato et al., 2002). Porcellato et al (2002) highlight the effectiveness of focus groups in obtaining universal perspectives and shared ideas as they allow for participants to clarify their ideas in the context of peer discussion, something not possible through individual interviews. Additionally, focus groups offer the opportunity to quickly obtain an array of perspectives from a diverse range of participants (Porcellato et al., 2002; Powell & Single, 1996). Therefore, focus groups offered a methodology through which to obtain a broad understanding of how adolescents universally conceptualize exercise that could be used to inform the interpretation of data, and procedures for measuring adolescent exercise, in subsequent studies.

In their 2002 paper, Porcellato and colleagues highlight some of the challenges they faced in conducting focus groups with children. First, their focus groups took place in a school context, which they found limited the scope of the discussions as participants found it hard to relax and accept that they were the key players in the group. Creating a relaxed environment has been identified as a key part of running a successful focus group with young people (Gibson, 2007) and thus, for the present study, youth clubs were used rather than schools. Youth clubs have successfully been used in qualitative studies with teenagers (e.g., Stewart-Knox, Sittlington, Rugkasa, Harrisson, Treacy, & Abaunza, 2005). It has been recognised that they offer a more informal environment than schools, where the participants may feel able to talk more freely than in a school or at home, as they are more used to being listened to and directing activities (Stewart-Knox et al., 2005).

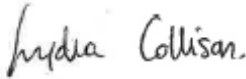
Second, Porcelleto et al. (2002) found that some participants were reluctant to engage in participant discussions, often waiting to be asked a question directly before verbalising their thoughts, increasing the amount of moderator to participant interactions. Other researchers have suggested that using a facilitative task to start the focus group can be beneficial for relaxing participants, adding variety to the content of the focus group, increasing concentration, facilitating participation from all members of

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the group, and initiating discussion by offering participant driven stimuli (Gibson, 2007; Punch, 2002). Facilitative tasks, such as pen and paper exercises, have also been suggested as a research method through which to access children's meanings (Morgan, Gibbs, Maxwell, & Britten, 2002). Therefore, as a means to encourage participant engagement, in combination with the more informal youth club setting, each focus group commenced with a written task, asking participants to write down exercise and non-exercise activities and used these as the stimuli for the subsequent discussion.

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Statement of Authorship

This declaration concerns the article entitled:									
An exploration of how adolescents understand the term 'exercise'									
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Draft manuscript	X	Submitted		In review		Accepted		Published	
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Candidate's contribution to the paper (detailed, and also given as a percentage).	<p>The candidate contributed to/ considerably contributed to/predominantly executed the...</p> <p>Formulation of ideas: 70% This was identified as a need in the wider exercise literature early on in the PhD process and, in conjunction with the other authors I proposed the research questions.</p> <p>Design of methodology: 80% With advice from the supervisory team, I decided upon focus group methodology and designed the focus group schedule.</p> <p>Experimental work: 100% I facilitated all of the focus groups and transcribed and analysed all of the data.</p> <p>Presentation of data in journal format: 80% The paper presented in this thesis was drafted by the candidate, and revised based on suggestions from the other authors</p>								
Statement from Candidate	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.								
Signed							Date	25/09/2016	

The data presented in this paper will be available to access through the the University of Bath Research Data Archive following publication of the manuscript.

2.1. Abstract

Objectives: The present study explored how adolescents (aged 11-16 years) understand the term 'exercise' and how their understanding relates to the widely used working definitions of exercise (e.g., World Health Organization, 2010).

Methods: Adolescents were recruited from youth clubs in the South West of England. Five focus groups involving a total of 21 boys and 19 girls were recorded, transcribed verbatim, and analysed using conventional content analysis.

Results: Participants had a universal understanding of exercise being related to physical activity and an excellent understanding of the health benefits of exercise. Their understanding of what activities are classified as exercise was somewhat conflated with sport and other physical activity behaviours. Although initial justifications for certain activities being exercise suggested that the participants did not distinguish between physical activity and exercise, more detailed discussions highlighted the importance of intensity, duration, and effort. Participants did not discuss the planned and structured aspects that are embedded within the WHO (2010) definition of exercise.

Conclusions: Generally, adolescents demonstrated a good and consistent understanding of both activities that may be classed as exercise, and the potential health benefits of engaging in exercise. There were some aspects of exercise that were more important to some participants than others (e.g., effort), although this did not affect their overall view of what constitutes exercise. Avenues for future research are highlighted.

2.2. Introduction

Physical inactivity during adolescence is a major health concern, with associated health risks including higher body mass, lower cardiovascular fitness, and raised cholesterol (Craig, Mindell & Hirani, 2011; Hallal, Victoria, Azevedo & Wells, 2006; Hancox, Milne & Poulton, 2004). The World Health Organisation (WHO) recommends that adolescents obtain at least 60 minutes of moderate to vigorous physical activity per day (WHO, 2010), yet measured physical activity levels during adolescence are lower than this (Craig et al, 2011; Hallal, Andersen, Bull, Guthold, Haskell & Ekelund, 2012). In an effort to understand the reasons for these low levels of physical activity, there has been considerable research attention regarding the factors that influence adolescent engagement in physical activity and exercise (e.g., Bauman, Reis, Sallis, Wells, Loos, & Martin, 2012; Plotnikoff, Costigan, Karunamuni & Lubans, 2013; Timo, Sami, Anthony, & Jarmo, 2015).

Exercise is defined by the WHO (2010) as '*a subcategory of physical activity that is planned, structured, repetitive and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective*' p.52. Herein, exercise is distinguished from the broader category of 'physical activity' behaviours which may be performed for a variety of purposes such as play, work, transport, household chores, and recreation. The WHO definition is commonly used by researchers to define exercise to their participants (e.g., Maltby, Wood, Vlaev, Taylor & Brown, 2012; Standage, Sebire & Loney, 2008), however, there are also numerous studies in which researchers do not provide participants with any definition of exercise (e.g., Bluemke, Brand, Schweizer & Kahlert, 2010; Buckley & Cameron, 2011). By not providing a definition of a construct such as exercise, issues may arise when interpreting data, as scholars cannot be certain that their participants have understood the term 'exercise' in a manner commensurate with the aims of their work. Similarly, providing a definition to participants that is incongruent with the participants' perceptions of the term may cause confusion about how they should respond to exercise-related questions. Therefore, it is important that researchers interested in adolescents' exercise behaviour better understand how their participants comprehend and perceive the constructs that they are measuring. Additionally, from a public health perspective, it is useful for practitioners to better understand what their target populations consider constructs to be, so that health promotion can be sufficiently targeted to the behaviour. To the best of our knowledge, there has been no empirical enquiry into whether adolescents understand what the terms

exercise relates to, and whether their understanding aligns with the widely used WHO (2010) definition.

Studies examining child and adolescent understanding of other physical activity-related behaviours (e.g., active play and physical activity) suggest that while children and adolescents hold a basic understanding of what the terms mean, there are fundamental differences between their understanding and that of adults (Burrows et al., 1999; Brockman, Fox, & Jago, 2011; Trost, Morgan, Saunders, Fetton, Ward, & Pate, 2002). Indeed, past work suggests that without some form of intervention and education children are not able to accurately classify physical activities and sedentary activities (Trost et al., 2002), suggesting that the way in which children conceptualize physical activity may be different to adults. If, as in the context of active play and physical activity, adolescents understand the concept of exercise in a different way to adults, it is important that scholars are aware of these differences, and do not make assumptions about our target population's understanding, especially with regards to research data obtained through questionnaires.

As well as an awareness of adolescents' understanding of exercise, it is also important to ascertain whether adolescents actually engage in exercise behaviour (i.e., do they engage in physical activity behaviours for the purpose of improving or maintaining health and fitness). Research in adult populations suggests that this could be especially important for research investigating the precursors of behaviour, as the predictors of behaviour may differ according to the purpose of behaviour (Kilpatrick, Hebert, & Bartholomew, 2005; Monteiro, Conde, Matsudo, Matsudo, Bonsenor, Lotufo, 2003). Past work also shows that people's reasons for engaging in sport (e.g., challenge, competition, affiliation) differ from those for exercise (e.g., appearance, stress management, health), and that these differing goals are related to different levels of exercise, with social and health related motives predicting higher levels of physical activity (Kilpatrick et al., 2005; Monteiro et al., 2003). Understanding how adolescents understand the term "exercise", and the activities that they believe to be encompassed by the word "exercise", may enable higher quality research that focuses on the specific precursors for the target behaviour, and better interpretation of research findings.

2.2.1. Present research

With a view to addressing the gap in the extant literature pertaining to how adolescents understand and perceive exercise, we sought to answer;

- 1) What do adolescents understand by the term 'exercise'?
- 2) What types of activities are encompassed within adolescents' understanding of exercise?
- 3) Is the understanding of what exercise is, consistent across adolescents?

2.3. Methods

2.3.1. Design

The present study is a cross-sectional qualitative investigation. Focus groups were chosen in order to benefit from the effects of group discussions, which can assist adolescents to verbalise their thoughts, feelings and ideas (Horner, 2000; Krueger & Casey, 2000; Mahon, Glendinning, Clarke, & Craig, 1996) and enable the study of collective understanding (Krueger & Casey, 2000; Porcellato, Dughill, & Springett, 2002). The focus group schedule was semi-structured, and combined verbal discussion with a facilitative written task that involved participants writing down activities that they consider to be exercise and activities that are not exercise. Written tasks are recommended as a means of engaging an entire group by making the focus group more varied and interesting, and can be useful for initiating discussion by providing participant driven stimuli to help engage the group (Punch, 2002). Experts in qualitative research, research with adolescents, and physical activity were involved in the design and refinement of the focus-group schedule.

2.3.2. Participants

An opportunistic sample of adolescents aged 11-16 years was recruited from youth clubs in the south west of England. All five youth clubs were within a local authority area and the lead youth workers were contacted and invited to take part in the research; the leaders of two youth clubs agreed to take part, and the adolescents were provided with information letters and parental consent forms to distribute to parents of club members. Participants aged 11-16 years who could speak and understand English sufficiently were eligible to take part. Based on previous focus group studies with adolescents, and the sample size at which data saturation was met, we aimed for a sample of 50 participants across six focus groups (Allison, Dwyer, Goldenber, Fein, Yoshida, & Boutilier, 2005; Dwyer, Allison, Goldenberg, Fein, Yoshida, & Boutilier,

2006; Slater & Tiggemann, 2010; Tiggemann, Gardiner, & Slater, 2000; Whitehead & Biddle, 2008).

2.3.3. Procedure

Prior to data collection, ethical approval was obtained from the researcher's institutional ethics committee. Data collection took place between June and October 2014 during youth club drop-in sessions. Youth club members from whom parental consent had been received were approached at the start of the youth club session by the youth club leader to take part in the focus group on a first come, first served basis. In line with recommendations, each group consisted of seven or eight members (Morgan, 1997).

The focus groups took place in a meeting room away from the normal running of the youth club, facilitated by the researcher (L.E.), and under supervision of a youth club leader. Information sheets were provided to each participant and L.E. explained the study to the participants verbally, including how the focus groups would be recorded and the anonymization processes for transcription. Written assent was then obtained from all participants. Participants were first asked to complete written task, writing down a) 'activities that are exercise', b) 'activities that are not exercise'. The content of this written task was then used to shape the subsequent discussions, exploring how adolescents perceived the term 'exercise' (e.g., "What is the first thing that comes to mind when you hear the word 'exercise'", "What activities did you write down in the 'exercise' column?"), the features of activities that make them exercise or not (e.g., "What is it about this activity/this group of activities that makes them exercise/not exercise") with follow up questions and prompting where necessary. Participants were encouraged to discuss any agreements or disagreements they had with what was written down or said, giving their reasons for why they agreed or disagreed. All the focus groups were audio recorded using a Sony Mp3 IC recorder and field notes recording non-verbal information were made.

2.3.4. Analysis

The audio recordings were transcribed verbatim by the researcher (L.E.), and uploaded into NVivo version 10 (QSR International, 2012) for analysis. As the primary research question was definitional in nature, seeking to ascertain the defining features of exercise behaviour in adolescence (Elliot & Timaluk, 2005), the data were analysed using conventional content analysis which is appropriate when the primary study aim is to describe a specific phenomenon (Hsieh & Shannon, 2005). With the aim of interpreting

how adolescents perceive and understand the term 'exercise', the first stage of analysis involved immersion with the data, through listening to audio recordings and reading transcriptions, so as to obtain an overview of the data as a whole. The development of the initial coding scheme involved a fluid process of first coding the data word for word (Hsieh & Shannon, 2005; Miles & Huberman, 1994; Morgan, 1997; Morse & Field, 1995) and then the coder making notes of first impressions and thoughts to allow for the coding of related thoughts that are derived within the data. Following this, the codes were categorised into clusters based on similarities, relationships, and links, giving more meaning and structure to the data. These clusters were subsequently organised into subthemes and, at a higher level, themes, to allow for more in depth description of the data. At this stage, the initial themes and subthemes were presented to youth club leaders who were present during the focus groups, and their feedback considered to ensure accurate interpretation of the data. Following confirmation of the subthemes and themes, the definition of exercise (WHO, 2010) was used to assist in interpreting the data. Quotes identified by focus group number are presented to illustrate key findings.

2.4. Results

2.4.1. Participant characteristics

40 participants (80% of eligible youth club attendees) returned parental consent and volunteered to be involved in the study, 39 of whom were involved in the final focus groups (87.5%), with one drop out due to absence from the youth club during data collection. Descriptive statistics are shown in table 2.1. Participants were aged from 11 to 16 years ($M=13.4$ years; $SD = 1.76$) and 21 (52.5%) were male. The sample was largely white (94.8%), which is consistent with the area population (94.6%; Bath and North East Somerset, 2011). Seventeen participants self-reported exercising at least 3 times a week, 13 reported exercises 1-2 times a week, and 9 reported never exercising.

Table 2.1

Participant characteristics overall and by focus group

	Focus group 1	Focus group 2	Focus group 3	Focus group 4	Focus group 5	Total
Age (Mean (SD))	14.9 (1.36)	13.0 (1.53)	12.6 (1.51)	12.8 (1.94)	13.3 (1.86)	13.4 (1.76)
Gender (N)						
Male	5	4	5	3	4	21
Female	3	4	3	4	4	18
Race (N)						
White	8	8	7	7	7	37
Mixed	0	0	1	0	1	2
Exercise status (N)						
≥3 times a week	4	4	4	3	2	17
1-2 times a week	1	3	3	2	4	13
Never	3	1	1	2	2	9
Total (N)	8	8	8	7	8	39

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Table 2.2.

Main themes, subthemes, and example codes

Theme	Subthemes	Example codes
Types of activity encompassed within exercise	- Team sports	Football, Hockey, Netball
	- Individual sports	Boxing, Cycling, Gymnastics
	- Exercise-related activities	Press-ups, Jumping
	- PE lessons	PE
	- Activities of daily living	Housework, gardening, sex
	- Sedentary activities	Computer games
The purpose and benefits of exercise	- Cardiovascular health	Heart pumping, making heart stronger
	- Strength	Using muscles, getting stronger
	- Aesthetic benefits	Building muscle, losing weight
	- Respiratory health	Makes breathing harder, working lungs
The role of effort	- Mental effort	Concentration, focus
	- Physical effort	Hard work, difficult, tiring
	- Duration	Duration
	- Intensity	High exercise, low exercise

2.4.2. Main findings

The themes and subthemes are presented in table 2.2. and an overview of the main themes by focus group is presented in table 2.3. Sport and fitness-related activities were the dominant type of activity that participants considered to be exercise across all five focus groups. Within this domain, bicycling, dancing, running, and sports were mentioned extensively, with swimming and walking also frequently cited (using the physical activity compendium to categorise activities: Ainsworth et al., 2011). Female participants were more likely to mention non-sport activities (e.g., dancing) in the discussions. Other activities discussed included; conditioning exercises (e.g., calisthenics, jumping and weight lifting), activities of daily living (e.g., housework, shopping and gardening), occupational activity (e.g., waitressing) and sexual activity. A male participant emphasised this variety in what he considered to constitute forms of exercise when discussing the exercise he personally engages in:

James: *'I do a lot of exercise at work, I do house clearings and that, and it burns a lot of muscles and calories off...and after that I go running in the evenings, I play rugby, umm I have gardening with my grand dad, I love it. I love gardening, love it'* (focus group 5).

The groups were also able to correctly identify sedentary behaviours as non-exercise activities (e.g., sitting down, playing computer games).

In addition to understanding exercise as a category of physically active behaviours, there was also a universal understanding of the purpose and benefits of exercise: Specifically, the adolescents showed a distinct recognition of exercise as being *'good for you'* (focus groups 1 and 3), as well as of how exercise can result in physical fitness. Most groups were able to identify the physiological effects of exercise based on their own personal experiences (e.g., *'you get sweaty'* (focus group 1), *'makes you out of breath and gets your blood pumping'* (focus group 3), and *'breathing heavier'* (focus group 5)) and the majority of participants were also able to extend beyond personal reflection and identify the processes underlying these changes;

Amy: *'yeah like breathing heavier and that...working your lungs, making them healthier'* (focus group 5)

Table 2.3

Summaries by theme and focus group

	Types of activity encompassed within exercise	The purpose and benefits of exercise	The role of effort
Focus group 1	This group identify activities that involve physical activity as exercise, and sedentary activities (e.g., computer games) as not exercise. The boys mainly suggest sports, such as football, tennis and boxing, whereas the girls identify a broader range of activities, from those conducted in PE lessons (e.g. netball), as well as more general activities such as housework and walking. Aside from sports, the boys also identify sex as a form of exercise.	Clear identification of the positive effects of exercise on a number of health and fitness outcomes. They are able to suggest how exercise is beneficial for the cardiovascular system, but this group focus mainly on muscular use and development.	This group show a very good understanding of the effort that is required for exercise. Of particular interest is the identification of some mental effort required (engaging, focus, concentration, reactions). As in focus group 5, duration is mentioned in relation to walking, with one participant saying 'If you're walking like 20 minutes a day it classed as exercise'.
Focus group 2	Some of the girls identify dancing and swimming and also highlight that sitting down is not exercise. Members of this group identified more specific movements, such as press-ups and jumping, as exercise.	The participants in this group do not focus on the health benefits of exercise, although some participants comments suggests they do understand that exercise is beneficial for health. There is more of a focus on the aesthetic benefits of exercise, particularly with regards to building muscles.	This group identify that exercise requires hard work, implying that it requires some effort. The girls in particular seem to ruminate on finding exercise difficult, and as a result display a very negative attitude towards exercise, saying it is horrible and they hate it.

Cont...

Focus group 3	Girls identify a number of team sports (hockey, football) as well as other activities such as jogging and gymnastics. Again, activities that involve sitting are identified as not being encompassed within exercise. The boys suggest team sports such as football and rugby and activities carried out in PE lessons, as exercise. This group do not classify activities where you are sat down, specifically playing computer games, as exercise.	This group show a clear understanding of how exercise is beneficial for health and fitness, particularly in reference to the cardiovascular system. They go further to say how exercise is beneficial over sedentary activities. They also highlight the aesthetic benefits of exercise (e.g. building muscle).	Effort is explicitly mentioned as a component of exercise by the girls in the groups, and the boys identify that you need to work, and that it makes you tired. The girls also display some negative attitudes, likely as a result of their personal experiences of exercise being difficult.
Focus group 4	This group were less divided by gender than some of the others, and identified as number of team sports (e.g. basketball, football, rugby) as exercise. They also mentioned running as its own exercise activity, but also a common feature of the other exercise activities discussed.	The idea of exercise being beneficial for different components of fitness was touched upon, specifically with regards to the cardiovascular system and muscular strength.	They group note that exercise makes you tired. There is also the mention of 'high exercise' making you sweatiest and getting your heart pumping, implying some recognition of intensity.
Focus group 5	As in other groups, sports (e.g., football and hockey) were identified as exercise. Some of the members of the group had part time jobs in cafes and restaurants or as labourers so they discussed how doing that type of work is exercise. Again walking was highlighted as exercise by some members of the group, but others disagreed. Other activities, such as cycling and gardening were also raised.	The participants demonstrate an understanding of how exercise can be beneficial for health and fitness, with particular focus on the respiratory system (e.g. lungs). The participants also discuss muscles in relation to exercise, but the focus is more on aesthetic goals (building biceps) rather than fitness related. This group were also the only group to discuss exercise in terms of weight loss and burning calories. The participants also highlight that they believe exercise is good for you.	The participants note that exercise is tiring and can be difficult, suggesting some effort needs to be put in, with some mention of intensity. A key discussion about walking and whether it can be considered exercise or not. Following debate, the effort put in (particularly how long you perform the activity for) is decided as crucial in determining whether an activity is classed as exercise or not.

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Participants in three of the discussion groups demonstrated a clear awareness of how exercise affects the cardiovascular system with '*Working your heart*' (focus group 3) and '*gets your heart pumping*' (focus group 4) being identified as key attributes of exercise. Further to this, participants in one of the focus groups conveyed how exercise is beneficial in contrast to sedentary behaviour; '*moving makes your heart work harder than it normally does...like when sitting and sleeping*' (focus group 3).

A number of aesthetic changes following exercise were also identified. In particular, the male participants focussed on muscular development ('*Building muscle*'; focus group 2 and 3), and it was evident that the participants were concerned more with the aesthetic side of this change through their body language when these topics were mentioned:

James: '*...that's how you get these bad boys (flexes muscles)*' (focus group 5).

Two of the focus groups touched upon how exercise may be used for weight loss and maintenance. A couple of participants highlighted how exercise burns calories;

Ben: '*cause you're using calories*' and '*it burns a lot of...calories off*' (focus group 1).

Daniel: '*Yeah you sweat and burn calories and get fitter*' (focus group 3).

Although the participants in each group generally agreed on the types of activities that were to be classified as exercise and the associated benefits, a small number of participants in focus group 5 felt that the effort exerted during the activity is also pertinent to exercise. An example of this is a discussion around high and low intensity activities in focus group 1:

Ed: '*There are different types of exercising though. High intensity...*'

Josh: '*There are like low exercises, like shot put where you're not really doing much, just going like that aren't you. So that's not...well I guess it is exercise...but you don't do a great deal do you*' (focus group 1).

Ed: '*...or like the wii or the kinect... Yeah that's, yeah cause you're moving about, if you're playing tennis you've got to...it's low intensity but it, I would say it still counts. Basketball, loads of work in basketball*'

Tim: '*Swimming! It does everything*'

Josh: *'Some of it is quite high and you just don't realise'* (focus group 1)

These points highlight that participants believe that exercise activities require a certain degree of perceived exertion. Of particular significance was a discussion around whether walking counts as exercise (following an initial task asking participants to write down activities that they class as exercise):

Tim: *Who said walking isn't exercise? Was it Chris?*

Chris: *Well I said it doesn't feel like exercise*

Ben: *No*

Becky: *Why isn't it? It's still moving your legs and using your muscles and you can get tired walking*

Chris: *Well that's just you*

Becky: *Right so if you walk like three miles that's not exercise*

Chris: *hmmm*

Becky: *Well I might write walking on both [the exercise and non-exercise sides of the paper] and put 'depending on how long'*

(focus group 5).

This discussion highlights the difficulty that some participants had in classifying activities on the borderline of their initial criteria, such as walking. Through this discussion, the participants were forced to rethink their original classification of what exercise is, which led to the suggestion that duration and intensity of the activity may be indicative of exercise.

2.5. Discussion

The present study sought to answer three questions: 1) What do adolescents understand by the term 'exercise', 2) What types of activities are encompassed within adolescents' understanding of exercise, and 3) Is understanding consistent across adolescents?

Results showed participants to have a clear understanding of exercise as physically active behaviours that can provide a number of health and fitness benefits. Participants' views of the activities that are encompassed within exercise are broad and inclusive. Indeed, for this set of participants exercise extends beyond activities that are exclusive to health and fitness goals to incorporate an array of activities that can be performed for a number of different reasons (e.g., sport and housework). With the exception of some nuances in relation to the degree of effort required for an activity to be termed exercise,

the way in which participants talked about exercise was consistent across the majority of participants and focus groups.

All of the activities that participants categorised as exercise were physically active behaviours (e.g., swimming, dancing). Previous research has found that children are not able to accurately classify active and sedentary behaviours without being provided with information about what physical activity is (e.g. Trost et al., 2002); the current findings suggest that this ability has emerged by adolescence, potentially due to improved cognitive abilities to understand and differentiate activities. Yet, the range of active behaviours that participants identified in the present work was vast, encompassing a number of activities that are more commonly categorised as sport (e.g., football, hockey) or activities of daily living (e.g., housework and shopping) which raises the question of whether, to these participants, exercise represents a subset of physical activity or whether they view exercise and physical activity as the same.

The broad range of activities identified as exercise suggest that the participants do not differentiate between physical activity and exercise in terms of type of activity. That is to say, the participants identified sports (e.g., football) and other physical activity behaviours (e.g., housework) as contributors to exercise. Evidence suggests that intensive physical activity may provide 'exercise' in terms of beneficial health outcomes (e.g., Lee & Paffenbarger, 2000) and the subsequent discussions suggest the participants view intensity and duration as key features of exercise behaviour. The participants also demonstrated awareness of the purposes and benefits of engaging in exercise. There was a general acceptance that exercise is 'good for you' and can contribute towards a healthy lifestyle. To this end, participants were able to identify specific benefits, including cardiovascular fitness, strength, and aesthetic outcomes (e.g. gaining a muscular physique). The identification and acknowledgement of these benefits indicates that the participants' understanding of exercise at least partially aligns with the WHO (2010) definition of exercise in terms of it being '*a subcategory of physical activity*' and with the objective of '*the improvement or maintenance of one or more components of physical fitness*'. Even though the participants demonstrated an understanding of the health benefits of exercise, it is unclear whether this is the primary purpose of performing exercise behaviours. Sports and other physical activities were frequently mentioned in discussions which, whilst also beneficial for health, are likely to be performed primarily for other reasons (e.g., social, daily living etc.; Kilpatrick et

al., 2005; Monteiro et al., 2003). This suggests that the participants view of exercise may be somewhat conflated with more general physical activity.

Although all participants agreed on most of the types of activities to include within the category of exercise, a small proportion of participants felt that effort put in to an activity was central to whether it was classed as exercise or not. Particularly in focus group 5, some participants made it evident that they categorise exercise in relation to their own physical and affective responses to the activity, as well as the length of time engaged in the activity, over and above the type of activity being undertaken. However, the debate in focus group 5 about whether walking was considered exercise led to differences in opinion and, even after participants had made the case for and against, consensus across the group was not achieved. Although we are not aware of any research that has directly investigated this in other populations, we speculate that there would be similar unresolved distinctions within adults.

2.5.1. Strengths, limitations, and future research

This paper presents the first exploration of how the term 'exercise' is interpreted by adolescents. Through providing an insight into adolescents understanding of exercise these findings offer potential applications for research, in terms of accurately interpreting study findings, and health promotion, in terms of being able to better target adolescent exercise behaviours through interventions. Additionally, in using the WHO definition of exercise (2010) as a framework for analysis, the findings offer initial insights into the similarities and difference between expert and adolescent understanding which may cause difficulties for research and health promotion. However, in contrast to previous findings with children that they are unable to correctly distinguish between sedentary and physically activity behaviours (Troost et al., 2002), the findings of this study suggest that adolescents do have a more comprehensive understanding of both the activities that are classified as active and sedentary, as well as the health and fitness benefits of exercise.

Notwithstanding the strengths of the study, there are also some limitations. First, as the data were collected during youth club drop in sessions, we cannot determine whether the views expressed by the participants reflect those of teenagers who do not attend youth clubs (e.g., those who attend sports clubs, socialise with their friends more informally, and/or stay at home). Second, focus groups were chosen as they are useful for gaining insights into thoughts and feelings, particularly in populations which find

articulating such matters more difficult, such as children and adolescents (Mahon et al., 1996). Despite this strength, previous studies have noted that by using focus groups there is also the potential for conformity and repetition of ideas (Brockman et al., 2011; Porcellato et al., 2002). It is possible that there was a certain degree of conformity, as evident during the debate regarding whether walking is classed as exercise, as there was a degree of persuasion from certain members of the discussion (e.g., '*Why isn't it? It's still moving your legs and using your muscles and you can get tired walking*' [focus group 5]). However, in all focus groups, there were a variety of responses from participants and therefore we suggest that conformity was not a major issue but that the discussions offered an opportunity for the participants to consolidate their ideas.

Finally, it is important to highlight that the discussions were centred on exercise, and we did not ask the same questions in relation to physical activity. It is therefore difficult to identify distinct differences in the adolescents' conceptualisations of these constructs without some speculation. It would be of interest in future research to investigate whether adolescents are able to distinguish between exercise, physical activity and sport.

2.5.2. Conclusion

This paper provides the first exploration of how adolescents understand and perceive exercise. Due to the qualitative nature of the study, it is important that the findings are not widely generalised. However, in contrast to evidence with children, the findings suggest that adolescents have a broad and generally consistent understanding of what exercise is, the activities that are classed as exercise, and the potential benefits of exercise. Although it was evident that some participants viewed effort as more important than others, this appeared to be a difference of opinion in terms of the threshold at which specific activities should be defined as 'exercise', rather than a marked difference in understanding of what exercise is. Greater challenges may be faced in asking adolescents to differentiate between exercise, physical activity and sport, which appeared to be conflated and therefore this offers an interesting avenue for future research.

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Concluding Commentary

The paper presented in this chapter provides the first exploration of how adolescents conceptualize exercise. The findings suggest that adolescents have a generally good understanding of what exercise is, and many aspects of their understanding align with the WHO (2010) definition.

With regards to this thesis, the findings presented in this paper indicate that studying exercise and its antecedents is appropriate in adolescent populations, as adolescents do have a generally good understanding of what exercise is, and what its benefits for health and fitness are. This highlights that adolescents conceptualisation of exercise and other physical activity behaviours may be more developed than younger children (e.g., Trost, Morgan, Saunders, Felton, Ward, & Pate, 2000). From a measurement perspective, and with a view to applying an SDT model to objectively assess adolescent exercise in chapter 4, these findings also provide insight into how best to capture adolescent exercise behaviour using accelerometers. From the findings it can be inferred that the activities that contribute towards the accumulation of exercise may not be dissimilar to those that contribute to more general physical activity. Rather, it could be said that any activity performed with a high enough intensity contributes towards adolescent exercise. Therefore, using these findings to support the measurement of exercise, in the later studies within this thesis (Chapter 4 and 5), moderate-to-vigorous physical activity through accelerometers will be used as an estimation of adolescent exercise behaviour.

Chapter 3

Development and Validation of the
Adolescent Psychological Need Support
for Exercise Questionnaire

Development and Validation of the Adolescent Psychological Need Support for Exercise Questionnaire

Pre paper-commentary

The primary aim of this thesis is to further understand the motivational processes that underpin adolescent exercise engagement. However, from the perspective of SDT, the existing literature has been limited by the lack of a holistic measure of need support specific to the context of adolescent exercise. Therefore, as a means to facilitate further investigation of the socio-contextual predictors of adolescent exercise motivation and behaviour, the paper presented in this chapter offers three studies through which the Adolescent Psychological Need Support for Exercise Questionnaire (APNSEQ) was developed and validated. Prior to the paper, this commentary provides justification for the psychometric assessments employed to refine and test the measure.

The majority of scale development papers within both the sport and exercise psychology and self-determination theory domain, have adopted classical test theory (e.g., confirmatory factor analysis; CFA) procedures (e.g., Bartholomew, Ntoumanis, Ryan & Thogersen-Ntoumani, 2011; Vlachopoulos & Michailidou, 2006; Wilson, Rogers, Rodgers & Wild, 2006). However, the American Educational Research Association (AERA), American Psychological Association (APA), and National Council on Measurement in Education (NCME; 2014) encourage psychometric analysis to account for the statistical properties of items, as well as the whole test. Accordingly, there is a move towards the inclusion of item response theory (IRT) in scale development and refinement.

Inherently, both CFA and IRT are concerned with the estimation of a latent construct (de Ayala, 2009), however there are some notable distinctions between the two estimation methods. First, while both CFA and IRT differentiate between the score that is derived from the latent construct and variation that is caused by error (DeVellis, 2012), CFA is underpinned by the assumption that the observed score (i.e., the score on the scale) is composed of the respondents true score and general error (DeVellis, 2006), and does not distinguish between different sources of error variance. In contrast, IRT attempts to differentiate sources of error, especially in terms of item characteristics that may affect performance on an item (e.g., difficulty; DeVellis, 2012).

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Second, CFA emphasizes the properties of the whole scale due to the reliance on inter-item correlations (DeVellis, 2012; Harvey & Hammer, 1999) whereas IRT takes a more item-centred approach, with less focus on items with low reliability, and more focus on identifying better performing items (DeVellis, 2012). Therefore, IRT methods offer a statistical framework through which to evaluate test items in terms of the efficacy of individual items at assessing the target latent variable (Reeve & Fayers, 2005; Streiner, 2010).

Third, CFA has great value for assessing whether items accurately assess their intended constructs, as the process identifies homogeneity between items (Whittaker & Worthington, 2016). However, IRT also considers the level of the attribute being measured, and thus is able to identify items that perform well across the breadth of the construct (DeVellis, 2012). With this in mind, CFA alone could lead to scales that do not adequately evaluate all elements of the target construct, and therefore the inclusion of IRT, allowing for the identification of highly performing items across the breadth of the latent construct, will facilitate the development of a reliable and comprehensive scale (DeVellis, 2012).

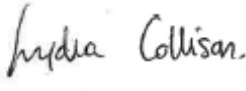
As one of the primary goals of this paper was to develop a parsimonious but theoretically encompassing measure of need support, and for the reasons outlined in this commentary, a combination of CFA and IRT was employed. Specifically, CFA offered a useful methodology for testing the factorial structure of the need support measure, assessing which items pertain to the constructs of autonomy-, competence-, and relatedness- support. In conjunction with this, the use of both the IRT parameters and graphs allowed the pool of items to be refined based on both prediction and the breadth of the construct, therefore maintaining the efficacy of the measure and the representation of the full breadth of the need support construct (Edelen & Reeve, 2007; Streiner, 2010). Here, I highlight that there was no a-priori goal to develop a 9-item measure. Rather, the IRT analysis indicated that the three items for autonomy-, competence-, and relatedness-support were sufficiently representative of the broader spectrum of items for these constructs, and minimal information was lost by reducing the measure from 29 to 9 items in Study 2. The two estimation methods have been successfully used for scale development in the wider psychology literature (e.g., Mallinckrodt, Miles & Recabarren, 2016; Waller, Ostini, Marlow, McCaffery, & Zimet,

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2013) but the paper presented offers the first application of combined CFA and IRT in the sport and exercise psychology domain.

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Statement of Authorship

This declaration concerns the article entitled:									
Development and validation of the adolescent psychological need support in exercise questionnaire									
Publication status (tick one)									
Draft manuscript	<input type="checkbox"/>	Submitted	<input type="checkbox"/>	In review	<input type="checkbox"/>	Accepted	<input type="checkbox"/>	Published	<input checked="" type="checkbox"/>
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Candidate's contribution to the paper (detailed, and also given as a percentage).	<p>Formulation of ideas: 60% In conjunction with the other authors, and following the initial literature review, the lack of a holistic measure of need support was identified as need in the wider SDT context, as well as in this thesis.</p> <p>Design of methodology: 70% Following guidelines for scale development and refinement, I designed the three studies presented within the paper, with guidance from the other authors.</p> <p>Experimental work: 100% I conducted all experimental work including recruitment, data collection, data management and analysis</p> <p>Presentation of data in journal format: 70% I drafted the original manuscript for publication, and amended based on comments from both the other authors and the reviewers</p>								
Statement from Candidate	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.								
Signed							Date	25/09/2016	

The data presented in this paper is from multiple datasets. These can be accessed through the University of Bath Research Data Archive (doi: 10.15125/BATH-00255).

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3.1. Abstract

Grounded within self-determination theory (SDT; Ryan & Deci, in press; Deci & Ryan, 2000), three studies were conducted to develop and psychometrically test a measure of adolescents' perceptions of psychological need support for exercise (viz., for autonomy, competence, and relatedness): the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ). In Study 1, 34-items were developed in collaboration with an expert panel. Through categorical confirmatory factor analysis and item response theory, responses from 433 adolescents were used to identify the best fitting and performing items in Study 2. Here, a 3-factor 9-item measure showed good fit to the data. In Study 3, responses from an independent sample of 373 adolescents provided further evidence for the 9-item solution as well as for internal consistency, criterion validity, and invariance across gender and social agent (friends, family, and PE teacher). The APNSEQ was supported as a measure of adolescents' perceptions of psychological need support within the context of exercise.

Keywords: self-determination theory, measurement, autonomy, competence, relatedness

3.2. Introduction

Research has consistently documented numerous physical and mental health benefits of a physically active lifestyle (cf. Janssen & LeBlanc, 2010). Yet, globally, adolescent physical activity levels are below those necessary for the maintenance of health (Hallal et al., 2006). The ill-effects of physical inactivity during adolescence include higher body mass, lower cardiovascular fitness, raised cholesterol, and poorer mental health (Craig, Mindell, & Hirani, 2011). The need, then, for a better understanding of the factors that support adolescents to engage in exercise is readily apparent.¹ One factor particularly predictive of adolescent engagement in exercise is their motivation and the social-contextual processes that support it (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Here, guided by self-determination theory (SDT; Deci & Ryan, 2000; Ryan & Deci, in press), we present data from three studies documenting the development and validation of a new measure of social contextual supports for adolescents' motivation in the exercise context, namely the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ).

3.2.1. Self-Determination Theory

SDT is an organismic theory of human motivation that addresses the inherent and social-contextual conditions influencing how individuals think, feel, and behave (Deci & Ryan, 2000; Ryan & Deci, in press). Within SDT, the extent to which social-contexts support or thwart three basic psychological needs is discriminative of whether individuals experience autonomy or heteronomy, engagement or disaffection, and wellness or illness (Deci & Ryan, 2000). The first psychological need is for autonomy. It reflects feelings of volition, responsibility, and a sense of inner endorsement over one's actions (Ryan, 1995). The second psychological need is for competence. It encompasses feelings of efficacy and the ability to overcome challenge (Deci & Ryan, 2000). The third psychological need is for relatedness. It encapsulates feelings of belonging and being connected and cared for by significant others (Ryan, 1995). In support of SDT, data from multiple life domains (e.g., academia, family, work, and sport) show that satisfactions to these psychological needs are associated with enhanced psychological and physical functioning (cf. Ryan & Deci, in press).

Within the exercise context, data has shown that a satisfaction of the basic psychological needs positively contributes to well integrated forms of exercise motivation, increased exercise engagement, and exercise-related wellness (e.g., Sebire,

Jago, Fox, Edwards, Thompson, 2013; Sebire, Standage, & Vansteenkiste, 2009; see Standage & Ryan, 2012 for a review). By contrast, a frustration of the basic psychological needs positively contributes to poorly integrated forms of exercise motivation and markers of ill-being (e.g., emotional and physical exhaustion and negative affect; Bartholomew, Ntoumanis, Ryan, & Thogersen-Ntoumani, 2011; Curran, Hill, Jowett, & Hall, 2014; Gunnell, Crocker, Wilson, Mack, & Zumbo, 2013). Due to the fundamental postulate within SDT that individuals are optimally motivated, function effectively, and experience well-being when their basic psychological needs are met, an understanding of social contexts that are conducive to supporting autonomy, competence, and relatedness is important, both from scientific and applied perspectives.

3.2.3. Basic Psychological Need Support and Measurement in the Adolescent Exercise Context

Within SDT, social contexts serve to facilitate well-integrated motivation, behavior and wellness by providing experiences that support the basic psychological needs for autonomy (e.g., supports for choice, self-initiation, and understanding), competence (e.g., supports for challenge, improvement, and the provision of appropriate positive feedback), and relatedness (e.g., supports for acceptance, of being valued, and for caring interactions). Equally, the social context can undermine functioning and wellness by thwarting these basic psychological needs (Ryan & Deci, 2000). In the context of adolescent exercise, research has shown that perceptions of autonomy support contribute to well integrated forms of exercise motivation, behavioral engagement, and markers of well-being (e.g., Gillison, Standage, & Skevington, 2013; Standage, Gillison, Ntoumanis & Treasure, 2012). However, such investigations have typically focused on autonomy-support from significant others (e.g., parents and teachers) with only a few instruments including measures of competence- and/or relatedness-support (e.g., in the education domain the Teacher as Social Context Questionnaire [Wellborn, Connell, Skinner, & Pierson, 1988] assesses involvement and structure as markers of relatedness and competence support, respectively). This limitation is partly due to a lack of systematically developed measures incorporating items to also assess competence- and relatedness-support. Some studies have implemented holistic measures of psychological need support in physical activity and exercise environments (e.g., Markland & Tobin, 2010; Standage, Duda, & Ntoumanis, 2005), but in these cases researchers have generated items for study-specific purposes, as opposed to using a targeted and systematic scale development approach.

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Although there are a lack of competence- and relatedness-support scales, a variety of measures have been used to assess autonomy support (e.g., Health Climate Questionnaire [HCCQ], Williams, Grow, Freedman, Ryan, & Deci, 1996; Learning Climate Questionnaire, [LCQ], Williams Wiener, Markakis, Reeve, & Deci, 1994; Perceived Autonomy Support Scale for Exercise Settings [PASSES], Hagger, Chatzisarantis, Hein, Pihu, Soos & Karsai, 2007). These available measures have guided SDT research in the exercise context, but suffer from two notable limitations. First, these measures primarily identify as autonomy-support measures, but are conflated with competence- and relatedness-support items (e.g., “*they provide me with positive feedback when I do physical activity*”; PASSES, Hagger et al., 2007). Second, these measures have focused on formal ‘provider-recipient’ social agents only (e.g., teachers, coaches). Adolescents’ exercise behaviors are, though, also influenced by other, more informal, relationships (e.g., peers, family; Salvy, de la Haye, Bowker & Hermans, 2012). Hence, extant measures are not readily applicable, nor tested for use, across alternative relationships with differing structures, degree of mutuality, and informality.

In addition to work on autonomy-support, observational studies have contributed to our understanding of what behaviours underpin competence- and relatedness-support. Collectively, this work can be used to inform the design of psychological need-support measures. For example, Haerens et al. (2013) identified a number of PE teachers’ behaviors which students perceived as psychologically need-supportive. Here, asking questions, paying attention to the students’ opinions, and providing choice and opportunities to work independently were identified as autonomy supportive behaviors, whereas emotional support (e.g., being empathic, asking questions), physical support (e.g., physical closeness) and teacher involvement in the lesson (e.g., showing enthusiasm and energy during the lesson) were found to be perceived as supportive of relatedness (Haerens et al., 2013). For structure, both the guidance provided before (e.g., giving clear verbal instructions and a demonstration of activities) and during the lesson (e.g., helping pupils, giving advice and positive feedback) were found to be perceived as supports for competence (Haerens et al., 2013). In accord, this work provides a useful framework of competence- and relatedness-support upon which measures might be developed.

Alongside a conceptual framework, a number of additional considerations are required to guide the development of new psychological need support measures.

Foremost here is the necessity to develop new items that are age, domain, and language appropriate. This is because it cannot be assumed that the modification of existing items validated in populations other than adolescents is appropriate (e.g., adults; HCCQ, Williams et al., 1996). Adolescents are still in the developmental stage of their cognitive, communicative, and social skills (de Leeuw, Borgers & Smits, 2004). Accordingly, using measures that align with adolescents' cognitive, linguistic, and social competence are needed to yield more accurate and reliable data.

3.2.4. Present Research

The purpose of the present work was to develop a new measure of psychological need support in the context of adolescent exercise behavior that is applicable to a number of social agents (i.e., family, friends and PE teachers) and encompasses all three psychological needs (i.e., for autonomy competence and relatedness). We term this measure the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ). Through three studies we developed, confirmed, and tested aspects of construct validity for the APNSEQ in line with the standards presented by the American Educational Research Association (AERA), American Psychological Association (APA), and National Council on Measurement in Education (NCME; 2014). In Study 1, we developed and explored the theoretical content validity of the APNSEQ items in relation to supports for autonomy, competence, or relatedness in liaison with SDT experts. In Study 2, we used categorical confirmatory factor analysis (CFA) to examine the lower and higher order measurement models for the APNSEQ measure (i.e., scale-level assessment), and item response theory (IRT) to examine the performance characteristics of each individual item. In addition to testing the internal validity of the APNSEQ measurement model, we also examined the reliability estimates of the subscale scores and the readability of the scale items. In Study 3, we sought to: (a) confirm the APNSEQ measurement model in an independent sample; (b) test for invariance of the APNSEQ scale responses across gender and social agent; and (c) examine the criterion validity of APNSEQ scores via associations with theoretically relevant SDT constructs (viz., psychological need satisfaction, psychological need frustration, and differing forms of motivation).

3.3. Study 1

In Study 1, our aim was to: (a) develop a pool of items assessing support for autonomy, competence, and relatedness in the context of adolescent exercise from family, friends,

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and PE teachers; and (b) obtain feedback from experts in SDT and adolescent exercise behavior in order to further develop and assess the content validity of the item pool.

3.3.1 Method

3.3.1.1. Participants

Following recommended procedures (Dunn, Bouffard, & Rogers, 1999), an expert panel ($N=7$; 6 male) of academic experts was recruited based upon their theoretical expertise and/or their involvement in adolescent physical activity and exercise research in the context of SDT. The panelists included two key SDT theorists, and five academics currently working with adolescents in a research setting; five members of the panel had previously been involved in scale development and validation. At the time of conducting this work, panel members had worked in academia for 4-40 years ($Mdn=10.00$, $IQR=25.00$) and had between 16 and 363 SDT-related publications in international peer-reviewed journals ($Mdn=65.00$, $IQR=292.00$).

3.3.1.2. Procedure

Prior to commencing the research, ethical approval for Studies 1, 2, and 3 was sought and granted by the authors' institutional ethics committee. To develop the item pool, existing measures of psychological need support (e.g., HCCQ, LCQ, PASSES) were screened and items assigned to their most relevant construct using SDT conceptualizations of autonomy-, competence-, and relatedness-support (Clark & Watson, 1995). Where items did not represent the theoretical breadth of the constructs, additional items were generated based on the findings of observational studies (e.g., Haerens et al., 2013) and the wider SDT literature (e.g., theoretical overviews and review papers). Items were screened for simplicity (i.e., eliminating any overly long or double-barreled items; Clark & Watson, 1995) and alignment with the theoretical definitions of psychological need support (i.e. ensuring each item was accurately categorized according to the SDT conceptualizations). At this stage, theoretically ambiguous items were retained for further analysis. In line with recommendations on assessing item content-relevance (Clark & Watson, 1995; Dunn et al., 1999), the expert panel were provided with a pool of items categorized into autonomy-, competence-, and relatedness-support, and asked to rate each item on a 5-point scale ranging from 1 (*low*)

Table 3.1.

Descriptive Statistics from the Expert Panel Feedback

Item	M Appropriateness (SD)	M Clarity (SD)
Autonomy		
I feel that I am provided with meaningful choices, options and opportunities.	4.71 (.49)	3.43 (1.62)
I feel that they understand why I choose to exercise.	3.29 (1.38)	4.00 (1.00)
I feel that they encourage me to do the exercise activities that I want to do.	4.00 (1.55)	4.67 (.52)
I feel that they listen to me about how I would like to take part in exercise activities.	4.14 (.90)	4.14 (1.21)
I feel that they encourage me to make my own exercise decisions.	4.71 (.49)	4.57 (.79)
I feel that they make sure I understand why it is important for me to exercise.	3.86 (1.46)	4.00 (1.15)
I feel that they carefully answer my exercise-related questions.	3.67 (1.21)	4.83 (.41)
I feel that they are interested in me and the exercise activities I do.	3.57 (1.27)	3.71 (1.50)
I feel that they provide me with the chance to put my own input to the exercise activities I do.	4.57 (.79)	3.86 (1.07)
I feel that they help me to make my own exercise-related decisions.	4.29 (.76)	4.57 (.53)
I feel that they provide options and choices that are important to me.	4.29 (.76)	3.71 (1.38)
I feel that they try to appreciate my point of view.	4.57 (.79)	5.00 (.00)
I feel that they provide me with meaningful reasoning for why I would engage in exercise activities.	4.57 (.79)	3.86 (1.07)
I feel that they really try to understand concerns I have about exercising.	4.14 (1.21)	4.71 (.49)
Competence		
I feel that they provide me with positive feedback when I try to improve my exercise abilities.	4.86 (.38)	4.71 (.49)
I feel that they display confidence in my exercise ability.	4.14 (1.07)	4.29 (.76)
I feel that they help me to improve my exercise abilities	4.57 (.53)	4.29 (.76)
I feel that they make me feel like I am good at exercise.	4.29 (.76)	3.57 (.79)
I feel that they support me in achieving my exercise goals.	4.43 (.98)	4.86 (.38)
They help me to feel like I am able to do challenging exercise activities.	4.57 (.53)	4.43 (.79)

They support me to feel confident in my ability to do well at exercise activities/tasks.	4.71 (.49)	3.57 (1.40)
They help me to feel capable of doing challenging exercise activities/tasks.	4.14 (.90)	4.00 (.58)
They help me to feel competent at doing exercise activities/tasks.	4.71 (.49)	4.29 (.76)
They help me to feel confident in my ability to achieve personal exercise challenges.	4.58 (.53)	3.57 (1.27)
I feel that they help me to fulfil my exercise potential.	3.71 (.95)	3.86 (1.07)
Relatedness		
I feel that they are very supportive of me.	3.86 (.90)	4.29 (.95)
I feel that they encourage me to work on exercise activities with others.	3.00 (1.41)	4.29 (1.11)
I feel that they have respect for me and my exercise engagement.	4.17 (.75)	3.50 (1.38)
I feel that they are interested in me.	4.00 (.58)	4.14 (.90)
I feel that they are friendly towards me.	4.14 (.90)	4.57 (.79)
I feel that they treat me with respect	4.14 (.90)	4.86 (.38)
I feel that they care about me	4.43 (.79)	4.86 (.38)
I feel a sense of being connected with them.	3.86 (1.46)	4.29 (.95)
I feel a sense of trust.	4.17 (.98)	4.83 (.41)
I feel accepted by them	4.57 (.79)	4.86 (.38)
I feel that I am valued by them.	4.43 (.79)	4.57 (.79)
I feel that I can openly talk to them about the exercise activities I want to do	4.29 (.76)	4.29 (.95)
I feel a sense of trust in their exercise-related advice	3.67 (.82)	3.67 (1.03)
They help me to feel important	3.57 (.98)	3.86 (1.07)

to 5 (*high*) for both appropriateness (i.e., “*how appropriate is this item for assessing its target construct in the target population*”) and clarity (i.e., “*how easy or difficult is this item to answer*”). In line with previous scale development papers (e.g., Arnold, Fletcher, & Daniels, 2013), panelists were also invited to make any additional written comments for specific items to justify specific ratings. Items were discarded if the majority of panelists rated them as <3 for appropriateness. Where the majority of the panel rated an item as <3 for clarity, amendments (based on the panels’ supplementary qualitative feedback) were made. By providing the opportunity for both quantitative and qualitative assessment, we obtained rich and specific information on the reasons and suggestions for improving each item’s rating (Dunn et al., 1999; Haynes, Richard, & Kubany, 1995).

3.3.2. Results and Discussion

Thirty-nine items were initially extracted through the screening process and included in the item pool for circulation to the expert panel. In line with the panelists’ feedback (see Table 3.1), five items were removed from the pool (four due to issues of appropriateness and one due to duplication) and seven items were modified based on qualitative suggestions. The resultant item pool consisted of 34 items assessing the range of psychological need support characteristics, spanning autonomy-support (13 items), competence-support (10 items), and relatedness-support (11 items), in the adolescent exercise context. This pool of items formed the basis for Study 2.

3.4. Study 2

In Study 2, we aimed to: (a) create a parsimonious, balanced, and theoretically encompassing measure of psychological need support through categorical CFA, IRT parameters, and graphics; and (b) assess the factorial structure (i.e., structural validity) of a measure tapping psychological need support.

3.4.1. Method

3.4.1.1. Participants

A sample of adolescents ($N=433$, 211 male) aged 12-15 years ($M=13.74$, $SD=.76$) were recruited through two schools in the south west of England. The inclusion criteria were; (a) to be enrolled in full time education and; (b) to have a good comprehension of English. Ninety-one percent of the sample were white, 4% Asian, 2% mixed race, 1% Chinese, 1% black, and 1% other.

3.4.1.2. Measures

Psychological need support. Participants were provided with the remaining 34 items from Study 1, preceded by the stem “In my interactions with my [either; family, friends, or PE teacher] regarding exercise...”. The questionnaire was completed three times, each time referring to a different social agent. Participants were instructed to interpret exercise as ‘any activity that you consider to be exercise’ and asked to respond using a 7-point Likert scale from 1 (*strongly disagree*) through 4 (*neither agree nor disagree*) to 7 (*strongly agree*).

3.4.1.3. Procedure

Schools were invited to take part in the study via telephone and email. The purpose and nature of the study was explained, and consent sought from senior members of staff in line with British Psychological Society guidelines (2014). Following this, information letters were sent out to parents via school email systems, providing them the opportunity to opt their child out of participating in the study. Informed assent was obtained from students who had not been opted out and who wished to participate. Questionnaires were completed in silence during a normal school day with a researcher present in order to answer any questions about the questionnaire. To ensure consistency and good practice, we did not re-interpret any of the questions to the students raising queries, but did provide definitions of words if required (cf. Katzmarzyk et al., 2013). Questionnaires were completed anonymously and posted into a box once completed to maintain anonymity.

3.4.1.4. Data Analysis

Data were screened based on the recommendations of Tabachnick and Fidell (2014). Five items (items 6, 14, 20, 23, and 25) were removed prior to the CFA analysis due to high proportions of missing data (>5% missing in reference to at least 2 social agents), thus suggesting that these were ambiguous items. The low number of remaining missing responses were replaced using within person median substitution.

The aims of Study 2 were addressed via a 4-step approach. In step 1, CFA were carried out using *Mplus 7.3* (Muthén & Muthén, 1998-2015). In view of both the deviations from normality and the ordinal categorical nature of the data, we used polychoric correlation matrices and robust weighted least squares estimation (WLSMV; Flora & P.J. Curran, 2004; McIntosh, 2007; Rhemtulla, Brosseau-Liard, & Savalei, 2012). The Satorra-Bentler χ^2 test statistic (Satorra & Bentler, 1994) was used

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as an indicator of model fit, yet this test is sensitive to sample size and over powered (i.e., falsely identifying ill-fitting models with large data sets; Brown, 2006; Cheung & Rensvold, 2002). Thus, several indices of fit were also used (Brown, 2006; Kline, 2005): (a) the scale corrected comparative fit index (CFI); (b) the Tucker Lewis Index (TLI); (c) weighted root mean square residual (WRMR); and (d) root mean square error of approximation (RMSEA). The thresholds used were $\geq .90$ for acceptable fit and $\geq .95$ for excellent fit with regards to the CFI and TLI (Hu & Bentler, 1999), < 1 for the WRMR (Yu, 2002), and close to (or less than) $.10$ for the RMSEA (Schermelleh-Engel, Moosbrugger, & Müller, 2003).

In step 2, the item pool was refined using a combination of methods. Standardized regression weights were transformed into IRT slope parameters using the guidelines provided by Wirth and Edwards (2007). The standardized regression weights, IRT slope parameters, and item characteristic curves (see supplementary material) were used to refine the item pool by identifying the strongest and most discriminating items (i.e., larger regression weights and slope parameters) for measuring autonomy-, competence-, and relatedness-support (Reeve & Fayers, 2005). The integration of CFA and IRT has been beneficial to a number of previous scale developments (e.g., Glockner-Rist & Hoijsink, 2003; Waller, Ostini, Marlow, McCaffery, & Zimet, 2013). IRT is particularly useful in the development and refinement stages of scale development as it is not dependent on the characteristics of the sample (Petscher & Schatschneider, 2012), and therefore the strength of the scale created should be consistent in the population. The theoretical content of each item was also considered (i.e., being mindful of the feedback from the original expert panel) and, if there was any theoretical redundancy due to a degree of duplication in item content, then the stronger item (i.e., with the higher slope parameter) was retained.

In step 3, CFA was used to test the final measurement tool using the same model fit criteria as used in step 1. Finally, in step 4 the tenability of the measure was tested by comparing a 1-factor model with the proposed 3-factor structure. Such an approach assesses whether the items best predict three separate latent variables (i.e., autonomy-, competence-, and relatedness-support) or one overall latent variable (i.e., psychological need support). Ordinal composite reliability scores (Raykov, 1997) were also calculated using information from the CFA to assess the internal consistency of the subscales

Table 3.2.

Median and Frequency of Responses for the 29-items

Item	Family								Friends								PE teacher							
	\tilde{x}	1	2	3	4	5	6	7	\tilde{x}	1	2	3	4	5	6	7	\tilde{x}	1	2	3	4	5	6	7
Autonomy																								
1	6	.7	.5	1.4	12.1	.2	18.0	25.6	6	2.2	1.5	3.7	19.4	15.2	20.6	37.3	6	4.8	1.3	3.7	21.9	12.0	17.9	38.2
4	6	.5	.7	2.1	8.8	14.2	26.1	47.6	6	2.5	.7	4.7	21.4	17.9	24.6	28.1	6	3.2	1.9	4.8	16.6	15.8	22.5	35.3
7	6	.7	1.4	2.1	13.7	18.0	27.7	36.2	6	2.7	1.5	3.7	22.1	18.2	23.4	28.4	6	4.0	1.6	4.0	20.9	16.8	24.7	27.8
10	6	.5	1.2	1.7	13.7	13.3	26.8	42.9	6	2.0	1.7	3.2	19.9	14.9	23.1	35.1	6	2.7	1.9	4.8	19.8	17.6	23.3	29.9
13	6	.5	.7	2.1	13.3	14.5	24.9	44.1	6	2.7	1.2	5.0	24.4	12.9	26.6	27.1	6	2.9	.5	3.2	17.6	11.8	25.1	38.8
16	6	2.1	1.9	5.5	18.7	17.5	25.8	28.4	5	3.7	4.5	5.5	25.9	16.7	20.4	23.4	6	3.7	.8	4.0	17.4	18.2	26.2	29.7
19	6	.9	2.1	1.7	10.7	18.0	28.2	38.4	6	2.7	2.0	4.5	21.1	17.7	25.4	26.6	5	4.5	1.9	5.6	23.5	17.4	22.7	24.3
22	6	.9	1.2	1.4	12.6	14.5	28.2	41.2	6	1.5	1.7	2.0	22.4	16.2	22.6	33.6	5	3.2	2.1	4.8	22.5	19.0	19.8	28.6
28	6	.7	.5	2.8	11.1	15.2	34.1	35.5	6	1.7	.5	3.5	25.6	17.7	23.4	27.6	6	3.5	2.4	5.3	19.8	16.8	25.1	27.0
31	6	1.9	.7	3.1	11.8	11.8	27.3	43.4	6	1.2	1.5	2.0	15.2	16.9	30.1	33.1	6	4.8	2.4	5.3	17.1	19.0	27.8	23.5
33	6	1.4	1.4	2.6	12.1	14.9	29.6	37.9	5	2.2	1.2	3.0	26.4	20.4	19.9	26.8	6	4.0	2.1	4.5	19.5	17.6	24.6	27.5
34	6	2.6	.9	2.6	14.7	18.0	29.1	32.0	5	3.7	2.5	4.7	24.6	20.4	19.7	24.4	5	4.8	3.2	5.3	24.6	15.2	21.9	24.9
Competence																								
2	6	.2	1.9	2.8	15.6	19.0	23.4	37.0	6	3.5	1.7	5.2	21.1	15.9	23.9	28.6	6	4.0	1.3	3.7	14.7	15.5	25.9	34.8
5	6	.5	.7	3.3	15.2	18.7	27.5	34.1	6	2.2	1.7	5.0	21.1	17.2	23.1	29.6	6	3.7	1.9	5.1	19.5	18.2	21.1	30.5
8	6	1.4	2.1	3.8	16.6	18.7	25.8	31.5	5	2.7	1.7	5.2	21.1	19.9	23.6	25.6	6	3.2	.8	2.9	16.6	15.5	25.1	35.8
11	6	1.9	1.4	4.3	16.8	13.3	25.8	36.5	6	3.5	1.0	5.0	18.4	13.2	23.8	35.1	6	4.5	3.5	3.7	18.7	18.2	22.7	28.6
17	6	.7	1.7	3.1	17.5	15.2	28.0	33.8	6	2.2	1.7	4.2	20.4	18.7	25.3	27.4	6	3.2	1.6	4.8	18.2	17.1	26.2	28.9
26	6	.7	1.7	2.1	14.5	16.9	29.9	35.3	6	1.2	2.0	2.2	21.3	20.4	24.9	27.9	6	3.2	2.7	6.4	19.8	15.5	27.8	24.6
29	6	.2	1.4	3.1	14.2	16.4	28.9	35.8	6	2.0	1.5	3.2	22.9	19.7	24.9	25.9	6	3.5	1.6	4.8	18.2	18.4	25.4	28.1

Cont...

Relatedness																								
3	6	.5	2.1	3.3	14.0	15.4	28.6	36.0	5	3.7	1.7	4.7	20.9	19.7	22.1	27.1	6	2.9	1.1	3.5	17.6	13.9	21.4	39.6
9	7	1.2	.7	1.4	6.2	10.7	19.7	60.2	7	.7	.5	2.7	8.7	10.4	18.7	58.2	6	4.3	.8	2.9	14.7	15.8	27.5	24.0
12	7	.9	1.2	2.6	9.0	12.1	18.5	55.7	6	2.2	2.2	2.0	11.9	12.4	21.1	48.0	6	3.5	.8	5.9	16.6	14.2	24.6	34.5
15	7	1.9	.2	2.4	5.7	6.2	14.0	69.6	6	1.0	.5	2.2	12.7	13.7	21.6	48.2	6	3.5	2.9	4.3	22.5	14.7	24.1	28.1
18	7	1.9	1.9	1.2	13.7	10.7	25.6	45.0	6	1.0	1.5	3.5	15.2	14.7	25.1	39.1	5	7.2	2.1	5.9	24.9	18.2	18.4	23.3
21	7	1.4	1.7	1.9	9.2	11.1	19.9	54.7	6	1.0	1.0	3.5	12.4	10.9	24.6	46.5	6	4.3	.2	5.9	21.9	17.4	23.3	27.0
24	7	.9	.7	1.9	8.5	8.8	19.4	59.7	6	1.5	1.7	2.7	11.7	11.4	20.9	50.0	5	4.8	2.4	7.2	19.0	16.8	20.6	29.1
27	7	.7	1.2	2.8	7.1	9.5	20.9	57.8	6	1.5	1.5	3.0	14.9	14.2	23.1	41.7	5	5.3	2.9	6.4	23.7	14.7	24.3	22.7
30	7	1.4	1.7	2.8	11.6	12.3	24.6	45.5	6	2.0	2.5	2.7	19.4	15.9	23.6	33.8	5	4.5	3.2	5.6	19.0	17.4	24.1	26.2
32	7	.9	2.1	1.9	10.2	12.8	21.8	50.2	6	1.5	1.0	1.7	16.2	18.2	24.9	36.6	5	5.3	3.5	6.7	21.7	16.3	21.4	25.1

Note. \bar{x} = median, N= 422

Table 3.3.

Model Fit Indices for all Models Tested in Study 2

	χ^2	df	CFI	TLI	WRMR	RMSEA (CI 90%)
29 Item, 3-factor model						
Family	1461.03	374	.97	.96	1.36	.08 (.08, .09)
Friends	2499.10	374	.94	.93	1.91	.12 (.11, .12)
PE teacher	2175.20	374	.97	.97	1.93	.11 (.11, .12)
9 Item, 3-factor model						
Family	85.70	24	.99	.99	.65	.08 (.06, .10)
Friends	88.55	24	.99	.99	.58	.08 (.06, .10)
PE teacher	187.99	24	.99	.99	.78	.14 (.12, .15)
9 Item, 1-factor model						
Family	424.36	27	.91	.95	1.72	.19 (.17, .20)
Friends	486.39	27	.95	.93	1.82	.21 (.19, .22)
PE teacher	375.99	27	.98	.97	1.40	.19 (.17, .20)

Note. All χ^2 values apart from the 9-item, 1-factor model with respect to friends are significant; $p < .001$. CFI= Comparative fit index, TLI= Tucker-Lewis index. WRMR= weighted root mean residual, RMSEA=root mean square error of approximation

and readability of the scale was tested using the Flesch reading ease and Flesch-Kincaid grade (Flesch, 1948).

3.4.2. Results

3.4.2.1. Descriptive Data

Median values and frequency distribution are presented in Table 3.2. Across all social agents, responses were negatively skewed and thus departed from normality. Thus, to address the nature and distribution of these data, polychoric correlation matrices and robust weighted least squares estimation were used in the CFA's.

3.4.2.2. Model Testing

Results of the categorical CFA's showed the 29-item, 3-factor model to provide an acceptable fit to the data. The results nonetheless indicated that there was room for improvement in fit (Table 3.3). Therefore, the item pool was refined using CFA and IRT. Supplementary Figures S3.1- S3.3 show the IRT distributions for all items in the scale (see appendix 3). Regression weights, slope parameters, and standard errors derived from the IRT analysis suggested a final 9-item, 3-factor solution to the data (i.e., 3 items loading onto each psychological need support latent factor). These items are shown in Table 3.4. The final model was based on these analyses and the theoretical tenets within SDT that underpin autonomy-, competence-, and relatedness-support. This 9-item, 3-factor model was shown to have acceptable fit to the data for all three social agents (Table 3.3).²

3.4.2.3. One factor model, reliability and readability

In order to further test the proposed 3-factor solution, the data were tested with a 1-factor model. The model fit statistics for the 1-factor model showed poorer fit to the data when compared to the 3-factor solution (Table 2.3). Ordinal composite reliability analysis showed the data generated for the three subscales of autonomy-, competence-, and relatedness-support display good levels of internal consistency and high inter-factor covariances (Table 3.5). The Flesch reading ease level (73.4) and the Flesch-Kincaid grade level (5.7) for the whole scale showed it to be of a suitable reading level for adolescents (Hensel, 2014).

3.4.3. Brief Discussion

In Study 2, we refined a new measure of adolescents' perceptions of psychological need support in the exercise context. With the use of CFA and IRT, 9 strongly performing items were identified that have face validity to cover the breadth

Table 3.4.

Standardized Estimates and Standard Errors for the 9-item APNSEQ

Item	Family			Friends			PE teacher		
	B	S.E	a	B	S.E	a	β	S.E	a
Autonomy									
1 I feel that they understand why I choose to exercise	.70	.03	.98	.76	.02	1.17	.83	.02	1.49
4 I feel that they encourage me to do the exercise activities that I want to do	.79	.02	1.29	.85	.01	1.61	.90	.01	2.06
7 I feel that they listen to me about how I would like to take part in exercise activities	.81	.02	1.38	.82	.02	1.43	.87	.01	1.76
Competence									
5 They display confidence in my exercise ability	.76	.02	1.17	.83	.02	1.49	.88	.01	1.85
8 They help me improve my exercise abilities	.81	.02	1.38	.83	.02	1.49	.87	.01	1.76
17 They help me to feel like I am able to do challenging exercise activities	.86	.01	1.69	.88	.01	1.85	.90	.01	2.06
Relatedness									
15 I feel that they care about me	.84	.02	1.55	.88	.01	1.85	.90	.01	2.06
24 I feel accepted by them	.91	.01	2.19	.86	.02	1.69	.90	.01	2.06
27 I feel that I am valued by them	.90	.01	2.06	.88	.01	1.85	.88	.01	1.85

Note. All regression weights are significant at the $p < .001$ level. β = Standardized regression weight, SE= Standard error, a= slope parameter.

Table 3.5.

Factor Covariances and Internal Consistency Estimates for the 9-item APNSEQ

	Family			Friends			PE teacher		
	Autonomy	Competence	Relatedness	Autonomy	Competence	Relatedness	Autonomy	Competence	Relatedness
Autonomy	<i>.70</i>			<i>.77</i>			<i>.72</i>		
Competence	.94	<i>.72</i>		.99	<i>.70</i>		.98	<i>.76</i>	
Relatedness	.80	.74	<i>.82</i>	.80	.79	<i>.79</i>	.87	.91	<i>.80</i>

Note. All factor covariances are statistically significant at the $p < .001$ level. Composite reliability (ρ) scores are presented in bold and italics on the diagonal of the factor correlations table.

of each psychological need support facet outlined within SDT (3 items for autonomy-, competence- and relatedness-support). The results of the subsequent analysis showed the 9-item, 3-factor model to have acceptable fit to the data whereas the 9-item, 1-factor model showed poor fit. The 9-item scale was also shown to be reliable and at an appropriate reading level for an adolescent population.

3.5. Study 3

Using an independent sample, in Study 3 we sought to: (a) cross-validate the 3-factor model supported in Study 2; (b) assess the invariance of the APNSEQ scale scores across gender and social agent; and (c) provide initial support for the criterion validity of the APNSEQ through correlational analysis with psychological need satisfaction, psychological need frustration, and behavioral regulations for exercise.

3.5.1. Method

3.5.1.1. Participants

A separate sample of adolescents ($N= 373$; 187 males) aged 11-15 years ($M= 13.91$, $SD= 1.22$) were recruited using the protocol outlined in Study 2. Ninety-six percent of the sample were white, 2% mixed race, 1% Asian, 0.5% black, 0.5% Chinese, and 1% other.

3.5.1.2. Measures

Psychological need support. Perceptions of psychological need support (viz., for autonomy, competence, and relatedness) were measured through the 9-item APNSEQ.

Psychological need satisfaction and frustration. Participants' perceptions of satisfaction and frustration of the basic psychological needs for autonomy, competence, and relatedness were assessed through an amended version of the Basic Psychological Need Scale (Chen et al., 2015). The original 24-item, 6-factor scale has been validated in multicultural samples of adolescents (Chen et al., 2015). In the present study, the stem used was 'When I exercise...' and minor amendments were made to some items to ensure that responses were in relation to the exercise context (e.g. replacing 'things' with 'exercise'). Items referred to need satisfaction (e.g. '...I feel I have been doing exercise that really interests me') and need frustration (e.g. '...I feel like a failure because of the mistakes that I make'). Participants responded using a 7-point Likert scale ranging from 1 (*strongly disagree*) through 4 (*neither agree nor disagree*) to 7 (*strongly agree*).

Behavioral regulation in exercise. Motivation towards exercise was assessed using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004). This 19-item scale measures the behavioral regulations of intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation. Participants responded on a 5-point Likert scale ranging from 0 (*not true for me*) through 2 (*sometimes true for me*) to 4 (*very true for me*). Responses to the scale have previously demonstrated acceptable psychometric properties in adolescent samples (e.g., Gillison, Standage, & Skevington, 2006; Standage et al., 2012).

3.5.1.3. Data Analysis

Normality was tested using the procedures outlined in Study 2. First, due to deviations from normality and ordinal categorical nature of the data, CFAs to test both the 3-factor and 1-factor solution were conducted using polychoric correlation matrices and WLSMV estimation. Second, a sequential model testing approach was employed using multi-sample categorical CFA to examine whether the APNSEQ displayed invariance across gender and social agent. A change in CFI of $\leq .01$ between more constrained models was considered necessary to support invariance (Cheung & Rensvold, 2002).

Third, bivariate correlation coefficients were calculated to explore the associations between the psychological need support variables and psychological need satisfaction, psychological need frustration and behavioral regulations for each social agent. Cohen's (1992) thresholds were used to distinguish between small ($>.20$), moderate ($>.40$) and large ($>.70$) correlations. For the purpose of this analysis, average scores for each subscale were used and therefore classical correction (i.e., accounting for the internal reliability of each scale) was used to account for measurement attenuation (Charles, 2005).

3.5.2. Results

3.5.2.1. CFA and invariance testing

Descriptive data and internal consistency values are shown in Table 3.6. Results of the multi-sample CFA showed the 3-factor model to provide excellent fit to the data for family and acceptable fit for friends and PE teacher: Family $\chi^2_{(24)}=93.12, p<0.001$; CFI= .99; TLI= .99; WRMR= .62; RMSEA= .08, CI [.07 to .10]; Friends $\chi^2_{(24)} = 116.49, p<0.001$; CFI= .99; TLI= .99; WRMR= .75; RMSEA= .09, CI [.08 to .11]; and

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Table 3.6.

Descriptive Statistics of Study 3 Variables

	Range	<i>M</i>	<i>SD</i>	95% CI	<i>α</i>
Autonomy support					
Family	1-7	5.72	1.24	[5.60, 5.85]	.82
Friends	1-7	4.83	1.39	[4.69, 4.98]	.77
PE teacher	1-7	5.65	1.26	[5.52, 5.78]	.81
Competence support					
Family	1-7	5.79	1.21	[5.66, 5.91]	.85
Friends	1-7	5.01	1.38	[4.87, 5.15]	.82
PE teacher	1-7	5.58	1.34	[5.44, 5.71]	.89
Relatedness support					
Family	1-7	6.23	1.25	[6.10, 6.36]	.92
Friends	1-7	5.92	1.25	[5.80, 6.05]	.88
PE teacher	1-7	5.19	1.56	[5.03, 5.35]	.93
Autonomy satisfaction	1-7	5.18	1.24	[5.05, 5.30]	.68
Competence satisfaction	1-7	5.43	1.27	[5.30, 5.56]	.78
Relatedness satisfaction	1-7	5.52	1.20	[5.39, 5.64]	.74
Autonomy frustration	1-7	2.97	1.50	[2.81, 3.11]	.78
Competence frustration	1-7	2.71	1.49	[2.56, 2.86]	.82
Relatedness frustration	1-7	2.70	1.48	[2.54, 2.84]	.77
Intrinsic motivation	0-4	2.82	1.01	[2.73, 2.93]	.83
Identified regulation	0-4	3.00	.97	[2.90, 3.10]	.80
Introjected regulation	0-4	1.45	1.00	[1.35, 1.55]	.72
External regulation	0-4	.94	.89	[.85, 1.03]	.76
Amotivation	0-4	.65	.93	[.56, .75]	.85

Note. α = Cronbach alpha.

Table 3.7.

Invariance Analyses of APNSEQ Scales across Gender and Social Agent

		χ^2	df	CFI	TLI	WRMR	RMSEA (CI 90%)
Gender							
Family	Configural (no constraints)	143.44	48	.99	.99	.86	.09 (.08, .12)
	Metric (factor loadings are equal)	127.93	54	.99	.99	.87	.08 (.06, .10)
	Scalar (factor loadings and intercepts are equal)	149.69	96	1.00	1.00	.98	.05 (.04, .07)
Friends	Configural (no constraints)	180.12	48	.99	.98	.94	.12 (.10, .13)
	Metric (factor loadings are equal)	186.49	54	.98	.98	1.02	.11 (.09, .13)
	Scalar (factor loadings and intercepts are equal)	263.20	96	.98	.99	1.35	.09 (.08, .10)
PE teacher	Configural (no constraints)	273.80	48	.99	.98	1.07	.15 (.13, .17)
	Metric (factor loadings are equal)	269.60	54	.99	.98	1.07	.14 (.12, .16)
	Scalar (factor loadings and intercepts are equal)	258.11	96	.99	.99	1.22	.09 (.08, .10)
Social Agent							
	Configural (no constraints)	403.52	72	.99	.98	1.31	.11 (.10, .12)
	Metric (factor loadings are equal)	404.26	84	.99	.98	1.31	.11 (.10, .12)
	Scalar (factor loadings and intercepts are equal)	458.83	168	.99	.99	1.71	.07 (.06, .07)

Note. All χ^2 values are significant at the $p < .001$ level. CFI= Comparative fit index, TLI= Tucker-Lewis index. WRMR= weighted root mean residual, RMSEA=root mean square error of approximation

PE teacher $\chi^2_{(24)} = 206.85, p < 0.001$; CFI = .99; TLI = .98; WRMR = .88, RMSEA = .14, CI [.12 to .15]. The 1-factor model provided poorer fit to the data for all three social agents: Family $\chi^2_{(28)} = 305.33, p = .02$; CFI = .97; TLI = .96; WRMR = 1.77; RMSEA = .16, CI [.14 to .17]; Friends $\chi^2_{(28)} = 558.92, p = .02$; CFI = .94; TLI = .92; WRMR = 2.59; RMSEA = .21, CI [.20 to .23]; and PE teacher $\chi^2_{(28)} = 356.19, p = .48$; CFI = .98; TLI = .97; WRMR = 1.97, RMSEA = .17, CI [.15 to .18]. Results of invariance testing provided initial support for the equivalence of the 3-factor model across gender and social agent (Table 3.7).

3.5.2.2. Criterion Validity

As shown in Table 3.8, significant and primarily moderate positive relationships were observed between the APNSEQ psychological need support scales and both psychological need satisfaction and autonomous forms of motivation. Significant, albeit weaker, negative relationships were found between the psychological need-support scales and the psychological need frustration and controlled forms of motivation variables. There were no significant associations between the perceived psychological need support variables and introjected regulation.

Perceived autonomy-support consistently correlated most strongly with autonomy-satisfaction across social agents. Perceived relatedness-support from family and friends had the strongest association with relatedness-satisfaction, however perceived relatedness-support from PE teacher showed a similar association with autonomy-satisfaction. Perceived competence-support from a PE teacher correlated most strongly with competence-satisfaction, however perceived competence-support from family and friends showed similar associations with relatedness-satisfaction.

3.5.3. Brief Discussion

In Study 3, we tested and reaffirmed the internal validity of the APNSEQ measurement model. Subsequent analysis showed the APNSEQ to provide a well-fitting model to the data, which was reliable and invariant across gender and social agent. Criterion validity of the APNSEQ scales were supported in relation to the broader SDT framework, with correlations supporting a nomological network of associations. Such findings provide initial support for the utility of the APNSEQ scores to assess autonomy-, competence-, and relatedness-support.

Table 3.8.

Bivariate Correlations among the APNSEQ Scales and Need Satisfaction, Need Frustration, and Exercise Behavioral Regulation corrected for measurement attenuation

	Family			Friends			PE teacher		
	Autonomy support	Competence support	Relatedness support	Autonomy support	Competence support	Relatedness support	Autonomy support	Competence support	Relatedness support
Family									
Autonomy support	-	.78**	.73**	.47**	.54**	.51**	.42**	.43**	.41**
Competence support	.78**	-	.84**	.44**	.54**	.53**	.52**	.54**	.48**
Relatedness support	.73**	.84**	-	.37**	.53**	.53**	.42**	.44**	.38**
Friends									
Autonomy support	.47**	.44**	.37**	-	.64**	.51**	.38**	.44**	.46**
Competence support	.54**	.54**	.53**	.64**	-	.77**	.38**	.42**	.37**
Relatedness support	.51**	.53**	.53**	.51**	.77**	-	.30**	.35**	.31**
PE teacher									
Autonomy support	.42**	.52**	.42**	.38**	.38**	.30**	-	.84**	.73**
Competence support	.43**	.54**	.44**	.44**	.42**	.35**	.84**	-	.88**
Relatedness support	.41**	.48**	.38**	.46**	.37**	.31**	.73**	.88**	-
Autonomy satisfaction	.63**	.63**	.58**	.53**	.47**	.35**	.57**	.62**	.57**

Cont...

Competence satisfaction	.54**	.60**	.55**	.48**	.53**	.36**	.53**	.58**	.53**
Relatedness satisfaction	.59**	.63**	.62**	.50**	.60**	.53**	.53**	.55**	.47**
Autonomy frustration	-.36**	-.36**	-.42**	-.21**	-.43**	-.32**	-.20**	-.28**	-.15**
Competence frustration	-.44**	-.42**	-.42**	-.26**	-.43**	-.39**	-.21**	-.28**	-.14**
Relatedness frustration	-.30**	-.33**	-.39**	-.18**	-.42**	-.39**	-.16**	-.28**	-.13*
Intrinsic motivation	.53**	.54**	.46**	.33**	.38**	.26**	.45**	.44**	.41**
Identified regulation	.48**	.51**	.48**	.27**	.36**	.23**	.35**	.38**	.36**
Introjected regulation	.00	-.04	-.07	-.07	-.01	-.06	.03	-.00	.00
External regulation	-.32**	-.36**	-.37**	-.20**	-.30**	-.29**	-.22**	-.19**	-.20**
Amotivation	-.38**	-.41**	-.36**	-.23**	-.34**	-.28**	-.30**	-.26**	-.24**

Note: **correlation is significant at the 0.01 level (one-tailed), * correlation is significant at the 0.05 level (1-tailed)

3.6. General Discussion

Across a series of studies, we developed and psychometrically evaluated scores from a new measure (APNSEQ) designed to assess adolescents' perceptions of psychological need support from family, friends, and PE teachers. Collectively, the findings provided initial support for the factorial structure, reliability, and criterion validity of the APNSEQ.

In Study 1, an item pool that had been formulated based on the extant SDT literature was refined based on appropriateness and clarity by a panel of experts. Good practice recommendations were employed for both item development (Clark & Watson, 1995) and expert panel procedures (Dunn et al., 1999). Although there was generally consensus amongst the panel members regarding how appropriate each item was, there were a few minor discrepancies with regards to clarity, perhaps due to differences in their personal research experiences (i.e., theorists versus applied researchers). In such instances, the qualitative written feedback provided by the panelists was informative of how we could refine items to improve clarity and/or theoretical alignment. Thus, the refinements to items yielded a conceptually coherent item pool for the subsequent studies.

In Study 2, and via categorical CFA and IRT analyses, we developed a 9-item measure that is efficient, highly discriminating, and represents the breadth of the psychological need support construct outlined within SDT (i.e., at a scale level via CFA and at the item level through IRT). Although a single factor model approached reasonable fit, the hypothesized 9-item 3-factor model provided better fit to the data. Three points are worthy of note. First, a degree of model misspecification was evident for responses to the relatedness-support items when targeting the PE teacher. Relatedness-support is likely to hold different interpretational connotations across interpersonal relationships differing in the degree of formality (formal vs. informal) and structure (e.g., in this case recipient-provider or hierarchal for PE teacher vs. mutual for family and peers). Future research into such issues seems warranted. Second, while the CFI, TLI, and WRMR values yielded strong support for the APNSEQ measurement model, the RMSEA values for some models were marginally higher than suggested criteria. Here, the models with higher RMSEA values were those with the lowest *df*. This is not especially surprising since the RMSEA is calculated using the ratio of the model χ^2 to its *df* and, thus, penalizes for complexity (i.e., larger model *df* leads to better

fit; Kenny, Kaniskan, & McCoach, 2014). The other fit index that penalizes for complexity is the TLI and we note that all values were acceptable in the present study. Likewise, model fit cannot be solely based on the interpretation of one fit statistic alone (Hu & Bentler, 1995). Rather, judgments should be based on an overall assessment of different fit indices and model parameters, and this is the approach we have taken in the current set of studies.

In Study 3, responses from an independent sample of adolescents confirmed the reliability and internal validity of the 3-factor 9-item measurement model. Again, the 3-factor model provided better fit to the data compared to the alternative single factor model, illustrating that basic psychological need support is multifaceted and best interpreted and measured through three distinct, yet highly related, constructs. A similar pattern has been found with regards to psychological need thwarting (Bartholomew et al., 2011). Extending these associations to the social context level, such findings align with the tenets within SDT, which hold that the three psychological needs are considered to be “basic”, interdependent and operate synergistically (see Ryan & Deci, in press).

Researchers often seek to investigate hypothesized differences between groups (e.g., gender differences), as well as attempt to understand the effects of differing social agents on motivation and engagement. For comparisons and interpretations to be meaningful, it is assumed that measurement tools are equivalent across various samples (Milfont & Fischer, 2010). In Study 3, the factorial invariance of the APNSEQ scores were tested and supported across gender and social agent. Such findings suggest that responses to the APNSEQ allow for meaningful comparison between genders, as well as providing a means to assess and compare psychological need support from different social agents (i.e., family, friends and PE teachers).

Moderate positive correlations between the three subscales of the APNSEQ, psychological need satisfaction, and more autonomous types of motivation (i.e., intrinsic motivation and identified regulation) provided support for criterion validity and the nomological network outlined within SDT. In prior studies using pre-existing measures, perceived autonomy-support has been shown to have small to moderate significant associations with autonomous motivation and psychological need satisfaction and negative relationships with external regulation (e.g., Curran, Hill, & Niemiec, 2014; Chatzisarantis, Hagger, Kamarova, & Kawabata, 2012; Standage et al., 2012). In this work, responses to the APNSEQ showed similar relationships, yet this

study extended on the extant literature to show that perceived competence- and relatedness- support also have significant relationships with psychological need satisfaction, psychological need frustration, and motivation variables in a manner highly consistent with the theoretical tenets within SDT. Although the associations between the psychological need support variables and behavioral regulations generally conformed to a gradient based on relative autonomy (i.e., psychological need support variables being positively correlated with more autonomous forms of motivation and negatively associated with external regulation and amotivation), no relationship was found between the psychological need support variables and introjected regulation. As introjection manifests as compulsive and rigid engagement to service internal contingencies, a lack of a relationship with psychological need supports provided by others does not depart from the tenets within SDT. Rather, it would be expected that psychologically need thwarting contexts would be positively related to introjected regulation, as such environments would attune to internal sanctions. Further research on this issue, though, is warranted.

3.6.1. Limitations and Future Directions

The present research is limited by the cross-sectional design. Although justified for the development and validation of a measure, future research would do well to: (a) overcome issues such as common-method variance by validating against objectively assessed exercise and sedentary behaviors; and (b) employ the APNSEQ across a diverse range of methodologies (e.g., ecological momentary analysis, longitudinal, and experimental) that better capture the dynamic and complex interplay among motivation-related constructs and health and well-being outcomes (cf. Standge & Ryan, 2012).

The APNSEQ was developed in conjunction with theoretical and academic experts, yet not with adolescents and their significant social others (e.g., family, friends, and PE teachers). Although some of the questionnaires from which the initial item pool was drawn had been developed and/or validated with adolescent populations (e.g., PASSES; Hagger et al., 2007), consulting a sample of adolescents and social agents during development stage would have provided insightful sources of information pertaining to item comprehension, relevance, and interpretation. As this is the first presentation of the APNSEQ measure, any future iteration to the measure could refine the instrument via user engagement and feedback.

Commensurate with an increased application of Bayesian estimation methods within the sport and exercise psychology literature (e.g., Gucciardi, Zhang, Ponnusamy, Si, & Stenling, 2016; Tamminen, Gaudreau, McEwen, & Crocker, in press; Stenling, Ivarsson, Johnson, & Lindwall, 2015), future work would do well to also test the psychometric properties of the APNSEQ using the Bayes' theorem. Data from the several samples presented in this paper provide initial and useful data to inform the prior distribution of the model parameters in such work. Researchers could also compare APNSEQ responses via the WLSMV approach, as used in this work, with the Bayesian method across factors such as sample size, normality, model misspecification, culture, gender, and age (see Liang & Yang, 2014).

Although the stem of the APNSEQ explicitly prompts respondents to have their exercise-related discussions in mind, the relatedness-support items do not explicitly refer to the exercise context to reinforce this, while the autonomy and competence items are contextually targeted. Yet, the associations among the relatedness items and other SDT constructs were of a similar magnitude to the autonomy- and competence-support scales, and thus it appears that this was sufficient to direct respondents to answers that were specific to the exercise context (proximal) as opposed to life more generally (distal).

3.6.2. Conclusion

In sum, within this paper we present three studies that outline the systematic development of a psychometrically sound measure of adolescent perceptions of psychological need support in the exercise context. Akin with the tenets within SDT, the APNSEQ encompasses the breadth of psychological need support (viz., supports for autonomy, competence and relatedness) and assesses need support from family, friends and PE teachers. Aspects of construct validity, reliability, and readability of the measure support the instrument as a valid and reliable tool. We hope that this measure will play a role in encouraging researchers to examine social contexts from a multi-faceted (i.e., psychological need support) and multi-social agent approach.

3.7. Footnotes

1. The term physical activity encompasses all movement produced by skeletal muscles that confer energy expenditure above rest. The term *exercise* is often used interchangeably with *physical activity*. Within this paper, we discuss *exercise* as a sub-component of physical activity that is more ‘*a subcategory of physical activity that is planned, structured, repetitive and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective*’ (World Health Organisation, 2010, p.52.). In considering exercise as a type of physical activity that is planned, structured, repetitive, and purposeful it appropriately delineates *exercise* from *physical activities of daily living* and captures exercise as a behavioural enactment that is sufficiently purposeful to require cognitive processes pertaining to the psychology of motivation (Standage & Ryan, 2012).
2. It should be noted that in the PE teacher model, the factor covariance between autonomy and competence exceeded 1 (i.e., 1.01). We therefore fixed this correlation to .98 on empirical grounds (the average value for this association across the CFA’s presented within this paper). The resulting model fit was largely unchanged; $\chi^2_{(25)} = 207.785, p < 0.001$; CFI= .99; TLI= .98; WRMR= .82, RMSEA= .14, CI [.12 to .16]).

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Concluding commentary

The paper presented in this chapter outlined the development and validation of the APNSEQ. In response to a key methodological pitfall within the extant SDT literature, the APNSEQ enables researchers to assess autonomy-, competence-, and relatedness-support from a number of social agents pertinent to adolescent exercise (i.e. family, friends, and PE teacher). In conjunction with recent developments within SDT, and the subsequent development of measures of need thwarting (e.g., Rocchi, Pelletier, Cheung, Baxter, & Beaudry, 2016), it is hoped that the APNSEQ will contribute to the acquisition of a more robust understanding of how the social environment contributes towards motivational, behavioural, and psychological outcomes.

In the context of this PhD, the development of this measure allows the subsequent papers to advance previous SDT grounded research that has focused on autonomy support from authority figures, by facilitating the assessment of need support encapsulating autonomy-, competence-, and relatedness- support, as well as considering a range of social agents pertinent to adolescent exercise, including family, friends and PE teachers. Thus, the APNSEQ is used in Chapters 4 and 5 to assess need support for adolescent exercise holistically.

Chapter 4

Predicting objectively assessed estimates of adolescents' exercise and sedentary behaviour: A self-determination theory approach

Predicting objectively assessed estimates of adolescents' exercise and sedentary behaviour: A self-determination theory approach

Pre-paper commentary

In the preceding chapters, two key methodological limitations of the existing literature were addressed. In Chapter 2, the results indicated that adolescents' conceptualisation of exercise is broad, encompassing an array of different physical activities that are defined as exercise by the intensity through which they are performed. Therefore, in both Chapters 4 and 5, accelerometer assessed MVPA was used as an estimate of adolescent exercise. In Chapter 3, the new APNSEQ measure was developed, allowing for the measurement of adolescent exercise-related autonomy, competence, and relatedness support from family, friends, and PE teacher. This measure was applied in the following two chapters, using the estimates of perceptions supports for the three needs from the three social agents to produce an overall estimate of need support that reflects the more holistic nature of the construct as defined in SDT. The paper presented within this chapter tested a comprehensive model of SDT, encompassing supports and thwarts for the three basic psychological needs of autonomy, competence, and relatedness, as well as need satisfaction and frustration, and motivation, in the context of adolescent exercise behaviour. Supplementing the methods section of the paper, this commentary provides an overview of the procedures used to measure exercise and sedentary behaviour using accelerometers.

Considering the limitations of self-report measures of exercise (outlined in Chapter 1), and in light of the qualitative findings presented in Chapter 2, ActiGraph™ accelerometers (GT1M, GT3X, and GT3X+) were used to assess exercise and sedentary behaviour in the paper presented in this chapter and in Chapter 5. Actigraph™ accelerometers have been shown to be reliable and valid for assessing physical activity in adolescents (see Cain, Sallis, Conway, van Dyck & Calhoun, 2013 and de Vries, Bakker, Hopman-Rock, Hirasing & van Mechelen, 2006 for reviews). Additionally, the use of the three generations of monitors (i.e., GT1M, GT3X, & GT3X+) within one study is supported by evidence showing that they produce comparable results for physical activity and sedentary behaviours in adolescents (Robusto & Trost, 2012). Following laboratory tests of how best to wear accelerometers for accurate measurement, they were waist-mounted, worn on the most lateral position of the waist

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(i.e. above the hip bone), and were well-fitting (Boerema, van Velsen, Schaake, Tonis & Hermens, 2014). This method has been shown to produce the most accurate estimates of activity, and enables the use of existing algorithms for data processing that have been developed using similar protocols (e.g., Evenson, Cattellier, Gill, Ondrak, & McMurray, 2008; Freedson, Prober & Janz, 2005; Mattocks et al., 2007; Puyau, Adolph, Vohra, & Butte, 2002; Treuth et al, 2004).

The first decision pertained to the amount of wear time required of participants in terms of the study protocol, acceptable minimum number of wear days, definition of a valid day, and definition of non-wear time. It was essential that the data obtained accurately reflected the participant's usual activity levels in order to effectively ascertain the role of motivational processes in determining behavioural outcomes (Troost, 2007). Therefore, in accordance with other large-scale assessments with children and adolescents (e.g., Craig, Mindell & Hirani, 2008; Katzmarzyk et al, 2013) an 8-day protocol was adopted, incorporating 1 acclimatisation day followed by 7 full measurement days. In doing so, the data encompassed both weekday and weekend activity across which activity has been shown to differ (Troost, Pate, Freedson, Sallis & Taylor, 2000; Troost, 2007). Additionally, a 24-hour wear time protocol, instructing participants to wear the accelerometers for the full 24 hour period, was employed as it has been shown to predict greater study compliance than a waking-hours (i.e., removed for sleep) protocol (Tudor-Locke et al., 2015). Further, the amount of time worn each day has been shown to have significant implications on how representative the data obtained are of actually physical activity levels (Troost, Morgan, Saunders, Felton, Ward, & Pate, 2000). Therefore, in line with other child and adolescent studies, at least 4 days of monitoring, including at least one weekend day, were necessary for valid data, with at least 10 hours of wear time required per day (Katzmarzyk et al., 2013; Plasqui, Bonomi & Westerterp, 2013). An hour was considered to be invalid if there were ≥ 20 consecutive zeros, allowing for the removal of the accelerometers for essential daily activities such as showering and dressing.

The second consideration was how frequently the accelerometers should record data. A recent review suggests that most studies with adolescents use a 60 second epoch length (Cain et al., 2013), however shorter epoch lengths are recommended for capturing more sporadic physical activity (Reilly, Penparze, Hislop, Davies, Grant & Paton, 2008; Troost, McIver & Pate, 2005). Therefore, akin with other studies (e.g.,

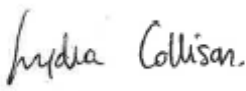
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Katzmarzyk et al., 2013; Leek, Carlson, Cain, Henrichon, Rosenberg, Patrick & Sallis, 2011), and in order to capture as much detail of daily physical activity patterns as possible, we used a 10 second epoch length (i.e., measurement recorded every 10 seconds).

The third consideration was with respect to the cut-points used to differentiate between the four different levels of activity (i.e., sedentary, light physical activity, moderate physical activity and vigorous physical activity). Using cut-points that differentiate activity intensity offers a useful route through which to distinguish between general physical activity, and activity of a higher intensity that the results of the qualitative paper presented in Chapter 2 indicate is central to adolescent's conceptualisation of exercise behaviour. At least five different cut-points have been specified for use in research with adolescents (e.g., Evenson et al., 2008; Freedson et al., 2005; Mattocks et al., 2007; Puyau et al., 2002; Treuth et al., 2004). Comparisons of these five cut-points have shown that only those proposed by Evenson et al. (2008) provide a reasonable account of both MVPA and sedentary behaviour (Trost, Loprinzi, Moore & Pfeiffer, 2011), and thus these cut points were adopted in the present study. These cut-points specify sedentary behaviour as ≤ 100 counts per minute and MVPA as ≥ 2296 counts per minute, offering less stringent estimates of MVPA than those used for the most recent population-wide survey (Craig et al., 2008).

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Statement of authorship

This declaration concerns the article entitled:									
The application of a comprehensive model of SDT to predict objectively assessed adolescent exercise and sedentary behaviour.									
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Draft manuscript	<input type="checkbox"/>	Submitted	<input checked="" type="checkbox"/>	In review	<input type="checkbox"/>	Accepted	<input type="checkbox"/>	Published	<input type="checkbox"/>
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Candidate's contribution to the paper (detailed, and also given as a percentage).	<p>Formulation of ideas: 60% The research questions were derived by me and the other authors at the start of my PhD programme</p> <p>Design of methodology: 70% In conjunction with the other authors, and considering the findings of my other studies, I compiled the questionnaires and made decisions regarding the measurement of behaviour.</p> <p>Experimental work: 100% I carried out all recruitment, data collection, data management and data analysis involved in this study</p> <p>Presentation of data in journal format: 80% I drafted the manuscript for publication and revised based on the other authors suggestions</p>								
Statement from Candidate	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.								
Signed							Date	25/09/2016	

The data presented in this paper are from a dataset which will be available to access through the the University of Bath Research Data Archive following publication of the manuscript.

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4.1. Abstract

The purpose of this work was to test a comprehensive model of motivation embedded within self-determination theory (SDT; Deci & Ryan, 2000) in predicting objectively assessed estimates of adolescent exercise and sedentary behaviour. Adolescents (N= 388) aged 11-15 years (M=12.74, SD=.90) completed questionnaires and wore an ActiGraph accelerometer for eight days (i.e., to provide seven full days of activity data). The proposed model was tested for the outcomes of daily moderate to vigorous physical activity (MVPA) and sedentary time separately using structural equation modelling (SEM). Results of both models supported the nomological network of associations as proposed within SDT. Autonomous motivation positively predicted average daily MVPA and negatively predicted average daily sedentary time. Controlled motivation and amotivation did not significantly predict either behavioural outcome. Results of multisample SEM analyses supported the invariance of the model across gender. Longitudinal research is required to ascertain the dynamic relationships between the social environment, motivation and behaviour, but the findings suggest that a need-supportive rather than need-thwarting environment may be instrumental in determining motivational and behavioural outcomes via the satisfaction of the basic psychological needs.

Keywords: Self-determination theory, adolescent, exercise, sedentary, accelerometer

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4.2. Introduction

Physical inactivity during adolescence has been identified as a major global health problem (Hallal, Victoria, Azevedo, & Wells, 2012). A convincing body of empirical evidence documents the associated health risks of physical inactivity (Craig, Mindell, & Hirani, 2011) as well as the health benefits of an active lifestyle (Janssen & LeBlanc, 2010). Adolescence provides a key opportunity to intervene and initiate adaptive exercise-related behavioural patterns that track through to adulthood (Biddle, Gorley, & Stensel, 2004; Flodmark, Marcus, & Britton, 2006) and, in order to effectively intervene, a comprehensive understanding of the exercise-related motivational processes at play during adolescence is required.¹ Addressing 'why people are moved into action', motivation research focusses on the factors that drive people to develop, behave, and think, and has been shown to be a key determinant of sustained physical activity engagement (cf. Standage & Ryan, 2012).

Self-determination theory (SDT; Deci & Ryan, 2000) is a macro-theory of human motivation, distinguishing between autonomous and controlled types of regulation and their behavioural and psychological consequences. Within SDT, effortful exercise engagement is most likely to occur when individuals act for autonomous (or 'high quality') reasons (Standage & Ryan, 2012). Autonomous motivation is comprised of identified regulation (i.e., when individuals identify with an activity as being useful and important to their goals; Deci & Ryan, 1985) and intrinsic motivation (i.e., behaviour due to the inherent enjoyment, interest, and satisfaction derived from the behaviour itself).² Controlled motivation is comprised of external regulation (i.e., actions are controlled by factors external to the self, such as rewards and punishments; Deci & Ryan, 1985) and introjected regulation (i.e., actions are controlled by self-imposed sanctions such as shame, pride, ego, and guilt; Deci & Ryan, 2002). Within SDT, amotivation represents a lack of; intention to act, value, competence, and control of behaviour (Ryan & Deci, 2000). A growing body of empirical evidence supports the notion that autonomous motivation is beneficial for predicting engagement in physical activity and exercise behaviour, lower levels of sedentary behaviour, and exercise-related wellness (e.g., Fenton et al., 2014; Gunnell, Crocker, Mack, Wilson, & Zumbo, 2014; Standage, Sebire, & Loney, 2008; Stenling, Lindwall, & Hassmen, 2015; see Standage & Ryan, 2012 for a review).

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Within SDT (Deci & Ryan, 1985; 2000), the quality of an individuals' motivation and their wellness is facilitated to the extent to which social conditions and processes support, as oppose to thwart, the satisfaction of three innate psychological needs (Deci & Ryan, 2000). To this end, the three basic psychological needs proposed within SDT are for autonomy (feelings of volition and responsibility, inner endorsement of actions; Ryan, 1995), competence (feelings of efficacy and the ability to overcome challenges; Deci & Ryan, 2000), and relatedness (sense of belonging and being connected and cared for; Ryan, 1995). Thus, the extent to which these basic psychological needs are satisfied and frustrated determines the quality of motivation that ensues (Deci & Ryan, 2000) and interactions with significant others, such as friends, family, and teachers, play a key role in whether the psychological needs are satisfied or frustrated. Recent work has labelled these social contexts as being need supportive (e.g., assisting in overcoming challenges, showing you value the individual) or need thwarting (e.g., limiting choices, imposing opinions on the individual; see Standage & Vallerand, 2014). Research has supported the notion that need supportive environments contribute to the satisfaction of, whereas need thwarting environments are frustrating of, the three basic psychological needs (e.g., Adie, Duda, & Ntoumanis, 2012; Haerens, Aelterman, Vansteenkiste, Soenens, & van Petegem, 2015; De Meyer, Soenens, Vansteenkiste, Aelterman, van Petegem, & Haerens, 2016). Moreover, a growing body of empirical work supports the proposition that need-supportive environments positively predict wellness, adjustment, high quality forms of motivation, and adaptive behaviours, both directly (e.g., Adie et al., 2012) and indirectly via need satisfaction (Adie et al., 2012; Haerens et al., 2015; Stenling et al., 2015). In contrast, research has shown need-thwarting environments to predict ill-being, motivation, and behavioural outcomes directly (e.g., Haerens et al., 2015) and via the frustration of the basic psychological needs (see Vansteenkiste & Ryan, 2013 for a review).

Support for the network of associations specified within SDT has been demonstrated across a number of domains, including sport (e.g., Fenton et al., 2016), physical activity (e.g., Owen, Astell-Burt, & Lonsdale, 2013), and physical education (e.g., Standage, Duda, & Ntoumanis, 2005). In the context of adolescent exercise behaviour, research has consistently shown autonomous forms of motivation to positively predict exercise behaviour (see Owen, Smith, Lubans, Ng, & Lonsdale, 2014, for a review). Similarly, there is an emerging body of SDT-related literature showing

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autonomous exercise motivation to negatively predict sedentary time (Fenton, Duda, Quested, & Barrett, 2014; Lonsdale et al., 2013). Additionally, studies linking controlled motivation for exercise to behavioural outcomes have found no relationship between controlled motivation and either physical activity or sedentary time (Fenton et al., 2014).

The majority of existing studies from a SDT perspective with adolescent samples have used self-report methods to assess exercise behaviour. Such assessments are prone to bias (Sallis & Saelens, 2000), and are often subject to overestimation, particularly in children and adolescents who find behavioural recall over a period of time more challenging (Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009). Estimates of behaviour based on accelerometer assessments have a distinct advantage over subjective measures due to real time data storage meaning they are able to provide reliable estimates about physical activity and exercise patterns over a set time period and in large samples (Troost, Pate, Freedson, Sallis, & Taylor, 2000). A few studies adopting an SDT framework have employed objectively assessed estimates (e.g. accelerometers) of behaviour within a specific setting (e.g., within a PE lesson; Owen et al., 2013; within youth sport; Fenton, Duda, & Barrett, 2016), with university students (e.g. Standage, Sebire, & Loney, 2008), and with children (Sebire et al., 2013). These studies consistently show a small to moderate relationship ($\beta = .21-.39$) between autonomous motivation and MVPA, and autonomous motivation to explain small-moderate-amounts of variance in MVPA ($R^2 = .05-.31$; Fenton et al., 2014; Fenton et al., 2016; Owen et al., 2013; Standage et al., 2008). Additionally, there is some evidence showing a small negative relationship between autonomous motivation for exercise and accelerometer-assessed sedentary time ($\beta = -.15$), and that autonomous exercise motivation explains a small amount of variance in sedentary behaviour ($R^2 = .02$; Fenton et al., 2014).

A consistent body of work supports the proposed theoretical relationships between need support, need satisfaction, autonomous motivation, and more adaptive exercise-related outcomes (e.g., Standage, Ntoumanis, & Duda, 2005; Standage, Gillison, Ntoumanis, & Treasure, 2012). Although there has been limited empirical enquiry in the context of adolescent exercise behaviour into the social contexts that facilitate need satisfaction, evidence in related contexts (e.g., PE, youth sport) show need support to positively predict need satisfaction, exercise motivation, behaviour and well-

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being (e.g., Chatzisarantis, Hagger, Kamarova, & Kawabata, 2012; Ntoumanis, 2005; Standage et al., 2005). There is also some evidence to support positive relationships between autonomy thwarting, need frustration, controlled motivation and amotivation in the PE context (e.g., Haerens et al., 2015). Research also shows need frustration to predict greater exercise-related ill-being (e.g., disordered eating, burnout, depression, negative affect; Curran, Hill, Hall & Jowett, 2014; Haerens et al., 2015). Although some aspects of need-supportive and need-thwarting social interactions have received attention independently in the exercise context, need support and thwarting co-exist, and therefore to obtain a more ecologically valid understanding of the motivational processes at play in the exercise domain, it is important that studies consider perceptions of these social contexts simultaneously. Also, and although recent studies of need supportive environments have extended beyond measuring autonomy support to include supports for competence and relatedness (e.g., Emm-Collison, Standage, & Gillison, in press), research assessing need thwarting in adolescents has been focused on controlling behaviours, and only from authoritative figures rather than peers (e.g. Fenton et al., 2016). To date, there has been no research incorporating both the brighter (i.e., need support, need satisfaction and autonomous motivation) and darker (i.e., need thwarting, need frustration and controlled motivation) sides of SDT in the context of adolescent exercise behaviour.

4.2.1.1. Present research

With a view to addressing gaps in existing literature, the present work had three aims. First, in light of the lack of studies adopting objective measures of adolescent exercise and sedentary behaviour, we applied the SDT model to exercise and sedentary time data obtained through accelerometer measurement. Second, we adopted a more comprehensive model of SDT looking at both the brighter (i.e., need support, need satisfaction and autonomous motivation) and darker (i.e., need thwarting, need frustration and controlled motivation) sides of human motivation simultaneously. Third, following recent developments in the measurement tools (e.g., Emm-Collison et al., in press; Rocchi, Pelletier, Cheung, Beaudry, & Baxter, 2016) we assessed need support and need thwarting holistically, measuring support and thwarts for autonomy, competence and relatedness and from a variety of social agents (family, friends and PE teacher).

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4.3. Method

4.3.1. Participants

Five hundred and fifty adolescents aged 11-15 years ($M=12.7$, $SD=.90$) were recruited through four schools in the south west of England. The inclusion criteria were (a) to be enrolled in full time education within the four schools, and (b) to have a good comprehension of English. Participants with less than 4 days of valid accelerometer wear time were excluded from the analysis. Significant differences were found between participants who had valid accelerometry and those who did not in terms of gender ($p<.001$; females more likely to complete accelerometry) and autonomous motivation ($p<.01$; higher autonomous motivation reported by those with complete accelerometry). There were no significant differences found between schools for any of the variables.

4.3.2. Measures

Psychological need support. Perceptions of need support (for autonomy, competence, and relatedness) were assessed using the Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ; Emm-Collison et al., in press). The 9-item, 3 factor measure has been validated in samples of British adolescents (Emm-Collison et al., in press). Participants completed the measure three times in relation to three different social agents; family, friends, and PE teacher. The participants responded to the stem 'In my interactions with my family/friends/PE teacher about exercise...' using a 7-point likert scale ranging from 1 (strongly disagree) through 4 (neither agree nor disagree) to 7 (strongly agree).

Psychological need thwarting. Perceptions of need thwarting (for autonomy, competence, and relatedness) were assessed using 12 items from the Interpersonal Behaviours Scale (Rocchi et al., 2016). As with the APNSEQ, the measure was completed three times in relation to family, friends and PE teacher, and for continuity and contextual specificity, the stem was adapted in an identical manner as the need-support items and the same 7-point likert scale used.

Psychological need satisfaction and frustration. Participants' perceptions of satisfaction and frustration of the three basic psychological needs for autonomy, competence, and relatedness were assessed through the Basic Psychological Need Scale (Chen et al., 2015). This 24-item, 6-factor scale has been validated in multicultural samples of older adolescents (Chen et al., 2015) and previously used in research with

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younger adolescents (Emm-Collison et al., in press). The stem used in the present work was 'When I exercise...' followed by items for need satisfaction (e.g., '...I feel confident that I can do the exercise well) and need frustration (e.g., '...I feel like a failure because of the mistakes that I make'). Participants responded using a 7-point Likert scale ranging from 1 (strongly disagree) through 4 (neither agree nor disagree) to 7 (strongly agree).

Motivation toward exercise. Motivation towards exercise was assessed using the Behavioral Regulations in Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004). The BREQ-2 is a 19-item scale measures the five subscales of intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation; the subscales can also be combined to provide composite scores for autonomous motivation, controlled motivation, and amotivation. Participants respond on a 5-point Likert scale ranging from 0 (not true for me) through 2 (sometimes true for me) to 4 (very true for me). Responses to the scale have previously demonstrated good psychometric properties in adolescent samples (e.g., Gillison, Standage, & Skevington, 2006; Standage et al., 2012).

Exercise and sedentary behaviour. Actigraph™ GT1M, GT3X and GT3X+ accelerometers were used to objectively measure physical activity and sedentary behaviour. Research has shown the use of different ActiGraph™ models within a single study to be acceptable (Robusto & Trost, 2012), and in the present study there were no significant between-person differences in MVPA or sedentary time from different monitors ($p < .05$)³. Accelerometers were waist mounted on the right side of the body by an elasticated belt. Participants were encouraged to wear the accelerometer for 24 hours a day for eight days (one adjustment day and seven measurement days) including two weekend days. In line with previous studies, the minimum amount of data to be considered valid was four days, with at least 10 hours of wear time per day and including one weekend day (Katzmarzyk et al., 2013; Tudor-Locke et al., 2015). The accelerometers provided data that were analysed in 10 second epochs so as to accurately classify different levels of physical activity (e.g., see Reilly, Penpraze, Hislop, Davies, Grant, & Paton, 2008; Trost, McIver, & Pate, 2005). Data were categorised using cut-points proposed by Evenson, Cattellier, Gill, Ondrak, and McMurray (2008) which are recommended for estimating sedentary, light, moderate, and vigorous activity in adolescents (Trost, Loprinzi, Moore, & Pfeiffer, 2011).

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4.3.3. Procedure

Ethical approval was sought and granted from the authors' institutional ethics committee prior to commencing the research. Schools were invited to take part in the study via telephone and email when the purpose and nature of the study was explained and consent sought from senior members of staff. In line with the British Psychological Society guidelines (2014) information sheets were then sent out to parents giving them the opportunity to opt their child out of participating in the study. Informed assent was obtained from students who had not been opted out and who wished to participate. Questionnaires were completed under exam conditions during a normal school day, with a researcher present in order to answer any questions about the questionnaire. To ensure consistency, and in line with established good practice (cf. Katzmarzyk et al., 2013) we did not re-interpret any of the questions to the students raising queries, but did provide definitions of words if required. Following completion of the questionnaire, anthropometric measures were taken. Once all measures had been completed, participants were fitted with the accelerometers. Participants were instructed to wear the accelerometers as much as possible over the measurement period, taking it off only for water-based activities (i.e., swimming, showering, bathing) or if there was a risk of injury to them or someone else (e.g., contact sports). The researcher returned to the school eight days later to collect the accelerometers and the data were downloaded, checked, and analyzed using ActiLife™ software (ActiGraph™, Pensacola, FL).

4.3.4. Data analysis

Data were first screened for missing data, outliers and normality, and composite reliability was calculated for all study variables (Raykov, 1997).

The main analyses were conducted using structural equation modelling with AMOS version 22 (Arbuckle, 2009). Here, we employed the two-step model building approach proposed by Anderson and Gerbing (1988). The measurement model was tested first prior to the proposed path model. The path model was tested for MVPA and sedentary time separately due to these outcome being measured through the same device. For all analyses, model fit was assessed using the following indices as proposed by Hu and Bentler (1999); the Chi-square value, the comparative fit index (CFI), the standardised root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). The thresholds used were $>.90$ for acceptable fit and $>.95$ for excellent fit with regards to the CFI and TLI, $< .08$ for the SRMR, and $< .06$ for the

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RMSEA (Hu & Bentler, 1999). A sequential modelling testing approach was adopted in order to test the model for invariance across gender (Byrne, 2010), in which a change in CFI \leq -0.01 provides support for invariance across groups (Cheung & Rensvold, 2002).

As the purpose of the research was to further understand the relationships between latent variables rather than items, and due to the complexity of the model in comparison to the sample size, we parcelled items to each latent variable (Little, Cunningham, Shahar, & Widaman, 2002). Despite criticism of parcelling techniques with respect to the masking of model misspecification, recent evidence suggests that parcelling actually heightens the sensitivity of some fit indices in identifying misspecifications (Rhemtulla, 2016). Further, there is substantive evidence for parcelling in terms of benefits for distribution and psychometric properties (Little et al., 2002). Parcelling has also been used in a number of previous studies testing complex motivation-related models (e.g. Standage et al., 2012, Sebire, Standage, & Vansteenkiste, 2009, Standage & Gillison, 2007). For both need support and need thwarting mean scores from the three subscales referring to support or thwarting for autonomy-, competence-, and relatedness- across all three social agents were calculated to form indicator variables for autonomy-, competence-, and relatedness- support and thwarting. These indicator variables were used in the model to predict the latent need support and need thwarting variables. Mean scores were calculated for autonomy-, competence-, and relatedness- satisfaction and frustration and these were used as indicator variables for need satisfaction and frustration. Six items assessing intrinsic motivation and identified regulation were randomly parcelled into three autonomous motivation indicators and, similarly, six items assessing introjected and external regulation (excluding the lowest performing external regulation item so as to provide a balanced number of parcels) were randomly parcelled into three controlled motivation indicators. The hypothesised model consisted of seven latent variables, and one observed variable (behaviour), representing all measured variables (Figure 4.1).

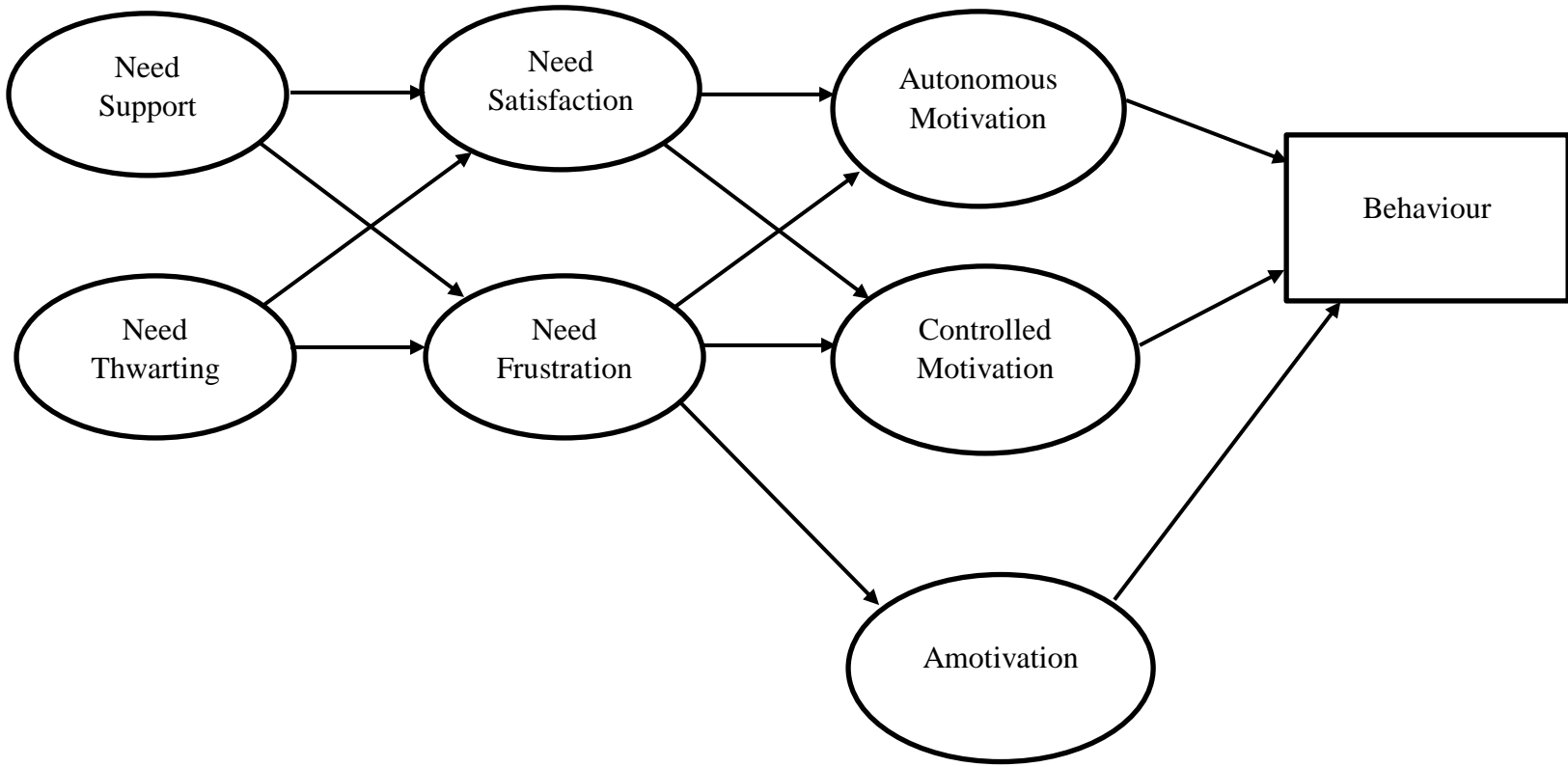


Figure 4.1. The hypothesised model based on Self-Determination Theory

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4.4. Results

4.4.1. Participant characteristics

Of the 550 participants recruited, 212 were removed due to insufficient accelerometer measurement (N=209) or a high proportion of missing questionnaire data (N=3). The final analytical sample consisted of 338 adolescents (234 female; $M_{\text{age}}=12.75$ years; $SD=.90$), 69.2% were female, and 87.7% were white ($M=12.7$, $SD=.90$). Body fat percentage ranged from 5.3 to 49.1% ($M=23.9\%$) and BMI ranged from 11.35 to 39.17 ($M=20.79$, $SD=4.25$).

4.4.2. Preliminary analyses

The data were screened for missing data, outliers, and normality. Three cases of high missing data (≥ 5 ; Tabachnick & Fidell, 2012) were found and removed, and other missing data were replaced using the mean of the available items from the subscale in each individual case (Graham, Cumsille, & Elek-Fisk, 2003). Three univariate outliers ($+/-3.29$, $p<.001$; Kline, 1999) were identified and removed, but the data still displayed multivariate asymmetry (Multivariate kurtosis; $MVPA=143.23$; Sedentary= 142.158). As a result, in line with recommendations (Byrne, 2010) subsequent analyses were conducted using maximum likelihood estimation coupled with bootstrapping procedures (Byrne, 2010), drawing five thousand bootstrap replications (Hayes, 2009) and reporting the Bollen-Stine corrected p value. Descriptive statistics, scale internal consistencies, one-tailed Pearson correlation coefficients, and significance levels are shown in Table 4.1. As shown, the composite reliability of the seven latent variables demonstrated good internal consistency ($CR \geq .70$; Raykov, 1997).

4.4.3. Model testing

The data were analysed using the two-step model building approach proposed by Anderson and Gerbing (1988), the measurement model was tested first via CFA, and showed acceptable fit to the data; $\chi^2_{(209)}=614.16$, $p<.001$; Bollen-Stine bootstrap $\chi^2 p < .001$, CFI=.91, RMSEA=.07 [90% .07, .08], SRMR=.07. The hypothesised path model (Figure 4.1) was then tested and yielded acceptable fit to the data for daily MVPA ($\chi^2_{(235)}=667.08$, $p < .001$; Bollen-Stine bootstrap $\chi^2 p < .001$, CFI=.90; SRMR=.07; RMSEA=.07 [90% CI=.07, .08]), and daily sedentary time ($\chi^2_{(235)}=655.714$, $p < .001$; Bollen-Stine bootstrap $\chi^2 p < .001$, CFI=.90; SRMR=.07, RMSEA=.07 [90% CI=.07, .08]). The model explained 4% and 5% of the variance in daily MVPA and sedentary time,

Table 4.1

Descriptive statistics, composite reliability and correlations between study variables

Variable	M	SD	1	2	3	4	5	6	7	8	9
1 Need Support	5.45	.81	.87								
2 Need Thwarting	2.63	.85	-.36**	.82							
3 Need Satisfaction	5.33	.93	.68**	-.26**	.73						
4 Need Frustration	2.90	1.09	-.37**	.65**	-.48**	.70					
5 Autonomous Motivation	2.89	.76	.46**	-.14**	.60**	-.38**	.82				
6 Controlled Motivation	1.48	.87	-.04	.25**	-.14**	.41**	.05	.79			
7 Amotivation	.53	.84	-.35**	.34**	-.35**	.47**	-.50**	.17**	.79		
8 Daily MVPA (hours)	.79	.32	.11*	-.04	.16**	-.03	.16**	-.03	-.11*	-	
9 Daily Sedentary (hours)	19.69	1.25	-.14**	.07	-.14**	.05	-.20**	-.02	.16**	-.57**	-

Significant relationship at * $p < .05$ and ** $p < .01$ (one-tailed). Composite reliability scores (Raykov, 1997) are shown on the diagonal. The cut point for Daily MVPA is ≥ 2296 counts per minute and the cut point for daily sedentary time is ≤ 100 counts per minute (Evanson et al., 2008).

respectively (Figures 4.2 and 4.3).⁴ Results of multi-sample SEM analysis provided support for the equivalence of the model across gender, and the model fit indices approach acceptable fit (Table 4.2). The small change in CFI value ($\leq .01$) between more constrained models support the equivalence of the parameters across gender (Cheung & Rensvold, 2002).

The standardised regression weights (Figures 4.2 and 4.3) showed that perceptions of need support positively predicted need satisfaction and negatively predicted need frustration. Need thwarting positively predicted need frustration but was not related to need satisfaction. Need satisfaction positively predicted autonomous motivation and negatively predicted amotivation. Need frustration positively predicted controlled motivation and amotivation. Autonomous motivation positively predicted minutes spent in MVPA and negatively predicted minutes spent in sedentary time. Neither controlled motivation nor amotivation were significant predictors of MVPA or sedentary time.

4.4.4. Indirect effects

The standardised indirect effects are shown in Table 4.3. As shown, perceptions of need support had a positive and significant indirect effect on autonomous motivation and time in MVPA, and a significant negative indirect effect on amotivation and sedentary time. Need thwarting had a significant positive indirect effect on amotivation and controlled motivation. Need satisfaction had a significant positive indirect effect on MVPA and a significant and negative indirect effect on sedentary time. No significant indirect effects were observed between need frustration and the other variables.

4.5. Discussion

This study applied a comprehensive model of both the bright (i.e., need support, need satisfaction and autonomous motivation) and dark (i.e., need thwarting, need frustration, and controlled motivation) constructs within SDT to predict objectively assessed estimates of exercise and sedentary behaviour in adolescents. Overall, the results provide support for the hypothesised models in predicting daily MVPA and sedentary time, and the variable relationships support a nomonological network of associations akin with the tenets of SDT (Deci & Ryan, 2000).

Past work in the context of sport and physical activity has largely focused on the extent to which participant's perceive environments created by others (e.g., sport coaches, PE

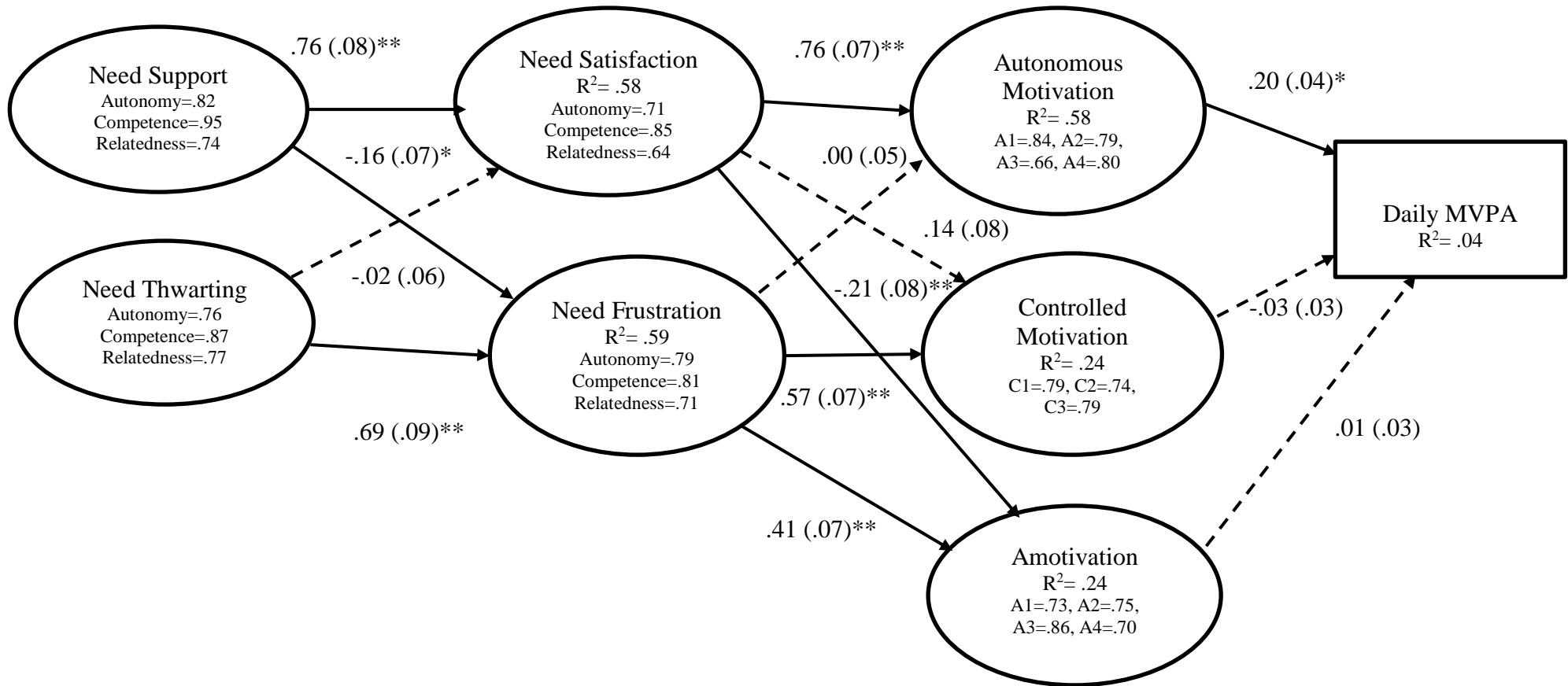


Figure 4.2. Standardised regression weights and bootstrapped standard errors for the proposed model predicting daily moderate to vigorous physical activity. Standardised regression weights for the manifest variables are presented within each latent variable circle. Path significant at * $p < .05$, ** $p < .01$

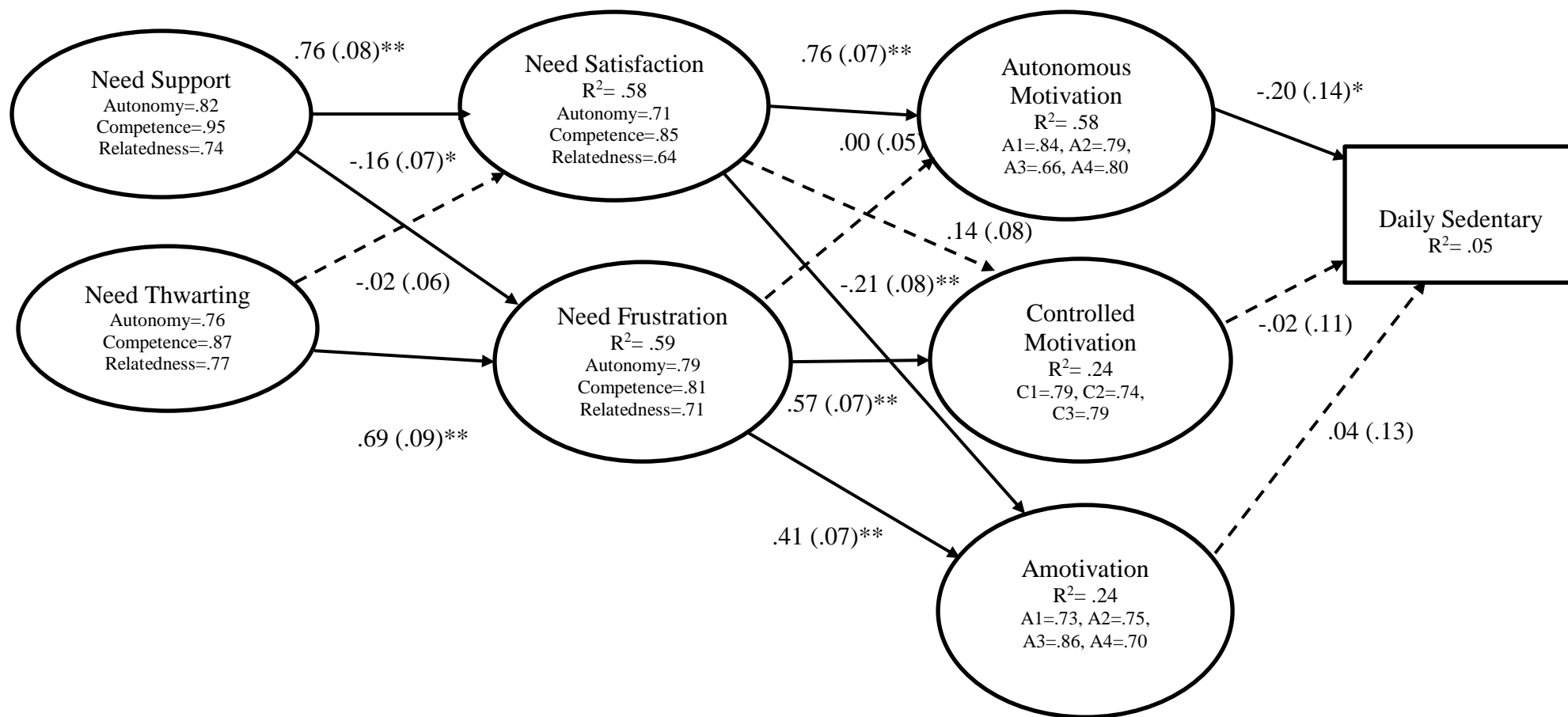


Figure 4.3. Standardised regression weights and bootstrapped standard errors for the proposed model predicting daily sedentary time.

Standardised regression weights for manifest variables are the same as in figure 4.2. Path significant at * $p < .05$, ** $p < .01$

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Table 4.2

Fit indices for invariance testing across gender

	χ^2	df	CFI	SRMR	RMSEA [90% CI]
Daily MVPA					
Unconstrained	964.81**	470	.89	.08	.06 [.05, .06]
Measurement weights constrained	989.73**	489	.89	.08	.06 [.05, .06]
Structural covariances constrained	1003.48**	502	.89	.09	.06 [.05, .06]
Daily sedentary					
Unconstrained	962.44**	470	.89	.08	.06 [.05, .06]
Measurement weights constrained	990.39**	489	.89	.08	.06 [.05, .06]
Structural covariances constrained	1004.07**	502	.89	.09	.06 [.05, .06]

Note. **indicates significance at the $p < .01$ level (2-tailed). Group N: Male= 104, Female= 234

Table 4.3
Standardised indirect effects for the three models predicting daily MVPA and daily sedentary time.

Parameter		β	Bootstrap bias-corrected 95% CIs (Lower, upper)
Need Support	→	Amotivation	-.23**
	→	Controlled Motivation	.02
	→	Autonomous Motivation	.57**
	→	MVPA	.11**
	→	Sedentary time	-.12**
Need Thwarting	→	Amotivation	.29**
	→	Controlled Motivation	.39**
	→	Autonomous Motivation	-.02
	→	MVPA	-.01
	→	Sedentary time	.01
Need Satisfaction	→	MVPA	.14**
	→	Sedentary time	-.16**
Need Frustration	→	MVPA	-.01
	→	Sedentary time	.00

Note. **indicates significance at the 0.01 level (2 tailed).

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teachers, peers) to be autonomy supportive or controlling. Few studies have adopted broader assessments to also encompass perceptions of need supportive (e.g., Ntoumanis, 2005; Standage et al., 2005) or need thwarting contexts (e.g., De Meyer et al., 2014; Haerens et al., 2015). Such extensions are important as within SDT, all three psychological needs are considered to be fundamental, thus it is essential that we gain a more systematic and thorough understanding of the supports and thwarts for competence and relatedness (i.e., in addition to autonomy supportive and controlling environments). In examining perceptions of need support and need thwarting behaviours from multiple social agents (i.e., family, friends, and PE teachers), the approach used in this work permits a broader and multifaceted understanding of exercise-related social contexts that are conducive to supporting, or frustrating, the basic psychological needs within the exercise context. Considering the social context provided by a number of social agents allows for a more comprehensive view of the contribution of the social environment to behavioural and wellness outcomes.

Consistent with previous research in PE settings (Gillison et al., 2013; Standage et al., 2005), perceptions of need support positively predicted need satisfaction. Extending on past work (e.g., Gillison et al., 2013; Standage et al., 2005), the results also show need support to negatively predict need frustration. In contrast, perceptions of a need thwarting context positively predicted need frustration. Further to this, the observed indicators for perceptions of autonomy-, competence-, and relatedness-support and autonomy-, competence- and relatedness-thwarting had similar loadings on the latent constructs of need-support and need-thwarting respectively. Due to the indirect effects that need-support and need-thwarting were shown to have on motivational and behavioural outcomes, the findings highlight the importance of social environments that are supportive of autonomy, competence, and relatedness to promote need satisfaction, autonomous motivation, and exercise behaviour. They also indicate that environments that thwart the needs for autonomy, competence, and relatedness can lead to need frustration and more controlled motivation. Collectively, these findings provide initial support for conceptually coherent relationships among need support and thwarting, and need satisfaction and frustration within the context of adolescent exercise.

The indirect effects show need support to indirectly and positively predict autonomous motivation and MVPA, and negatively predict amotivation and sedentary time. Such findings support the tenets within SDT that need support influences MVPA

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through the serial mediation of need satisfaction and autonomous motivation which demonstrated in previous studies (e.g., Adie, Duda, & Ntoumanis, 2012; Haerens et al., 2015; Stenling et al., 2015). Previous research has shown need support to have indirect effects on both self-reported and objectively assessed physical activity in the context of PE (Hagger, Chatzisarantis, Culverhouse, & Biddle 2003; Standage et al., 2012). This work extends beyond work by looking at multiple social agents, and presents initial data on the indirect effects of need support from a variety of significant others (i.e., family, friends and PE teacher) on motivation and behavioural outcomes. Although the results indicate that need thwarting influences controlled motivation indirectly through need frustration, there was no significant effect on behavioural outcomes. It may be that need thwarting behaviours are more pertinent to ill-being outcomes, as previous evidence in the youth sport context has found need thwarting to be related to disordered eating, burnout, depression and negative affect (Curran et al., 2014; Haerens et al., 2015).

Need satisfaction was found to positively predict autonomous motivation, and need frustration was found to positively predict controlled motivation. Providing evidence within a more general exercise setting, such findings are consistent with SDT and the work of Haerens et al. (2015) who reported similar relationships in their study in the context of school PE. The indirect effects show that exercise need satisfaction had a positive indirect effect on MVPA, and a negative indirect effect on sedentary time. Supporting the tenets of SDT and the utility of using a basic needs approach, the present findings add to a cogent body of literature that documents the satisfaction of the needs to necessitate high quality forms of motivation and functioning in exercise settings (Standage & Ryan, 2012) as well within and across life domains (Deci & Ryan, 2008; Ryan & Deci, in press). No significant indirect effects were found for need frustration on MVPA or sedentary time. To our knowledge, this is the first study to examine need frustration and associations with objectively assessed physical activity and sedentary behaviour in an adolescent exercise context. These initial findings suggest that perceptions of need frustration are not conducive to instigating behavioural outcomes. This is likely due to need frustration predicting controlled motivation and amotivation which the present study, and previous literature, have shown to not predict MVPA or sedentary behaviour (Fenton, et al., 2014; Standage et al., 2008).

Consistent with the tenets within SDT and previous research (e.g., Aelterman, Vansteenkiste, Keer, Berghe, Meyer, & Harnes, 2012; Fenton et al., 2014; Owen et al.,

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2013), the present results showed autonomous motivation toward exercise to positively predict time spent in MVPA. The current data therefore supplement similar results from PE (Aetlerman et al., 2012), leisure time activity (Owen et al., 2013), and sport and active games (Fenton et al., 2014) settings in the context of exercise and support the validity of high quality forms of motivation in supporting objectively assessed exercise behaviour. Similarly, the findings also show autonomous motivation to negatively predict sedentary behaviour, further supporting the adaptive nature of autonomous motivation. We found no association between controlled motivation, and either exercise or sedentary behaviour, which is consistent with previous evidence assessing objectively assessed exercise with both adults (Standage, Sebire, & Loney, 2008) and adolescents (e.g., Fenton, et al., 2014; Standage et al., 2008). We also found no association between amotivation and the two behavioural outcomes.

Although the current study adopted a cross-sectional design, and therefore causal relationships cannot be inferred, the findings indicate some useful practical insights. The results suggest that fostering a need-supportive environment may serve to facilitate greater engagement in exercise behaviour and less sedentary time among adolescents. In doing so, interventions may facilitate more autonomous motivation through the satisfaction of the basic psychological needs, ultimately influencing engagement in exercise behaviour.

Although there were a number of strengths to the current research, there were also a number of limitations. First, although the cross-sectional study design is appropriate for initial model testing, the approach treats motivation as a static process. Future research should seek to investigate the ongoing interplay of key variables via longitudinal within-and-between person designs as such an approach would better capture the ongoing and dynamic relationships among the motivational constructs within SDT and exercise behaviour (Standage & Ryan, 2012).

Second, the measures for the SDT constructs were completed with respect to motivation for exercise, and did not include items relating to motivation for sedentary behaviours. Evidence consistently demonstrates the independence of physical activity and sedentary behaviours (e.g., Marshall, Biddle, Sallis, McKenzie, & Conway, 2002), and differences in their determinants (Biddle, Gorley, & Stensel, 2004). The evidence for differences in the determinants of physically active and sedentary behaviours

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highlights the importance of measures specifically designed to assess the predictors of sedentary behaviour. It is also acknowledged by experts that sedentary behaviour is not just the absence of physical activity, but that rather it involves purposeful engagement in activities involving little bodily movement (Reilly, Penpraze, Hislop, Davies, Grant, & Paton, 2008). Therefore, the measurement of both exercise and sedentary time using the same accelerometer does not represent this independence. Issues have previously been highlighted with the assessment of sedentary behaviour purely through accelerometers, as it may be conflated with low levels of physical activity (Hardy et al., 2013), although laboratory evidence suggests that the cut points used can almost perfectly discriminate sedentary time (Evenson et al., 2008). Triangulation of methods (such as observation, accelerometry and self-report) would help to obtain more detailed information regarding the context of the participants sedentary behaviour through the identification of specific activities (e.g., homework, computer games, television). Assessing sedentary behaviour and its determinants separately from exercise, in terms of accelerometers and questionnaires, would also accommodate the independence of these constructs.

Third, sample composition may limit the generalisability of the findings. The participants were largely white (87.6%), and the participants who completed accelerometer measurements sufficiently (i.e., those involved in these analyses) were found to have higher autonomous motivation for exercise than those not providing valid accelerometer data, which may mean the analyses excluded those who were least autonomously motivated. This limits the generalisability of the study in terms of the representation of individuals with more controlled motivation in the final analysis sample, and thus findings may be somewhat bias towards adolescents who have better quality motivation for exercise.

Although the data provided acceptable fit to the proposed model, the variance in MVPA and sedentary behaviour explained by the model was small (i.e., 4 and 5% respectively) and the relationship between autonomous motivation and both MVPA and sedentary behaviour was also small ($\beta=.20$ and $\beta=-.20$ respectively). Such findings point to a motivation-behaviour gap. Future research should seek to explore potential proximal mediational processes through which motivation is translated to behaviour by identifying the moderators and mediators of the motivation- behaviour relationship.

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4.5.1. Conclusion

The present work provides support for the role of need support, need satisfaction, and autonomous motivation in predicting both daily MVPA and sedentary behaviour in adolescents. In line with tenets within SDT and previous research, the present data showed perceived need support within exercise to positively predict exercise-related need satisfaction, autonomous motivation toward exercise, and more positive exercise outcomes. Contrary to the proposed theoretical relationships, the findings presented in this study indicate that the darker SDT constructs (i.e., need thwarting, need frustration, and controlled motivation) are not predictive of adolescent exercise or sedentary behaviour. It is likely that these constructs are more pertinent to exercise-related well and ill-being (e.g., Curran et al., 2014; Haerens et al., 2015), although further research should investigate the longitudinal associations between the SDT variables and behavioural outcomes, and the processes through which motivation influences exercise behaviour. From an applied perspective, these findings suggest that interventions that promote a need-supportive environment will lead to more autonomous motivation, greater engagement in exercise behaviour, and less sedentary time through satisfying the psychological needs.

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4.6. Footnotes

¹ In line with recommendations to optimise correspondence between behavioural predictors and outcomes (Atkin, van Sluijs, Dollman, Taylor, & Stanley, 2016), we concentrate on exercise defined as a subcomponent of physical activity that is '*planned, structured, repetitive, and purposeful in the sense that the improvement or maintenance of one of more components of physical fitness is the objective*' (World Health Organisation, 2010, p52). Focussing on exercise this way appropriately delineates exercise from physical activities of daily living and captures exercise as a behavioural enactment that is sufficiently purposeful to require cognitive processes pertaining to the psychology of motivation (Standage & Ryan, 2012).

² Integrated regulation (i.e., when the value placed on the behaviour assimilates with one's sense of self) also contributes towards autonomous motivation, but is not measured in the current work.

³ Between subjects effects: MVPA ($F_{(2)} = 1.473, p = .231$), sedentary time ($F_{(2)} = .348, p = .706$),

⁴ The model was also tested when controlling for BMI and Age. The model showed acceptable fit to the data for both MVPA $\chi^2_{(260)} = 732.243, p < .001$; Bollen-Stine bootstrap $\chi^2 p < .001$, CFI=.90, SRMR=.07, RMSEA=.07 (90% CI=.07, .08) and Sedentary time $\chi^2_{(260)} = 722.393, p < .001$; Bollen-Stine bootstrap $\chi^2 p < .001$, CFI=.91, SRMR=.07, RMSEA=.07 (90% CI=.07, .08). , and explained 6% of the variance in MVPA and 5% of the variance in sedentary time.

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Concluding Commentary

Through the paper presented in this chapter, a comprehensive model of SDT was applied and tested via CFA in the context of objectively assessed adolescent exercise and sedentary behaviour. The findings supported the theoretical tenets proposed within SDT, and demonstrated both direct and indirect relationships between SDT constructs and objectively assessed exercise and sedentary behaviour. However, the SDT model predicted just 4% variance in MVPA and 5% variance in sedentary behaviour, which suggests that there are other mechanisms that may mediate the relationship between exercise motivation and behaviour.

With these findings in mind, and considering the aim of this thesis was to explore the motivational processes underlying adolescent exercise and sedentary behaviour, the paper presented in Chapter 5 investigated the processes through which motivation may influence behaviour. Specifically, drawing on wider health behaviour theory (e.g., Schwarzer & Luszczynska, 2008) and recent SDT literature (e.g., Nurmi, Hagger, Haukkala, Araujo-Soares, & Hankonen, 2016), the role of self-regulation in translating autonomous motivation for exercise to exercise and sedentary behaviour was explored.

Chapter 5

The role of conscious and automatic self-regulation in translating motivation to behaviour: A self-determination theory perspective on adolescent exercise

The role of conscious and automatic self-regulation in translating motivation to behaviour: A self-determination theory perspective on adolescent exercise

Pre-paper commentary

Building upon the findings of the paper presented in Chapter 4, this paper explored the processes through which autonomous motivation influences adolescent exercise and sedentary behaviour. The findings presented in Chapter 4 indicate that the darker constructs within SDT (i.e., need thwarting, need frustration, and controlled motivation) have minimal influence on behavioural outcomes, this paper focussed on the brighter aspects of the theory, particularly the relationship between autonomous motivation and behaviour. Additionally, need support was also incorporated within the model, with the view of future applications and interventions in mind. Taking heed from theories that explain the cognitive processes through which motivation is translated to behaviour (e.g., Health Action Process Model; Schwarzer & Luszczynska, 2008), and considering the self-regulatory processes that are conducive to SDT (Hagger, Wood, Stiff, & Chatzisarantis, 2010), this paper explored the role of habit, action planning, and self-monitoring in translating autonomous motivation to exercise and sedentary behaviour. Additionally, the role of need support in facilitating autonomous motivation and self-regulation was also investigated through the APNSEQ measure developed in Chapter 3. The model was tested using path analysis, and an overview of these procedures is presented within this commentary.

Path modelling is an extension of regression that refers to the visual modelling of manifest variables. As with structural equation modelling (SEM), it is recommended that the sample size exceeds a ratio of 10 participants to each parameter in the model (Kline, 2005). Therefore, where SEM does not permit this ration, path analysis offers an alternative method, with fewer parameters, through which to explore theoretical relationships between variables. As path modelling involves only manifest variables, there is an assumption that the measures provide reliable estimates of the constructs they represent (Bollen, 1989). However, one of the most pertinent criticisms of studies that have used path modelling is the way in which they deal with measurement error (Cole & Preacher, 2014).

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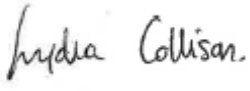
One of the methods for reducing measurement error is to adopt reliable, valid, and domain-representative measures of constructs (Hancock & Mueller, 2011; Ledgerwood & Shrout, 2011). In this paper, all the measures used were shown to be reliable ($\alpha > 0.7$; Raykov, 1998; see table 5.1), and the development, validation and application of the measures offers pervasive evidence for their validity in the context of adolescent exercise (e.g., Emm-Collison, Standage & Gillison, in press [Chapter 3], Markland & Tobin, 2004; Luszczynska & Schwarzer, 2003; Sniehotta, Scholz, & Schwarzer, 2005). Therefore, we can be confident that the measures are appropriate, reliable, and valid for use in the context of adolescent exercise behaviour.

A second recommendation is to use multiple indicators to predict a factor (i.e. as in full SEM; Cole & Preacher, 2014). As the sample size did not permit a full SEM model, factor scores were estimated through the testing of a measurement model. These factor scores were imputed to SPSS and used to estimate the score for each latent variable (DiStefano, Zhu, & Mindrila, 2009). In doing so, the latent variable estimates are weighted based on the contribution of each item in the appropriate scale, as would be the case in SEM. In the present study, this was particularly important for estimating autonomous motivation due to the different contribution of intrinsic motivation and identified regulation in predicting behavioural outcomes (e.g., Craike, Polman, Eime, Symons, Harvey & Payne, 2014; Lim & Wang, 2009; Taylor, Ntoumanis, Standage & Spray, 2010).

Therefore, in the present study, path modelling offers a compromise between regression analyses and full SEM for exploring the potential mediators of the motivation and behaviour relationship.

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Statement of Authorship

This declaration concerns the article entitled:									
The role of conscious and automatic self-regulation in translating motivation to behaviour: A self-determination theory perspective on adolescent exercise									
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Candidate's contribution to the paper (detailed, and also given as a percentage).	<p>Formulation of ideas: 70% The ideas for this paper emerged as a result of my previous PhD papers, and were refined in consultation with the other authors</p> <p>Design of methodology: 70% I used existing literature to identify measures of the potential mediators, and developed the proposal for the study with advice from the other authors.</p> <p>Experimental work: 100% I carried out all recruitment, data collection, data management and data analysis involved in this study</p> <p>Presentation of data in journal format: 80% The analyses and manuscript were conducted by me, and revised according to suggestions from the other authors</p>								
Statement from Candidate	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature.								
Signed							Date	25/09/2016	

The data presented in this paper are from a dataset which will be available to access through the the University of Bath Research Data Archive following publication of the manuscript.

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5.1. Abstract

It is well documented that the motivational processes outlined within self-determination theory (Deci & Ryan, 2000) predict adolescents' exercise behaviour. Yet the unifying processes that underpin these associations, at the proximal level of behaviour, are modestly understood. We propose that conscious (action planning and self-monitoring) and automatic (habit) self-regulation may be important in the translation of motivation to behaviour. The purpose of this study was to test the indirect relationships between psychological need support and adolescents' objectively assessed exercise behaviour and sedentary time, via autonomous motivation, and conscious and automatic self-regulation. Two-hundred and fifty-seven adolescents (M age = 13.5 years, SD = 1.04) completed questionnaires and wore ActiGraph™ accelerometers for eight days. Path analysis showed psychological need support to have a positive indirect effect on objectively assessed exercise behaviour, and a negative indirect effect on objectively assessed sedentary time, via autonomous motivation and automatic self-regulation. These findings provide evidence for the central role of automatic self-regulation in the translation of motivation to exercise behaviour.

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5.2. Introduction

Adolescent physical inactivity is a global health problem (Hallal, Victoria, Azevedo, & Wells, 2012). Across both developed and developing countries, physical inactivity increases the risk of a number chronic health problems including asthma, obesity, cardiovascular disease, and diabetes (e.g., Mitchel, Beasley, Bjorksten, Crane, Garcia-Marcos, & Keil, 2013). In the United States (U.S.), Canada, and the United Kingdom (UK) it is recommended that adolescents engage in moderate intensity activity for a minimum of 60 minutes a day, and undertake some vigorous intensity activity at least 3 times a week to maintain healthy functioning (Canadian Society for Exercise Physiology, 2016; Department of Health, 2011; US Department of Health and Human Services, 2008). Yet, estimates of objectively assessed exercise show that the majority of adolescents do not meet these recommendations (Colley, Garriguet, Janseen, Craig, Clarke, & Tremblay, 2011; Fakhouri, Hughes, Burt, Song, Fulton, & Ogden, 2014; Craig, Mindell, & Hirani, 2009), with levels as low as 7% in boys and 0% in girls in the UK (Craig et al., 2009). Understanding the determinants of exercise uptake and sustained engagement in adolescence is therefore a critical goal for researchers seeking to enhance population health.

5.2.1. Self-determination theory and adolescent physical activity and sedentary behaviour

Motivation is a key predictor of adolescent exercise behaviour (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Self-determination theory (SDT; Deci & Ryan, 2000) offers a framework of human motivation which can help to understand the motivational processes that underpin adolescent exercise behaviour. An organismic-dialectical approach to motivation, SDT addresses the inherent self-actualisation tendencies that underlie behavioural initiation, behavioural regulation, and psychological functioning (Deci & Ryan, 2012). Specifically, SDT proposes that behaviour and psychological wellness are governed by an internalisation process, which hinges on the extent to which social environments are supportive or thwarting of three basic psychological needs, namely; autonomy (feelings of volition and responsibility, inner endorsement of actions; Ryan, 1995), competence (feelings of efficacy and the ability to overcome challenges; Deci & Ryan, 2000), and relatedness (sense of belonging and being connected and cared for; Ryan, 1995). To the extent that these psychological needs are satisfied, behaviour is internalised, meaning that engagement and psychological wellness are likely to ensue (Deci & Ryan, 2000). However, to the extent that these

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psychological needs are frustrated, behaviour is only partially or non-internalised, leading to disaffection and psychological ill-being (Vansteenkiste & Ryan, 2013).

The internalisation process outlined within SDT has two key implications for exercise behaviour. The first is that the more internalised exercise is, the more likely one is to be physically active. The second is that social environments supportive of the psychological needs are likely to foster this internalisation process. To the former, within SDT a continuum of motivation regulations that differ in degree of internalisation is proposed (Deci & Ryan, 1985). Fully internalized and implicit regulations, often referred to as autonomous motivation, are identified (i.e. identification of the activity as useful in fulfilling personally meaningful goals, such as losing weight) and intrinsic (i.e., engagement in behaviour due to inherent enjoyment and interest derived). Non- and partially-internalized forms of motivation regulation are external (i.e., regulatory forces mandated by factors external to the self, such as rewards and punishments) and introjected (i.e., regulatory forces mandated by self-imposed contingencies, such as shame and guilt), which together are referred to as controlled motivation. In support of SDT, autonomous motivation is consistently shown to positively predict physical activity and exercise (e.g., Dishman, McIver, Dowda, Saunders, & Pate, 2015; Owen, Astell-Burt, & Lonsdale, 2013; Sebire, Jago, Fox, Edwards, & Thompson, 2013), as well as more sustained behavioural engagement (e.g., Curran, Hill, & Niemiec, 2013; Taylor, Ntoumanis, Standage & Spray, 2010; Papaioannou, Bebetos, Theodorakis, Christodoulidou, & Kouli, 2006), and negatively predict sedentary behaviour (Fenton et al., 2014). Similarly, controlled motivation is either unrelated or inversely associated with physical activity outcomes (e.g., Dishman et al., 2015; Sebire et al., 2013; Standage, Sebire & Loney, 2008).

The second implication of SDT for exercise is that autonomous motivation is promoted in social environments that are supportive of autonomy, competence, and relatedness. Supporting the tenets of SDT, research has shown that supports for the psychological needs are salient predictors of autonomous motivation for exercise (e.g. Hagger et al., 2009; Standage, Gillison, Ntoumanis, & Treasure, 2012; Zhang, Solmon, Kosma, Carson, & Gu, 2011). However, a limitation of this research is that it has focussed on the social environment in terms of autonomy support only (e.g., Curran, Hill, Ntoumanis, Jowett, & Hall, 2016; Gillison, Standage, & Skevington, 2013; Hagger et al., 2009), or psychological need support from just one social agent (e.g., PE teacher or coach; Adie, Duda, & Ntoumanis, 2012; Gagne, Ryan, & Bargmann, 2003; Zhang et

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al., 2011). Current research therefore overlooks the role of supports for competence and relatedness, and psychological need support from other social agents (e.g., family and peers), in the context of exercise behaviour.

Recent methodological developments, though, allow for the measurement of the full array of psychological need supports (i.e., autonomy, competence, and relatedness support), as well as the most relevant social agents (i.e., family, peers, and teachers; Emm-Collison, Standage, & Gillison, 2016). This research shows that supports for all three of the psychological needs predict autonomous motivation for exercise, through perceptions of psychological need satisfaction (Emm-Collison et al., in press; Zhang et al., 2011). Such work advances the previous SDT literature by suggesting that an environment that is supportive of competence and relatedness, as well as autonomy, is most effective at promoting overall psychological need satisfaction and autonomous motivation.

Despite empirical support for SDT's model of adolescent exercise, a number of questions remain. Of note, the associations between autonomous motivation and exercise are typically small-to-moderate (see Owen et al., 2014, for a review), with lower associations found in studies that adopted objective measurements (e.g., Aelterman, Vansteenkiste, Keer, Berghe, Meyer, & Haerens, 2012; Emm-Collison et al., in press; Owen et al., 2013). For example, Owen et al. (2013) found that autonomous motivation predicted 5% variance in leisure time activity. The weak direct association between motivation variables within SDT and exercise behaviour alludes to possible mediating processes that are rooted more proximally in the cognitions associated with the initiation of behaviour (Hagger et al., 2009).

5.2.2. The role of conscious and automatic self-regulation in translating motivation to behaviour

The contention that cognitions may bridge the motivation-behaviour divide has some empirical support. Indeed, it has been noted that although SDT offers a detailed conceptual model of the contextual factors and regulatory processes that underpin the reasons for behavioural imitation, it is not effective at explaining the cognitions through which these regulations are translated to behaviour (Hagger et al., 2009). Theories that disaggregate the motivation phase, whereby intentions to engage in a behaviour are formed, and the action stage, whereby cognitions mandate the implementation of the intention, provide a more comprehensive understanding of behaviour change, and allude to the instrumental role of self-regulatory processes in translating motivation to

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behaviour (Heckhausen & Gollwitzer, 1987). Here, the automatic self-regulatory process of habit, and the conscious self-regulatory processes of action planning and self-monitoring may be especially important.

Habit is defined as a self-regulatory process consisting of automatic behavioural initiation, which is enacted in response to repeated stimulus in certain contexts (e.g., school), and conditioned through recurrent engagement (Gardner, 2012). Due to its central role in persistence, habit formation has been identified as a target self-regulatory strategy in behavioural interventions (Lally & Gardner, 2011; Rothman, Sheran, & Wood, 2009). Evidence shows habit to be a strong predictor of sustained engagement in adaptive health behaviours, including a healthy diet (Rothman et al., 2009), and physical activity (Rhodes, De Bruijn, & Matheson, 2010). A recent view of the effects of non-conscious self-regulatory processes in the physical activity domain found distinct evidence for the role of habit in predicting physical activity (Rebar, Dimmock, Jackson, Rhodes, Kates, Starling, & Vandelanotte, 2016). For adolescent physical activity, habit has been shown to be a strong positive predictor of behavioural persistence, alluding to its important role in translating exercise motivation to behaviour (Kremers & Brug, 2008; Kremers, van der Horst, & Brug, 2007). However, habits are not readily formed and, in the early stage of activity uptake when habit strength is weak, studies show that conscious self-regulatory strategies, such as action planning and self-monitoring, are important compensatory predictors of behavioural outcomes (Tam, Bagozzi, & Spanjol, 2010).

Action planning is a conscious self-regulatory strategy that encompasses a number of cognitions through which behaviour is initiated (de Bruijn & Rhodes, 2011; Gollwitzer & Brandstatter, 1997). These cognitions include identifying where, when, and alongside whom a behaviour will be carried out, with contextual cues (e.g., a specific location and time) paired to the behaviour to enhance the likelihood of behavioural initiation. This self-regulatory strategy has consistently been shown to predict engagement in health behaviours, including cancer screening (Browne & Chan, 2012), a healthy diet (Adriaanse, Oettingen, Gollwitzer, Hennes, de Ridder, & de Wit, 2010), and physical activity (Sniehotta, Scholz, & Schwarzer, 2005). For adolescents, in particular, action planning has been shown to be an especially strong predictor of physical activity (e.g., Araujo-Soares, McIntyre, & Sniehotta, 2009; Dombrowski & Luszczynska, 2009; Luszczynska, Cao, Mallach, Pietron, Mazurkiewicz, & Schwarzer, 2010). Hence, alongside habit formation, studies suggest that this conscious self-

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regulatory strategy may be an important unifying process, linking motivation regulation to the initiation of physically active behaviour.

In addition to habit and action planning, self-monitoring provides another conscious self-regulatory process through which motivation may be translated to behaviour (Abraham & Michie, 2008). When self-monitoring, individuals use action plans as a reference, and involve a recurrent cognitive appraisal of whether these aims are being met (e.g., constantly keeping in mind how much exercise one should do each day). Self-monitoring has been shown to be a robust feature of successful physical activity initiation in adults (Michie, Abraham, Whittington, McAteer, & Gupta, 2009; Nahas, Goldfine, & Collins, 2003), particularly when combined with action planning (de Bruijn & Rhodes, 2011; Sniehotta, Scholz, & Schwarzer, 2005). There is also evidence for the effectiveness of self-monitoring as an intervention technique for increasing physical activity in adolescents (e.g., Pangrazi, Beighle, Vehige, & Vack, 2003; Pate, Wars, Saunders, Felton, Dishman, & Dowda, 2005). Together, this evidence suggests that self-monitoring, especially alongside action planning, is likely to be an important predictor of adolescent exercise behaviour.

In support of these ideas, habit, action planning, and self-monitoring have been shown to mediate relationships between motivation regulation and self-reported physical activity (Brickell & Chatzisarantis, 2007; Gardner & Lally, 2013; Nurmi, Hagger, Haukkala, Araujo-Soures, & Hankonen, 2016). For example, Nurmi et al. (2016) recently showed that both planning and self-monitoring mediated the positive indirect relationship between autonomous motivation and physical activity in older adolescent exercisers. Moreover, other studies similarly show that higher autonomous motivation yields higher self-reported physical activity through higher action planning and self-monitoring (Brickell & Chatzisarantis, 2007; Nurmi et al., 2016) and autonomous motivation has also been shown to influence automaticity independently of past behaviour (Gardner & Lally, 2013), indicating that motivation and its social-contextual determinants may be fundamental in habit formation.

These important empirical insights aside, there has to date been no research testing the mediating role of habit, action planning, and self-monitoring in relationships between autonomous motivation and objectively assessed adolescent physical activity. This is important because self-report measures are reliant on recall of activity over a period of time, the accuracy of which has been shown to be particularly problematic for

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children and adolescents (Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009). Further, extant research has also not attempted to integrate the social-context in this model to account for the array of psychological need supports (i.e., autonomy, competence, and relatedness) that govern the development of autonomous motivation. This is important because the array of psychological need supports are of fundamental importance to interventions committed to enhancing the autonomous motivation that is instrumental in behavioural persistence.

5.2.3. *The present study*

The present study had the primary purpose of testing a process model of objectively assessed physical activity and sedentary behaviour in a sample of high-school adolescents. This model can be seen in Figure 5.1. Based on extant theory and research, we hypothesised that perceived psychological need support from parents, teachers, and peers would positively predict adolescents' autonomous motivation for exercise. In turn, adolescents' autonomous motivation for exercise was expected to positively predict their exercise habits, action planning, and self-monitoring. Finally, exercise habit, action planning, and self-monitoring were expected to positively predict adolescents' objective physical activity and negatively predict sedentary behaviour.

5.3. Method

5.3.1. *Participants*

Adolescents aged 11-15 years were recruited through four schools in the South West of England. The inclusion criteria were; (a) to be enrolled in full time education within the UK, and (b) to have a good comprehension of English so as to understand the questionnaire sufficiently.

5.3.2. *Measures*

Psychological need support. Perceptions of support for autonomy (e.g., 'I feel that they encourage me to do the exercise activities that I want to do'), competence (e.g. 'They help me to improve my exercise abilities'), and relatedness (e.g., 'I feel that they care about me') were assessed using the 9-item Adolescent Psychological Need Support in Exercise Questionnaire (APNSEQ; Emm-Collison et al., in press). Participants completed the measure three times in relation to three different social agents; family, friends, and PE teacher. In the present study, the stem was 'In my interactions with my family/friends/PE teacher about exercise...' and participants were asked to respond

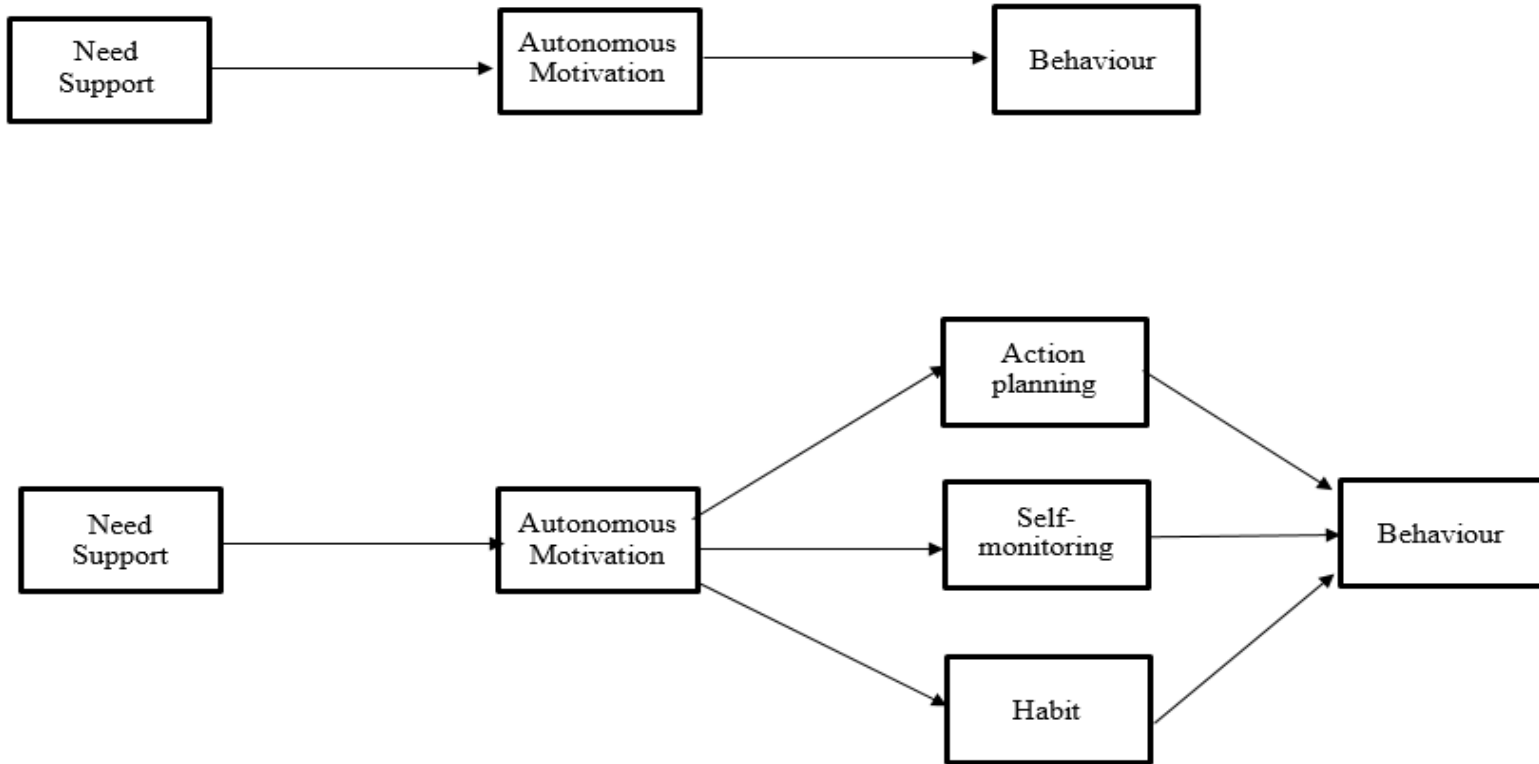


Figure 5.1. The hypothesised model for the relationship between autonomous motivation and exercise behaviour as mediated through action planning, self-monitoring, and habit.

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using a 7-point Likert scale ranging from 1 (*strongly disagree*) through 4 (*neither agree nor disagree*) to 7 (*strongly agree*). The measure has been validated in a sample of British adolescents (Emm-Collison et al., in press). Responses to all the subscales were combined to provide a mean score of overall psychological need support.

Autonomous motivation towards exercise. Autonomous motivation towards exercise was assessed using items from the Behavioural Regulations in Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004). Two scales from the BREQ-2 were used, with four items pertaining to intrinsic motivation (e.g., ‘I enjoy my exercise sessions’) and four to identified regulation (e.g., ‘I value the benefits of exercise’). Participants respond using a 5-point Likert scale ranging from 0 (*not true for me*) through 2 (*sometimes true for me*) to 4 (*very true for me*). The scale has previously demonstrated good psychometric properties in adolescent samples (e.g., Gillison, Osborn, Standage, & Skevington, 2009; Gillison, Standage, & Skevington, 2006). For the purposes of our analysis, the intrinsic and identified regulation subscales were combined and appropriately weighted as a composite for autonomous motivation.

Action planning. Four items were used to assess action planning (Luszczynska & Schwarzer, 2003). Here, participants were asked to think about their plans for exercise over the next 7 days. The stem ‘I have made a detailed plan regarding...’ preceded the four items asking about plans of when, where, how, and how often they would exercise over the next 7 days (e.g., ‘I have made a detailed plan regarding when to do my exercise’). Responses were recorded on a 6 point Likert scale from 1 (*not at all for me*) to 6 (*exactly true*). This scale has demonstrated good reliability in adolescent physical activity contexts (Nurmi et al., 2016).

Self-monitoring. Six items assessed self-monitoring in exercise (Sniehotta et al., 2005). The measure was completed upon hand in of the accelerometer, and the items referred to the previous seven days of accelerometer measurement. The stem used was ‘During the past seven days, I have...’ and items referred to the extent to which they self-monitored their exercise behaviour during this time (e.g., ‘always been aware of my planned exercise programme’). Responses were given on a 5-point Likert scale from 1 (*totally disagree*) through 3 (neutral) to 5 (*totally agree*). The scale has been used in previous exercise and physical activity research and demonstrated good reliability (Nurmi et al., 2016).

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Habit strength. Habit strength was measured using the 10-item self-reported habit index (SRHI; Verplanken & Orbell, 2003). Items were preceded by the stem ‘Exercising on at least 3 days a week for at least 20 minutes a day is something...’ so as to assess the automaticity of obtaining some exercise through items such as ‘...I do without thinking’ and ‘...I would find hard not to do’. Levels of agreement with each statement were recorded on a 5 point Likert scale from 1 (*totally disagree*) through 3 (*neutral*) to 5 (*totally agree*). The scale has previously been shown to be a reliable tool in exercise research with children (e.g., Jurg, Kremers, Candl, Van Der Wal, & de Meij, 2006) and adults (e.g. Chatzisarantis & Hagger, 2007).

Exercise and sedentary behaviour. Actigraph™ GT1M, GT3X and GT3X+ accelerometers were used to objectively measure exercise behaviour. Research has shown the use of different ActiGraph™ models within a single study to be acceptable (Robusto & Trost, 2012). Accelerometers were waist mounted on an elasticated belt, worn on the right side of the body. Participants were encouraged to wear the accelerometer for 24 hours a day for eight days (one adjustment day and seven measurement days) including two weekend days (Tudor-Locke et al., 2015). In line with previous studies, the minimal amount of data to be considered valid was four days, with at least 10 hours of wear time per day and including one weekend day (Tudor-Locke et al., 2015). The accelerometers were initialised to measure in 10 second epochs and the data were categorised using cut points proposed by Evenson, Cattellier, Gill, Ondrak & McMurray (2008) which are recommended for estimating sedentary, light, moderate and vigorous activity in adolescents (Reilly, Penprze, Hislop, Davies, Grant, & Paton, 2008; Trost, Loprinzi, Moore, & Pfeiffer, 2011).

5.3.3. Procedure

Ethical approval was sought and granted from the authors’ institutional ethics committee prior to commencing the research. Schools were invited to take part in the study via telephone and email. The purpose and nature of the study was explained and consent sought from senior members of staff, in line with British Psychological Society guidelines (2014). Following consent from senior school staff, information sheets were sent out to parents, giving them the opportunity to opt their child out of participating in the study. Informed assent was obtained from students who had not been opted out and who wished to participate. The questionnaire, consisting of measures of psychological need support, autonomous motivation, exercise habit strength, and action planning for

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the subsequent eight measurement days were completed during a normal school day, with a researcher present in order to answer any questions. To ensure consistency, and in line with established good practice (Katzmarzyk et al., 2013), we did not re-interpret any of the questions to the students raising queries, but did provide definitions of words if required. Once all measures had been completed, participants were fitted with the accelerometers. Participants were instructed to wear the accelerometers for the full eight day measurement period, taking it off only for water-based activities (i.e., swimming, showering, bathing) or if there was a risk of injury to them or someone else (e.g., in contact sports). The researcher returned to the school eight days later to collect the accelerometers, and a measure of self-monitoring of exercise over the previous eight measurement days was completed. Measurements were matched by a unique participant number.

5.3.4. Data analysis

Data were first screened for missing data and outliers. Following data screening, the main analyses were conducted via path analysis in MPlus 7.3 (Muthén & Muthén, 1998-2015). We used path analysis because our sample size did not permit a participant to parameter ratio sufficient for latent variable structural equation modelling (i.e., 10:1; Kline, 1998). In line with previous papers adopting this methodology (e.g., Ntoumanis et al., 2014; Trost, Sallis, Pate, Freedson, Taylor, & Dowda, 2003) each latent variable was indicated by one observed variable representing the mean score of all items representing that factor. Model fit was assessed using the following indices; the Chi-square index, the comparative fit index (CFI), standardised root mean square residual (SRMR), and root mean square of approximation (RMSEA). The thresholds used were $>.90$ for acceptable fit and $>.95$ for excellent fit with regards to the CFI and TLI (Hu & Bentler, 1999), $< .08$ for the SRMR, and $< .06$ for the RMSEA (Hu & Bentler, 1999).

5.4. Results

5.4.1. Participant characteristics

A sample of 258 adolescents aged between 11 and 15 completed all study measures (M age = 13.5, $SD = 1.04$). Of these, 72.9% were female and 88% were white. Body fat percentage ranged from 5.3 to 49.1 ($M = 23.9$, $SD = 8.02$). At least seven valid days of accelerometer data were obtained for the majority of participants ($N=191$), with 67 participants providing between 4 and 6 valid days of data.

Table 5.1

Descriptive statistics and correlations for all study variables.

	M	SD	Need support	Autonomous motivation	Action planning	Self-monitoring	Habit	Daily MVPA	Sedentary time
Need support	5.50	.78	.88						
Autonomous motivation	2.96	.74	.51**	.72					
Action planning	3.70	1.09	.26**	.49**	.71				
Self-monitoring	3.11	.67	.41**	.56**	.48**	.71			
Habit	3.86	.99	.41**	.80**	.49**	.48**	.71		
MVPA (hours per day)	0.78	.32	.16**	.16**	.18**	.15*	.20**	-	
Sedentary time (hours per day)	19.50	1.70	.01	-.05	-.01	.01	-.09	-.48**	-

Significant relationship at * $p < .05$ and ** $p < .01$ (two-tailed). Composite reliability scores (Raykov, 1997) are shown on the diagonal. The cut point for Daily MVPA is ≥ 2296 counts per minute and the cut point for daily sedentary time is ≤ 100 counts per minute (Evenson et al., 2008).

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5.4.2. Preliminary analyses

The data were screened for missing data and outliers. All participants had less than 5% missing data and hence missing data were imputed using the mean of the available subscale items (Graham, Cumsille, & Elek-Fisk, 2003). Following data imputation univariate and multivariate outliers ($p < .001$) were inspected. Two outliers were identified and removed from the dataset (Tabachnick & Fidell, 2007). However, the resulting data still displayed multivariate asymmetry, and following recommendations, all subsequent analyses were conducted using maximum likelihood estimation coupled with a bootstrapping procedure drawing 5000 bootstrap replications (Byrne, 2010). The confidence intervals of the parameter estimates are those derived from the standard deviations yielded by this bootstrapping procedure. Descriptive statistics, scale internal consistencies, Pearson correlation coefficients (2 tailed), and significance levels are shown in Table 5.1. Composite reliability of the study variables demonstrated good internal consistency ($CR \geq .70$; Raykov, 1997) and the correlational relationships supported the hypothesised model (see Table 5.1 and Figure 5.1).

5.4.3. Primary analyses.

First, the simple path model (figure 5.1) was tested twice for the two outcome variables (viz., daily MVPA and sedentary time). The model was an excellent fit to the data for: MVPA; $\chi^2_{(1)} = 2.38, p = .12$; Bollen-Stine bootstrap $p = .12$, CFI=.98, SRMR=.03, RMSEA=.07 90% CI [.00, .20] and sedentary time $\chi^2_{(1)} = .57, p = .45$; Bollen-Stine bootstrap $p = .45$, CFI=1.00, SRMR=.01, RMSEA=.00 90% CI [.00, .15]. Standardized regression weights (figures 5.2 and 5.3) showed that need support positively predicted autonomous motivation, and autonomous motivation positively predicted MVPA but had no significant association with sedentary time. The model explained 3% variance in MVPA and 1% variance in sedentary behaviour.

Subsequently, the hypothesised mediation model (figure 5.1) was tested twice for the two outcome variables. Many of the indices of model fit suggest that the model was an acceptable fit to the data for: daily MVPA $\chi^2_{(7)} = 42.52, p < .001$; Bollen-Stine bootstrap $p < .001$, CFI=.94, SRMR=.07, RMSEA=.14 90% CI [.10, .18] and sedentary time $\chi^2_{(7)} = 40.77, p < .001$; Bollen-Stine bootstrap $p < .001$, CFI=.94, SRMR=.05, RMSEA=.14 90% CI [.10, .18]. However, the RMSEA and chi-square values suggest that the model is a poor fit to the data in both models, perhaps due to the increased complexity of the model and thus higher degrees of freedom.

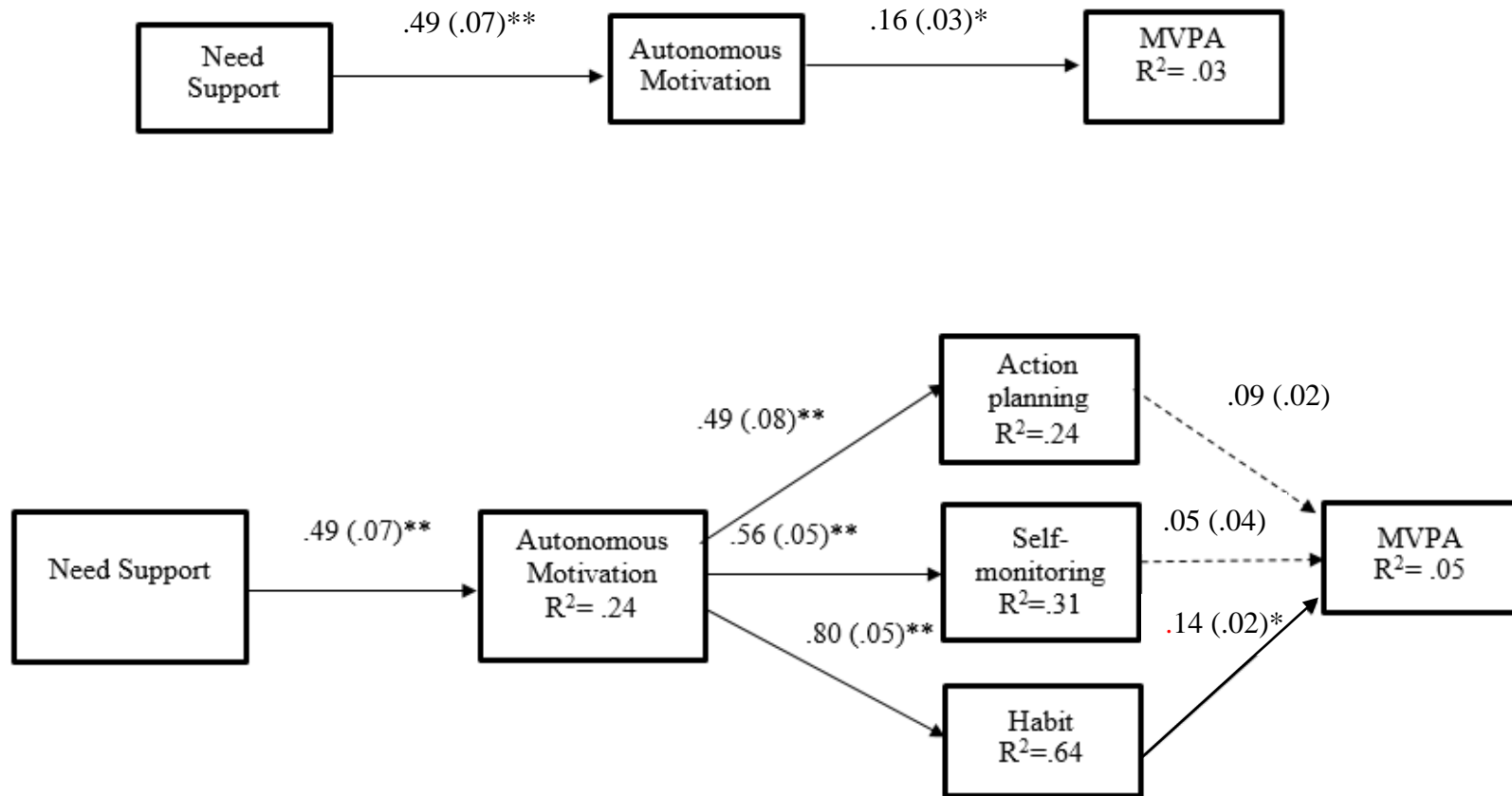


Figure 5.2. The path analysis model for the relationship between autonomous motivation and daily MVPA as mediated through action planning, self-monitoring and habit. ** denotes significance at the $p < .001$ level (2-tailed), * denotes significance at the $p < .05$ level (2-tailed).

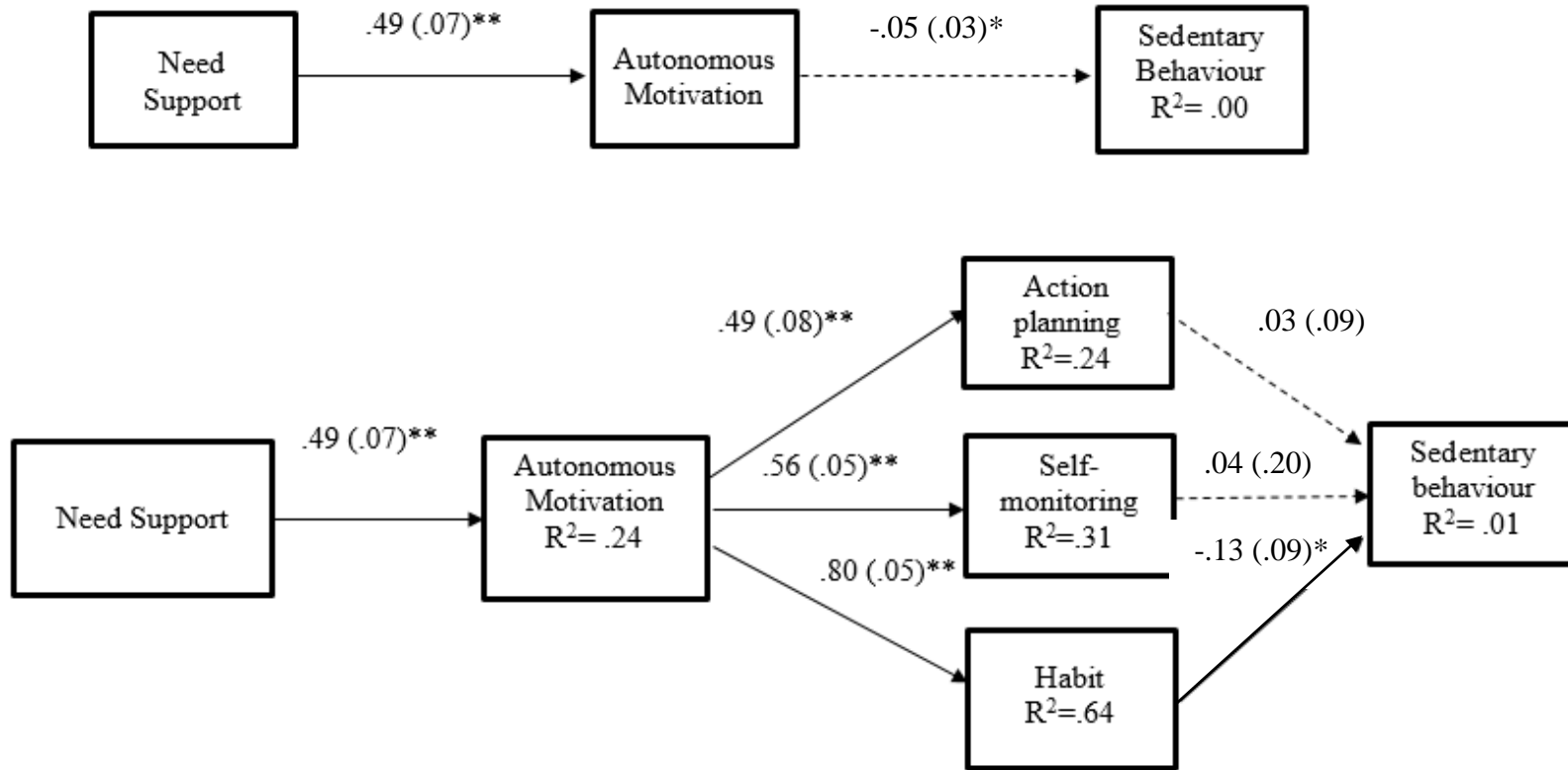


Figure 5.3. The path analysis model for the relationship between autonomous motivation and sedentary behaviour as mediated through action planning, self-monitoring and habit. ** denotes significance at the $p < .001$ level (2-tailed), * denotes significance at the $p < .05$ level (2-tailed).

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Standardised regression weights (Figure 5.2 and 5.3) showed that overall psychological need support positively predicted autonomous motivation. Autonomous motivation, in turn, positively predicted action planning, self-monitoring, and habit. Habit positively predicted MVPA and negatively predicted sedentary time. No other significant paths were observed in the path models. The models explained 24% of the variance in autonomous motivation, 64% of the variance in habit, 24% of the variance in action planning, 31% of the variance in self-monitoring, 5% of the variance in MVPA, and 1% of the variance in sedentary behaviour.

The standardised total and specific indirect effects are shown in table 2. The findings show a significant positive indirect effect of autonomous motivation on MVPA. The specific indirect effects illustrate that this indirect effect is due to the direct effects of autonomous motivation on habit strength. The total indirect effect for the relationship between autonomous motivation and sedentary behaviour was approaching significance ($p=.08$), and the data supported a significant negative indirect pathway of autonomous motivation to sedentary time via habit. Further to this, the specific indirect effects show need support to significantly positively predict habit strength, action planning, and self-monitoring through autonomous motivation.

5.5. Discussion

The present study sought to investigate the processes through which autonomous motivation influences objectively assessed adolescent exercise and sedentary behaviour. The results showed autonomous motivation to predict greater conscious (i.e., action planning and self-monitoring) and automatic self-regulatory processes (i.e., habit), but only habit significantly predicted exercise and sedentary behaviour. The indirect effects showed that autonomous motivation indirectly predicted daily MVPA through its direct effects on habit, but not through action planning or self-monitoring, indicating that automatic self-regulatory processes may be more influential for exercise and sedentary behaviour than conscious processes. Additionally, and in line with previous research (e.g., Nurmi et al., 2016; Gardner & Lally, 2013), autonomous motivation predicted action planning, self-monitoring, and habit. Further to this, and beyond the scope of previous research (e.g., Nurmi et al., 2016), perceptions of need support predicted autonomous motivation and self-regulation. Further, the mediation model explained more variance in behaviour than the simple model. This study provided the first test of

Table 5.2

Standardised total and specific indirect effects for the two models (Daily MVPA and sedentary time)

Parameter			β	Bootstrap bias-corrected 95% CIs (Lower, upper)		
Total indirect effects						
Autonomous motivation	→	MVPA	.19**	.09, .27		
Autonomous motivation	→	Sedentary	-.07	-.14, -.00		
Specific indirect effects						
Need Support	→	Autonomous motivation	→	Habit	.35**	.25, .45
Need Support	→	Autonomous motivation	→	Action Planning	.21**	.14, .28
Need Support	→	Autonomous motivation	→	Self-Monitoring	.24**	.16, .32
Autonomous motivation	→	Habit	→	MVPA	.12*	.02, .20
Autonomous motivation	→	Habit	→	Sedentary	-.11*	-.18, -.03

Note. **indicates significance at the 0.001 level (2 tailed), * indicates significance at the .05 level (2 tailed).

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the relationship between need support, autonomous motivation, habit, action planning and self-monitoring simultaneously.

Beyond existing research that has shown habit to be a strong predictor of both exercise and sedentary behaviour in children, adolescents, and adults (Kremers & Brug, 2008; Rebar et al., 2016) and, in line with suggestions that autonomous motivation may be involved in habit formation (Gardner & Lally, 2013), our findings provide initial evidence for habit as a mediator in the relationship between autonomous motivation and exercise and sedentary behaviour. Whilst more longitudinal research investigating the process of habit formation is needed in order to ascertain the motivational antecedents of habit and behaviour, these findings allude to the process through which autonomous motivation may influence long-term behaviour (e.g., Taylor et al., 2010; Papaioannou et al., 2006), primarily through promoting more habitual behaviour. It has been suggested that less internalised regulation inhibits the development of behavioural automaticity due to a conscious focus on external factors (Gardner & Lally, 2013) and therefore, due to a decreasing focus on external factors, promoting the internalisation process, and in turn facilitating more autonomous motivation, may foster stronger exercise habits.

Despite autonomous motivation positively predicting engagement in action planning and self-monitoring, these conscious self-regulatory processes did not predict behavioural outcomes, and did not significantly mediate the relationship between autonomous motivation and behavioural outcomes. Evidence in adult populations has consistently shown self-regulatory processes to be key predictors of physical activity related outcomes, and also to be central in translating motivation to behaviour (Brickell & Chatzisarantis, 2007; Hagger, Wood, Stiff & Chatzisarantis, 2010; Nurmi et al., 2016; Sniehotta et al., 2005). However, biases within the existing evidence orienting towards frameworks that focus on conscious self-regulation over automatic processes have been highlighted (Rebar et al., 2016). Our findings suggest that self-regulation may not be as pertinent to exercise outcomes as habit in the context of adolescent exercise behaviour. Although this is in contrast to previous cross-sectional studies using self-reported physical activity as the dependent variable (e.g., Dombrowski & Luszczynska, 2009), our findings align with longitudinal research which has found no significant individual effects of action planning or self-monitoring on behavioural outcomes (e.g., Araujo-Soares et al., 2009).

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Considering existing evidence for the role of conscious self-regulation in promoting exercise habits (de Bruijn, Gardner, van Osch, & Sniehotta, 2011; de Bruijn & Rhodes, 2011), and the proximity of habit to behaviour, there is likely to be some shared variance between these factors in predicting exercise outcomes. This may have resulted in a suppression effect, whereby the influence of habit masked any unique contribution of action planning and self-monitoring in predicting exercise outcomes. However, Gardner, de Bruijn, & Lally (2011) suggest that habits may override any intentional processes relating to behaviour, and therefore research adopting a longitudinal design is required in order to ascertain the relative roles of conscious and automatic processes in determining adolescent exercise and sedentary behaviour. There is also evidence in other health behaviour contexts to suggest that conscious self-regulation is more pertinent to behavioural outcomes when habit strength is weak (Tam et al., 2010), indicating a moderation effect of habit. In the current sample, habit strength was generally high which could explain why action planning and self-monitoring were not related to exercise or sedentary behaviour. Future research could further investigate the potential moderation effect of habit strength on the relationship between self-regulation and behavioural outcomes through techniques such as cluster analysis.

While habit was shown to significantly mediate the relationship between autonomous motivation and both exercise and sedentary behaviour, the inclusion of the self-regulatory mediators in the model did not explain much additional variance in either behaviour, compared to the simple SDT model alone. This suggests that there are additional processes, aside from those incorporated within the present paper, involved in the translation of autonomous motivation to behaviour. Drawing on the existing literature within the SDT framework, coping planning (i.e., the pairing of situational cues associated with undesired behaviour or non-action, with a cognitive or behavioural response that inhibits the undesired behaviour, or facilitates actions; Sniehotta, 2009) may offer a key mediator, as it has been shown to mediate the relationship between autonomous motivation and physical activity in older adolescents (Nurmi et al., 2016), and is also consistently shown to be a key predictor of adolescent physical activity behavior (Araujo-Soares et al., 2009; Luszczynska et al., 2010). Additionally, it should be considered that conscious self-regulatory processes can be engaged in for controlled reasons, and thus they may have limited influence on behavioural outcomes (Hagger et al., 2010). With this in mind, it may be useful for future research to consider these mediators in the context of a more

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comprehensive model of SDT, encompassing both the brighter (i.e., need support, need satisfaction, and autonomous motivation) and darker (i.e., need thwarting, need frustration, and controlled motivation) theoretical constructs.

Whilst the current study adopted a cross-sectional design, and therefore causal relationships cannot be inferred, there are some useful practical insights. Our findings suggest that a need supportive environment predicts self-regulatory behaviours and behavioural automaticity, through fostering more autonomous motivation. Therefore, if the development of long-term behavioural patterns is a primary intervention goal (Lally & Gardner, 2011; Rothman et al., 2009), cultivating need supportive environments for adolescent exercise (i.e., promoting need supportive behaviours from families, friends and PE teachers) may offer a practical route through which to impact exercise behaviour in the long term, by promoting automaticity and effective engagement in self-regulatory behaviours.

Notwithstanding the strengths of the current research, there are a number of limitations which must be acknowledged. First, whilst the cross-sectional design of this study was appropriate for initial exploration of the processes through which motivation may influence physical activity outcomes in adolescence, it did not allow for causal inferences to be made. Future research should obtain longitudinal data and test the hypothesised mediation model in order to further understand the dynamic relationships between need support, autonomous motivation, self-regulatory processes and exercise and sedentary behaviour. A particularly insightful avenue for future research would be to obtain data during the development of new exercise behaviours, in order to further investigate the role of self-regulation in behavioural change, and to provide insight into the antecedents of habit formation (Judah, Gardner & Aunger, 2013).

Second, all questionnaire measures were completed with regards to exercise, and not to sedentary behaviour. Previous research suggests independence of exercise and sedentary behaviours (e.g., Marshall, Biddle, Sallis, McKenzie & Conway, 2002), and highlights that the antecedents of these behaviours differ (Biddle, Gorley & Stensel, 2004). Further, sedentary behaviours have been shown to be underpinned by habits (Conroy, Mather, Elavsky, Hyde & Doerksen, 2013). Therefore, an understanding of the predictors of sedentary behaviour, and the processes involved in developing sedentary habits, would allow for interventions to target existing habitual sedentary behaviour.

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Similarly, physical activity and sedentary behaviour were assessed with the same accelerometers, and therefore these outcomes are dependent on each other. The assessment of sedentary behaviour purely through accelerometers may be problematic due to conflation with low levels of physical activity (Hardy et al., 2013), although the cut points used have been shown to be suitable for distinguishing between sedentary and active time (Evenson et al., 2008). Using a combination of methods (e.g., observation, self-report, and accelerometry) would allow for more detailed information regarding sedentary behaviour to be obtained.

Third, experts have highlighted issues with using the SRHI to assess automaticity due to its inclusion of items referring to behavioural frequency (e.g., Gardner, 2015; Rebar et al., 2016). Whilst these items were not used in the current study, it is proposed that assessing habit through any self-report measure may be problematic, due to an inability to accurately reflect on non-conscious regulatory processes (Rebar et al., 2016). However, there are currently no alternative methods through which to assess behavioural automaticity. Therefore, the development of more creative ways in which to assess behavioural automaticity, ideally through methods other than self-report would be useful for future research.

5.5.1. Conclusions

Through the present study we provide initial evidence for the mediating role of exercise habit in the relationship between autonomous exercise motivation and adolescent exercise and sedentary behaviour. Autonomous motivation predicted higher levels of conscious and automatic self-regulation (i.e., action planning, self-monitoring and habit) and habit predicted higher exercise and lower sedentary time. Further to this, a need supportive environment indirectly predicted both conscious and automatic self-regulation through fostering more autonomous motivation. However, the mediation model only predicted a small amount of additional variance in objective estimates of exercise and sedentary behaviour than the simple path model alone. These initial findings suggest that promoting an autonomy supportive environment may positively influence behavioural outcomes, through increasing autonomous motivation and exercise habit.

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Concluding commentary

With a view to further understanding the motivational processes underpinning adolescent exercise and sedentary behavior, and in light of the weak association between autonomous motivation and behavioural outcomes found in Chapter 4, the paper presented in this chapter tested a mediation model whereby the relationship between autonomous motivation and exercise and sedentary behavior was mediated by habit. The findings provide evidence for the role of automatic self-regulation in the translation of autonomous motivation to exercise and sedentary behavior. Further to this, the findings provide initial evidence for the role of need support in facilitating both autonomous motivation and self-regulatory processes.

Whilst further research investigating the motivational processes that underpin adolescent exercise and sedentary behaviour is encouraged, the papers presented in this thesis offer evidence for the role of need support from family, friends, and PE teachers as an antecedent for exercise motivation, and the subsequent role of regulatory processes in determining adolescent exercise and sedentary behaviour. The collective contribution of the papers encompassed within this thesis will be discussed in the Chapter 6.

Chapter 6

General Discussion

General Discussion

6.1. Introduction

Through the four studies presented in this thesis, I aimed to address some of the theoretical and methodological issues highlighted in the existing literature. Specifically, four common limitations of the extant SDT literature were addressed; a lack of awareness of how adolescents conceptualise of exercise, the absence of a holistic measure of need support specific to the adolescent exercise context, a traditional reliance on self-report measures for exercise and sedentary behaviours, and the need for a deeper understanding of the more proximal mediators in the relationship between exercise motivation and behaviour. In addressing these limitations, I sought to obtain a better understanding of the motivational processes that underpin adolescent exercise engagement.

This chapter summarises the findings of these four studies which collectively support the application of SDT in the adolescent exercise context. I discuss how these findings correspond with theoretical proposals and research findings in the extant literature, and also discuss the theoretical and methodological advances made through these studies. Limitations, practical applications and avenues for future research are also considered.

6.2. Summary of findings

6.2.1. The meaning of exercise to adolescents

In Chapter 2, I used qualitative methods to address the measurement issue of how adolescents conceptualise exercise. There is an abundance of research investigating physical activity and exercise behaviour in children and adolescents, but while many researchers refer to exercise in their studies with adolescents (e.g., Gillison, Standage, & Skevington, 2006; Maltby, Wood, Vlaev, Taylor, & Brown, 2012) there has been no empirical enquiry into whether adolescents' understanding of exercise aligns with our own perceptions as researchers, or definitions of exercise (e.g., WHO, 2010) that are sometimes presented to participants in research studies (e.g., Standage, Sebire, & Loney, 2008). With a view to addressing the gap in the literature regarding how adolescents understand exercise, through this study I sought to identify the types of activities adolescents consider to be exercise, and the reasons why they classify activities as such.

The findings show that adolescents understand exercise as a broad concept that encompasses a range of specific activities that experts may classify in a different way

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(e.g., housework and sport; Ainsworth et al., 2011). In contrast to previous research that has shown younger children to be unable to accurately separate physical activity and sedentary behaviours (e.g., Trost, Morgan, Saunders, Feton, Ward, & Pate, 2000), these findings suggest that adolescents have a more accurate understanding of whether behaviours are active or not, and thus the capacity to recognise activities that can contribute towards exercise. The results also suggest that adolescents differentiate between exercise and physical activity in terms of intensity, rather than by activity. From this it can be inferred that adolescents may engage in exercise through a vast array of activities provided that they are performed at a sufficient intensity.

Additionally, the participants displayed an excellent awareness of the health and fitness benefits of exercise. The findings of previous qualitative studies suggest that adolescents are motivated to engage in physically active behaviours for social and aesthetic reasons rather than as a means to improve health and fitness (Allender, Cowburn, & Foster, 2006; O'Dea, 2003), although much of this literature has focussed on adolescent girls. However, our findings suggest that adolescents are also aware of the health and fitness benefits of exercise. Whilst we are unable to infer whether adolescents exercise for health and fitness reasons from the data obtained in this study, the awareness of the health benefits of exercise that the participants communicate may reflect a cultural change since the previous studies were conducted, where health and fitness have become more prevalent to adolescents (e.g., through media such as the internet; Wartella, Rideout, Montague, Beaudoin-Ryan, & Lauricella, 2016). Therefore, with these cultural changes in mind, it may be of interest in future research to once again investigate the reasons why adolescents engage in exercise.

The results highlight the importance of considering the breadth of adolescent's conceptualisation of exercise in the interpretation of exercise-related questionnaire responses (e.g., BREQ-2; Markland & Tobin, 2004), as participants may be responding to measures with reference to an array of different activities, including sport and activities of daily living. Furthermore, considering the importance that the participants placed on intensity when defining exercise, the results of this study can also be used to inform the measurement of adolescent exercise behaviour. Specifically, measurement should ensure that activity intensity is accurately captured in order to differentiate between adolescent exercise and physical activity.

6.2.2. Measurement of need support in the adolescent exercise context

In Chapter 3 I present the development and validation of the Adolescent psychological need support in exercise questionnaire (APNSEQ) which was designed to assess perceived need support for exercise from significant others. Prior to this, measures of need support in the exercise context either focussed on autonomy-support whilst being conflated with competence- and relatedness- support items (e.g., PASSES; Hagger, Chatzisarantis, Hein, Pihu, Soos, & Karsai, 2007), or were specific to authoritative others, such as teachers and coaches, whilst neglecting to account for support from peers and families (e.g., LCQ; Williams Wiener, Markakis, Reeve, & Deci, 1994). The development of the APNSEQ addresses these issues by providing a holistic measure of need support (i.e., adequately encompassing support for autonomy, competence, and relatedness) that is applicable to a number of significant relationships significant to adolescent exercise (i.e., family, friends and PE teacher).

The results substantiate the psychometric integrity of the APNSEQ through confirming the 3-factor structure and the composite reliability of the subscales in independent samples of adolescents, therefore supporting the measure as a valid and reliable tool to assess competence- and relatedness-support. Additionally, as this measure was designed and validated within the adolescent exercise context, it offers a more contextually relevant measure than adapted versions of other context specific questionnaires (e.g., Teacher as a social context questionnaire; Wellborn, Connell, Skinner, & Pierson, 1988).

The results also support the use of the APNSEQ for assessing support from three social agents pertinent to the context of adolescent exercise (i.e., family, friends, and PE teacher; Gagne, Ryan, & Bargmann, 2003; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003; Salvy, de la Haye, Bowker, & Hermans, 2012). In light of evidence to suggest that adolescent exercise behaviour is influenced by informal relationships, such as with family and friends (Gagne et al., 2003; Salvy et al., 2012), the APNSEQ provides a valid measure through which to extend the growing body of literature pertaining to need support from family members and friends, as well as PE teachers (Cox & Ullrich-French, 2010; McDavid, Cox, & Amorose, 2012; Amorose, Anderson-Butcher, Newman, Fraina, & Iachini, 2016). Additionally, the invariance of the APNSEQ across social agents provides support for the comparability of results from family, friends, and PE teacher. Therefore, the APNSEQ measure can be used to compare the independent effects of need-support from these different social agents in predicting motivational, behavioural, and

well-being outcomes. Similarly, considering evidence showing autonomy-support from multiple social agents to be more predictive of motivation than support from just one (Amorose et al., 2016), the APNSEQ can be used to assess need-support from three different social agents, allowing researchers to capture a more comprehensive overview of the positive social-contextual antecedents of motivation.

6.2.3. The holistic SDT model as applied to objectively-assessed adolescent exercise behaviour

In light of methodological advances both within this thesis (i.e., the insights into the conceptualisation of adolescent exercise and the development of the APNSEQ) and in technology (e.g., objective assessment of physical activity and exercise through accelerometers), in Chapter 4 I empirically tested a holistic model of SDT within the context of adolescent exercise and sedentary behaviour. In this study the APNSEQ measure developed in Chapter 2 was applied alongside a measure of need thwarting, measures of both need satisfaction and frustration, and autonomous and controlled motivation, to predict accelerometer-assessed exercise and sedentary behaviour. This study was the first test of a holistic SDT model assessing both the brighter (i.e., need support, need satisfaction, and autonomous motivation) and darker (i.e., need thwarting, need frustration, controlled motivation, and amotivation) theoretical constructs in predicting objectively assessed exercise and sedentary behaviour in adolescents. The results supported the theoretical relationships proposed within SDT, and demonstrated the role of the brighter aspects of the theory in predicting behavioural outcomes. However, the findings did not support the relationship between the darker constructs (i.e., need thwarting, need frustration, controlled motivation, and amotivation) and behaviour.

Extending previous literature that has considered the role of autonomy support in predicting need satisfaction and motivation (e.g., Haerens, Aelterman, Vanseenkiste, Soenens, & van Petegem, 2015), the findings provide initial evidence for the role of autonomy-, competence-, and relatedness-support in determining motivational outcomes. The relationship between need support and need satisfaction was stronger than in studies where just autonomy-support has been assessed (e.g., Balaguer, Gonzlalez, Fabra, Castillo, Merce, & Duda, 2012; Haerens et al., 2015). Similarly, the relationship between need thwarting (encompassing autonomy, competence, and relatedness) and need frustration was stronger than in studies where just autonomy-thwarting has been assessed (e.g., Balaguer et al., 2012; Haerens et al., 2015). These findings suggest that support and thwarting for competence and relatedness contribute

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to need satisfaction and frustration over and above the contribution of autonomy support and thwarting, and thus offer further support for the inclusion of these constructs in SDT research. Additionally, the findings suggest that environments and relationships that support the needs of autonomy, competence, and relatedness may be effective at promoting more autonomous exercise motivation and behaviour. Therefore, interventions which seek to foster more autonomous motivation through creating a need supportive environment may be successful in increasing physical activity and exercise behaviour. However, the findings also suggest that controlled motivation and amotivation are not predictive of the behavioural outcomes. Despite these findings contrasting with the propositions within SDT (Ryan & Deci, 2000), they are in line with previous research in similar contexts that have also shown no relationship between controlled motivation and amotivation with physical activity related outcomes (e.g., Fenton et al., 2014; Taylor et al., 2010). The growing body of literature indicating that these constructs are not related to behaviour suggest that future research should focus on further investigating the role of these darker constructs on well- and ill-being outcomes (e.g., Jackson-Kersey & Spray, 2013).

Chapter 4 also represents the first application of the holistic SDT model to objectively assessed exercise and sedentary behaviour. Through the use of accelerometers, more accurate estimates of exercise and sedentary behaviour were obtained than through self-report measures, which are often biased and overestimate activity levels (Sallis & Saelens, 2000). Also, given the findings presented in Chapter 2 regarding adolescents' conceptualisation of exercise, accelerometers offered a method through which to distinguish between general physical activity, and more intense moderate-to-vigorous activity akin to adolescent exercise behaviour. Commensurate with studies that have used aspects of the SDT model to predict objectively assessed MVPA and sedentary behaviour (e.g., Aelterman, Vansteenkiste, van Keer, van de Berghe, de Meyer, & Haerens, 2012; Fenton, Duda, Quested, & Barrett, 2014; Lonsdale et al., 2013; Owen, Astell-Burt, & Lonsdale, 2013; Stenling, Lindwall, & Hassmen, 2015), the model predicted a small amount of variance in both MVPA and sedentary behaviour.

6.2.4. The translation of motivation to behaviour in the context of adolescent exercise and sedentary behaviour

The findings presented in Chapter 4 support previous research which has shown autonomous motivation towards exercise to have a significant but weak relationship with both exercise and sedentary behaviour. This suggests that high quality motivation

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does not necessarily lead to behavioural engagement directly and, therefore, there are likely to be other factors influencing the relationship between motivation and behavioural outcomes. As a means to further understand the motivational processes underpinning adolescent exercise behaviour, in Chapter 5, I explored the self-regulatory pathways through which motivation may influence behaviour.

Drawing on literature that has emphasised the importance of self-regulation mechanisms for translating motivation to behaviour (e.g., Hagger, Wood, Stiff, & Chatzisarantis, 2010; Heckhausen & Gollwitzer, 1987; Schwarzer & Luszczynska, 2005; Sniehotka, Scholz, & Schwarzer, 2005), habit, action-planning and self-monitoring were explored as mediators of the relationship between autonomous motivation and behaviour. In contrast to previous studies that have shown self-monitoring to mediate the relationship between motivation and physical activity in adults (e.g., Nurmi, Hagger, Haukkala, Araujo-Soares, & Hankonen, 2016), only habit was found to be a significant mediator of this relationship. Previous research has demonstrated that conscious self-regulatory processes such as action planning and self-monitoring are more strongly associated with behavioural outcomes when habit strength is weak (e.g., Tam, Bagozzi, & Spanjoy, 2010). In the paper presented in Chapter 5, the participants largely displayed strong exercise habits, and therefore the effect of habit may be overriding the unique effects of action planning and self-monitoring on behaviour. Our findings substantiate extant literature that has highlighted habit as a strong and proximal predictor of physical activity behaviours (e.g., Rebar, Dimmock, Jackson, Rhodes, Kates, Starling, & Brug, 2007; Rhodes, de Bruijn, & Matheson, 2010), and offers support for this in the context of adolescent exercise and sedentary behaviour. Research focusing on habit formation, considering different habit strengths and stages of habit formation, may be useful for differentiating between the role of conscious self-regulation and habit in predicting adolescent exercise and sedentary behaviour.

In addition to exploring the mediators of the relationship between autonomous motivation and behaviour, and with future intervention design in mind, the premise that a more need supportive social environment would lead to stronger exercise habit, and more engagement in action planning and self-monitoring through increased autonomous motivation was tested. Need support was shown to be indirectly associated with action planning, self-monitoring, and habit through its influence on autonomous motivation. This extends existing research that has shown autonomous motivation to predict these

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self-regulatory processes (e.g., Brickell & Chatzisarantis, 2007; Gardner & Lally, 2013; Nurmi et al., 2016) by identifying the social-environmental precursors of motivation and self-regulation. Therefore, considering that interventions to increase adolescents exercise levels often contain a self-regulatory component, but have been shown to have limited long-term effect (see Metcalf, Henley & Wilkin, 2012 for review), fostering autonomous motivation through a need supportive environment may offer a way in which to increase the effectiveness of interventions.

The mediation model tested in Chapter 5 explained 5% variance in MVPA and 1% variance in sedentary behaviour. Compared to the simple model, which predicted 3% variance in MVPA and 1% variance in sedentary behaviour, the inclusion of the self-regulatory mediators did not explain a substantial amount of additional variance. This indicates that there are other processes involved in translating exercise motivation to behaviour that the mediation model tested within Chapter 5 does not account for. Drawing on recent evidence with older adolescents (Nurmi et al., 2016), coping planning may be an additional self-regulatory mediator of the relationship between autonomous motivation and exercise and sedentary behaviour. It has been suggested that coping planning (i.e., the pairing of situational cues associated with undesired behaviour or non-action, with a cognitive or behavioural response that inhibits the undesired behaviour, or facilitates actions; Sniehotta, 2009) is of particular relevance to younger adolescents, as they may not have the self-regulatory capacity to follow through with their action plans (Araujo-Soares, McIntyre, & Sniehotta, 2009). Therefore, it may be of interest in future research to explore the role of coping planning in mediating the relationship between autonomous motivation for exercise and behavioural outcomes in young adolescents. Additionally, it is important to note that the mediation model tested in Chapter 5 did not account for the influence of need thwarting and controlled motivation for exercise on self-regulation or behaviour. Individuals can self-regulate for controlled-reasons, however this may elicit less-effective self-regulation in terms of behavioural outcomes (Hagger et al., 2010). Therefore, the inclusion of self-regulatory mediators in a more comprehensive SDT model may be useful for fully understanding their role in translating motivation to exercise and sedentary behaviour.

6.2.5. Summary

Together, the studies presented in this thesis provide a comprehensive exploration of the motivational precursors of adolescent exercise behaviour within the SDT framework. The findings provide evidence to support some of the theoretical relationships proposed within SDT (Deci & Ryan, 1985; 2000). For the first time in the context of adolescent exercise behaviour, the results provide evidence for the independent role of psychological need support and thwarting, encompassing support and thwarting for all three of the basic psychological needs and from a variety of social agents (family, friends, and PE teacher) in determining exercise motivation and behaviour. Further to this, the findings offer the first evidence for the role of habit in mediating the relationship between autonomous motivation for exercise and objectively assessed exercise and sedentary behaviour in adolescents. Through providing evidence to support the role of the social environment (in the form of need support) in facilitating more autonomous motivation, and the role of autonomous motivation in instigating stronger exercise habit and behaviour, the present work highlights the potential utility of the brighter aspects of SDT in understanding adolescent exercise behaviour.

6.3. Practical applications

The present findings offer a basis from which to offer some tentative applied recommendations into how interventions can promote more exercise behaviour, and less sedentary behaviour in adolescents. In light of the potential health risks that accompany the low levels of physical activity in adolescents (Hancox, Milne, & Poulton, 2004; Mitchel, Beasley, Bjorksten, Crane, Garcia-Marcos, & Keil, 2013) and, in line with the UK governments aims to improve the health of our nation, increasing physical activity and decreasing inactivity in adolescence is a key health objective (Chief Medical Officer, 2011). Existing interventions designed to increase children and adolescents physical activity have been shown to have limited effects on behaviour (see Metcalf et al., 2012 for review). Suggested reasons for this include poor delivery and uptake of the intervention, or the intervention sessions replacing previous active time (Metcalf et al., 2012). Whilst speculative, these reasons highlight a need for interventions to target motivational constructs in order to foster greater enjoyment in and adherence to exercise (Ryan, Patrick, Deci & Williams, 2008). The correlational relationships presented in Chapter 3 imply that PE teachers, friends, and family are all associated with adolescent exercise and sedentary behaviour. Therefore, in this section I propose ways in which the

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school and family environment may be able to foster more autonomous motivation for exercise through the provision of need support.

The school environment is a useful domain for intervention, as schools influence the lives of most children, and therefore offer a social-context through which to promote health behaviours (Kothandan, 2014). Considering one of the primary aims of the PE curriculum is to ensure all children and adolescents develop the motivation for exercise that helps them to sustain a healthy active lifestyle throughout their life (Department for Education, 2013), fostering an environment that is need supportive may offer a way in which PE teachers can help instil healthy motivation and exercise behaviour in their students.

Drawing on studies in the PE and wider education domain (e.g., De Meyer et al., 2014; Haerens, Aelterman, van den Berghe, de Meyer, Soenens, & Vansteenkiste, 2013; Reeve, 2006; Tessier, Sarrazin, & Ntoumanis, 2008), there are a number of specific teacher behaviours that have been shown to be need supportive or thwarting. In the broader education context, studies have focused on autonomy-supportive teaching styles (e.g., Reeve, 2006). General teacher behaviours that have been identified as autonomy-supportive include aligning instructional activities with student's interests and competencies, avoiding external contingencies (e.g., rewards, deadlines), relying on informational and non-controlling language (e.g., 'your running is improving' or 'I notice you've chosen not to join in today, is anything wrong?'), communicating value, and providing rationale (e.g., suggesting why the task may be important; Reeve, 2006). However, evidence within the context of PE suggests that some of these behaviours may be perceived as competence- and relatedness-supportive (e.g., Haerens et al., 2013). For instance, in their observations during a PE lesson, Haerens et al. (2013) found providing positive feedback, such as 'your running is improving', and the provision of a rationale for the exercise to be perceived by students as competence-supportive. Additionally, they found that taking students perspectives into account (e.g., through aligning instructions to students interests) was perceived as relatedness-support (Haerens et al., 2013). As well as identifying positive teacher behaviours that are conducive to need support, exercising power, using commands, displaying irritation, yelling at students, destructive criticism, and not allowing input from students have been identified as autonomy-thwarting (De Meyer et al., 2014).

In terms of how to facilitate need-supportive behaviours in PE teachers, education-based interventions focusing on training teachers in how to adopt a need-

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supportive interpersonal style have been shown to elicit meaningful improvement in students' class engagement and autonomous motivation for PE (e.g., Chatzisarantis & Hagger, 2009; Tessier, Sarrazin, & Ntoumanis, 2010). In an intervention with French PE teachers, Tessier et al., (2010) provided teachers with an overview of the different types of student motivation (i.e., autonomous and controlled motivation) and offered concrete examples of need-supportive teacher behaviours (e.g., offering choice and initiative taking to support autonomy, enduring optimal challenge and learner-centred feedback to support competence, and investing time and effort towards students to support relatedness). Due to the success of this intervention style in terms of changing teaching style, and eliciting more autonomous motivation for PE, widespread use of similar teacher-training may be beneficial for improving adolescent exercise behaviour, at least within the PE context.

Beyond the role of the PE teacher, and considering the importance of peer relationships during adolescence (Brustad, 2010; Davison & Jago, 2009; Smith, 2003), educating students on how best to support their peers may also provide opportunities through which to foster good-quality motivation and behaviour in adolescents. Need support from peers has been shown to predict motivation for PE and leisure time physical activity and well-being (e.g., Cox & Ullrich-French, 2010; Hagger et al., 2009; Kipp & Weiss, 2013). Research has highlighted that perceptions of peers providing you with choices, options, and opportunities to do exercise, displaying confidence in your exercise abilities, looking out for you, and having similar interests to you are conducive to need-supportive relationships (Cox & Ullrich-French, 2010; Hagger et al., 2009). Additionally, a number of studies suggest that quality friendships may support the basic psychological needs in peer relationships (e.g., Cox, Duncheon, & McDavid, 2009; Kipp & Weiss, 2013; Weiss & Smith, 2002). Friendship quality is specific to dyadic relationships (i.e., peer relationships), and high quality friendships are characterised by loyalty, intimacy, companionship, similar interests, esteem enhancement, and emotional support (Weiss & Smith, 2002). In the context of sport, praising each other for doing well, having common interests, spending time together and working through disagreements may all contribute towards high quality friendships (Weiss & Smith, 1999). Such characteristics have been shown to be associated with perceptions of basic psychological need support and subsequent need satisfaction in the youth sport context (e.g., Cox et al., 2009; Kipp & Weiss, 2013; Weiss et al., 2002). However, there has been little investigation into how best to cultivate a need-supportive peer climate, or

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how to instil high quality friendships, and therefore this offers a route for future investigation.

Reviews highlight that interventions combining school- and family-based components are the most effective at increasing overall physical activity (Kreimler, Meyer, Martin, van Sluijs, Andersen & Martin, 2011; Salmon, Booth, Phongsavan, Murphy & Timperio, 2007). Therefore, engaging families in physical activity interventions may offer a useful approach for targeting behaviour. Interventions which seek to promote a more need supportive interpersonal style within families may be effective at increasing autonomous motivation and exercise behaviour in adolescents. A review of strategies for engaging parents in youth physical activity interventions suggests that face to face parent or family training and telephone communication may be effective (O'Connor, Jago, & Baranowski, 2009). Additionally, making the benefits of an intervention clear to families, offering regular feedback, and considering the family structure may help to engage families in intervention based research (Brown, Schiff, & van Sluijs, 2015).

Stuntz and Weiss (2010) highlight the importance of parents for providing their children with physical activity experiences, interpreting their child's experiences, and being good role models. Suggestions for doing this in a need supportive way include providing optimally challenging activities (e.g., modifying an activity according to skills level) and focusing on improvement, learning, and skill mastery to support competence, providing opportunities for a range of activities and allowing children choice in their activities to support autonomy, and encouraging children to be physically active with others and encouraging supportive relationships (e.g., through allowing them to spend time with friends and work together) to support relatedness (Stuntz & Weiss, 2010). Therefore, considering the evidence of how to engage parents and families in intervention research, and in a similar vein to previous interventions with PE teachers (e.g., Tessier et al., 2010), educational interventions for parents that focus on specific behaviours to support the basic psychological needs may offer a strategy to facilitate more autonomous motivation for exercise outside of school.

Beyond facilitating autonomous motivation for exercise, need-supportive environments may be fundamental for the instigation of long-term behavioural patterns and exercise habits. The findings in Chapter 5 suggest that need support indirectly influences exercise habit through its influence on autonomous motivation, suggesting that autonomous motivation may lead to long-term behaviour change through

instigating strong exercise habits. With this in mind, motivation-based interventions that promote a need-supportive social climate may be beneficial for behaviour change and maintenance, by promoting the formation of exercise habits that persist beyond the intervention itself. It has been suggested that autonomous motivation supports habit formation through enjoyment leading to a more regular routine, thus reinforcing the relationship between past behaviour and habit strength (Garnder & Lally, 2013). Additionally, need-supportive interventions may assist in promoting self-regulation. Although not predictive of behaviour in the present thesis, evidence in other health behaviour contexts (e.g., snacking) suggests that conscious self-regulatory processes such as action-planning and self-monitoring are more pertinent to behaviour when habit strength is weak (Tam et al., 2010). Orbell and Verplanken (2010) highlight that planning and self-monitoring strategies are only effective when the goals or behaviour are endorsed, therefore more autonomous motivation (i.e., internalisation, integration and endorsement of actions) may lead to more effective self-regulation. Consequently, interventions fostering need supportive environments could promote exercise behaviour through these conscious processes until habits are formed.

6.4. Limitations and future directions

The specific limitations to each of the empirical studies are discussed within Chapters 2 to 5. In this section I therefore discuss more general limitations of the thesis as a whole, and integrate these with recommendations for future research.

6.4.1. Longitudinal research, intervention research, and within person variation

The majority of the work within this thesis was cross-sectional in design, focussing on the individual differences in the SDT constructs, and their effects on objectively assessed exercise and sedentary behaviour. This cross-sectional methodology was appropriate for the research aims of the thesis, but provides only a singular account of motivation and behaviour. Intervention-based research, manipulating the social environment and testing the behavioural outcomes of enhanced need support would allow for inferences regarding the causal relationships between SDT constructs and behaviour to be made. In addition, it would be insightful to conduct a longitudinal investigation of the pre-cursors of adolescent exercise behaviour. Previous studies have assessed adolescent physical activity across periods of 3 months to a year (Cox, Smith, & Williams, 2008; Taylor, Ntoumanis, Standage, & Spray, 2010) however none of these have adopted objective measurements of behaviour. It may be of interest to future

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researchers to assess exercise behaviour longitudinally, over more than 2 time points so as to ascertain how trajectories of change influence exercise and sedentary behaviour, and to also adopt objective methods of assessing exercise as a means to improve the measurement of behaviour, and reduce the biases which can occur through self-report (Sallis & Saelens, 2000).

In Chapter 4, a comprehensive model of SDT was tested at the between person level (i.e., individual differences), but not within person variation (i.e., daily fluctuations). Assessing within person variation in the SDT constructs, as well as behavioural outcomes, allows for examination of the dynamic relationships proposed within SDT (Ryan & Deci, 2000). Daily fluctuations in the basic psychological needs and motivation have been shown to be predictive of daily fluctuations in well-being (Sheldon, Ryan & Reis, 1996), and the same may be true for exercise and sedentary behaviour. Therefore, adopting methodology such as ecological momentary assessment (EMA) will allow researchers to test the intricacies of the relationships between the basic psychological needs, exercise motivation and behaviour. Specifically, if situational need support and thwarting is assessed, we may obtain a greater understanding of how perceptions of the immediate social environment influence fluctuations in need satisfaction, need frustration, motivation, and behaviour (Standage & Ryan, 2012). Advancements in technology mean that diary watches can be used to implement EMA methodology, allowing participants to complete measures through the watch. The use of these technologies may enhance response rates, and also allows researchers to know the exact times at which participants completed each measure. Such methodologies have been used successfully to measure adolescent physical activity and sedentary behaviour and predictors (Biddle, Gorely, Marshall, & Cameron, 2009; Dunton, Whalen, Jamner, & Floro, 2007).

6.4.2. The identification and facilitation of a need supportive environment

The findings presented in Chapter's 4 and 5 suggest that need support is associated with high quality motivation and engagement in other self-regulatory processes.

Additionally, need thwarting is negatively associated with autonomous motivation through frustrating the basic psychological needs. As highlighted in the practical applications section, there is an emerging body of evidence identifying specific teacher behaviours that are conducive to supporting the basic psychological needs of autonomy,

competence, and relatedness (e.g., Haerens et al., 2013), however there is limited evidence for how families and friends can support the three basic psychological needs.

From the measures used in existing literature, it can be inferred that perceptions of family and friends as understanding of your reasons for exercising, confident in your exercise ability, accepting of you are supportive of the needs of autonomy, competence and relatedness (Cox & Ullrich-French, 2010; Emm-Collison, Standage, & Gillison, in press; Hagger et al., 2009). In contrast, perceiving friends and family to be pressuring you to engage in certain behaviours, feeling like they don't care about you, and doubting your capacity to improve at a behaviour are all indicative of need thwarting behaviours (Rocchi, Pelletier, Cheung, Baxter, & Beaudry, 2016). Yet, there has been no investigation of how these perceptions relate to actual behaviour from social agents. Therefore, studies that simultaneously measure observed behaviour from significant others and adolescent perceptions of need support and need thwarting may assist in the identification of specific behaviours that support, or thwart, the three basic psychological needs. Additionally, experimental or intervention research investigating the processes through which to effectively instigate a need supportive climate with respect to family and friends would allow for specific behaviours, and effective communication of these behaviours, to be identified for use in future interventions. Another avenue of potential interest would be longitudinal research across the lifespan to ascertain how social agents independently influence exercise motivation and behaviour at different points in time.

6.4.3. Further exploration of the processes involved in translating motivation to behaviour

The findings presented in this thesis suggest that habit is strong proximal mediator in the relationship between autonomous motivation and adolescent exercise behaviour. While not significant mediators in this study, previous evidence has also highlighted the role of conscious self-regulation (action planning and self-monitoring) in habit development (e.g., De Bruijn, Gardner, van Osch, & Sniehotta, 2014; de Bruijn & Rhodes, 2011). Future research investigating the processes involved in habit formation would provide insight into the roles of both autonomous motivation and conscious self-regulation in determining habit strength and behaviour. It could also be useful for future research to further investigate the role of habit as a moderator in the relationship between autonomous motivation and behaviour, as previous studies have shown conscious self-regulation to be more pertinent to behaviour when habit strength is weak

(Tam et al., 2010), suggesting that when habit is strong, it may override the contribution of other psychological variables to behavioural outcomes.

While the mediation model tested in Chapter 5 explained slightly more variance in exercise behaviour than the SDT model presented in Study 4, the variance explained was still low. This suggests that there are additional processes at play that were not accounted for within this thesis. Therefore, future research should seek to further investigate proximal mediators of the motivation behaviour relationship in order to understand the processes through which motivation influences behaviour. Whilst there are numerous additional social-cognitive variables that may be involved in translating motivation to behaviour (e.g., coping planning), it could be more efficient to use qualitative methodology as a starting point. Specifically interviewing autonomously motivated exercisers and non-exercisers may help to identify key factors that facilitate or challenge behavioural engagement beyond their motivation.

6.4.4. Measurement of sedentary behaviour and predictors

In Chapters 4 and 5, I assessed both exercise and sedentary behaviour through accelerometers. Sedentary behaviours are often neglected in the literature, but given the high levels of physical inactivity within UK adolescents (Craig et al., 2009), it is important that the factors influencing these behaviours are understood.

While I assessed sedentary behaviour through accelerometers, all the questionnaire based measures were completed with respect to exercise. Scholars acknowledge that sedentary behaviour is not just the absence of physical activity, but rather the purposeful engagement in activities that involve little bodily movement (Biddle, Gorley, & Stensel, 2004; Reilly, Penpraze, Hislop, Davies, Grant, & Paton, 2008). Therefore, the predictors of physical activity and exercise may not be predictive of sedentary behaviours, and research should seek to identify the unique predictors of inactive behaviours in order for interventions to decrease sedentary time. From a methodological perspective, scales specifically measuring predictors of sedentary time are required, and this should be an immediate focus of future research. However, much like physical activity, sedentary behaviour is multifaceted and broad, which means accurate measurement of its psychological determinants should be specific to the subcomponents of sedentary behaviour (e.g., screen time; Lubans, Lonsdale, Plotnikoff, Smith, Dally, & Morgan, 2013).

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Additionally, some experts have questioned the use of the same accelerometer to assess physical activity and sedentary time, suggesting that doing so leads to overestimations of sedentary time as it is conflated with low levels of physical activity (Hardy et al., 2013). However, evidence from laboratory studies has shown that data obtained through ActiGraph accelerometers and processed using the cut points used within this study can almost perfectly discriminate sedentary behaviour as identified through oxygen consumption (Evenson et al., 2008). Additionally, there has been a recent move towards assessing health behaviours (i.e., physical activity, sedentary behaviour, sleep) collectively rather than accounting for each of them individually (Tremblay et al., 2016). In doing so, all behaviours along the continuum can be considered simultaneously, and thus the time-dependency of these behaviours can be considered (e.g., Chastin, Palarea-Albaladejo, Dontje, & Skelton, 2015). In the context of physical activity promotion, this is particularly useful for ascertaining whether higher levels of physical activity come at the expense of sedentary time (as desired) or other behaviours, such as sleep (Tremblay et al., 2016). In light of this shift, future research should account for all of these behaviours simultaneously (Tremblay et al., 2016).

6.5. Conclusion

Adolescent exercise and sedentary behaviour have previously been studied from the SDT perspective, however there have been a number of methodological issues with these efforts. As the primary aim of the thesis was to obtain a better understanding of the motivational processes that underpin engagement in adolescent exercise behaviour, it was first necessary to address two of the key limitations of the extant SDT literature.

First, the qualitative paper presented in Chapter 2 provides justification for the assessment of adolescent exercise, as well as offering insight into how best to interpret exercise-related questionnaire responses, and how to measure adolescent exercise behaviour. Second, through three studies presented in Chapter 3, the APNSEQ measure, assessing supports for autonomy, competence, and relatedness from family, friends, and PE teacher, was developed and validated. Following the first two studies, in Chapter 4, the new APNSEQ measure was applied, alongside measures of need thwarting, need satisfaction, need frustration, and motivation, to objectively assess exercise and sedentary behaviour. In addition to providing further support for the validity of the APNSEQ measure, the results supported the application of the holistic SDT model in the context of adolescent exercise behaviour, although only a small amount of variance in behaviour was explained. Therefore finally, with a view to

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further understanding the processes through which autonomous motivation influences behaviour, a mediation model showed habit to be a significant mediator in the relationship between autonomous motivation and exercise and sedentary behaviour.

The present work extends the existing SDT literature pertaining to exercise motivation in adolescence, as well as the wider adolescent exercise literature, by offering a conceptualisation of exercise which can be used to inform interpretation and measurement in research. Further to this, the new APNSEQ measure offers a reliable and domain-specific tool through which to assess need support holistically, thus allowing the further investigation of the independent contribution of support for each of the three psychological needs, as well as need support from different social agents, in predicting motivation, behaviour, and well-being outcomes. Whilst there are still some methodological issues that need resolving (many identified in the present thesis), the findings support the use of SDT as a framework through which to study the motivational precursors of behaviour, and offer exciting potential for the further development of the theory through the exploration of the processes through which motivation influences behavioural outcomes.

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Appendix 2

Supplementing Chapter 2: An exploration of how adolescents understand the term 'exercise'

2.1. Pre-focus group questionnaire

We are interested in the people who are answering our questionnaire, so this section is to get some basic information about you.

1) **Date of Birth:** _____

2) **Gender** (please circle)

Male

Female

3) **Ethnicity** (please circle)

White

Mixed

Asian or
Asian British

Black or
Black British

Chinese

Other

4) **How many times a week do you exercise for more than 20 minutes at a time?**
(please circle)

Never

1-2 times
per week

At least 3
times per week

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2.2. Focus group schedule

Opening activity

- 1) Write down 3/4 activities that can be considered 'exercise' and then place them in the box at the front
- 2) Write down 3/4 activities that are not considered to be 'exercise' (encourage them to make sure at least one of their choices is an active behaviour (e.g. not sedentary/sitting) and then place them in the box at the front

Initial lead question for discussion

- When I say 'exercise' what do you think of?

Discussion of what makes certain activities exercise or not

- Select a piece of paper from the box (participant can do this) and as a group discuss what it is about the activity that makes it exercise (or not if people disagree)
 - Features of the activity
 - Intensity/duration?
 - Reasons why you do it
 - Where/When/With who

As the focus group takes place, the researcher will write on a board/flip chart the comments made by participants.

If there is time at the end, the researcher will ask the participants to come up with a working definition of 'exercise' based on what has been said in the group

APPENDIX

Appendix 3

Supplementing Chapter 3: Development and validation of the adolescent psychological need support for exercise questionnaire

3.1. Initial item pool sent to expert panel

Could you please rate the appropriateness and clarity of the items using a response format from low (1) to high (5). Items with an ‘A’ refer to Autonomy Support; ‘C’ to Competence Support; and ‘R’ to Relatedness Support. We would also be very grateful for any additional comments, and ideas on how to improve the scale.

In my interactions with my Family/Friends/PE teacher regarding exercise.....

	Item	Appropriateness (1-5)	Clarity (1-5)
1A	I feel that they provide me with meaningful choices, options and opportunities.		
2A	I feel that they understand why I choose to exercise.		
3A	I feel that they encourage me to do the exercise activities that I want to do.		
4A	I feel that they listen to me about how I would like to take part in exercise activities.		
5A	I feel that they encourage me to make my own exercise decisions.		
6A	I feel that they make sure I understand why it is important for me to exercise.		
7A	I feel that they carefully answers my exercise-related questions.		
8A	I feel that they are interested in me and the exercise activities I do.		
9A	I feel that they provide me with the chance to put my own input to the exercise activities I do.		
10A	I feel that they help me to make my own exercise-related decisions.		
11A	I feel that they provide options and choices that are important to me.		
12A	I feel that they try to appreciate my point of view.		
13A	I feel that they provide me with meaningful reasoning for why I would engage in exercise activities.		
14A	I feel that they really try to understand concerns I have about exercising.		
15C	I feel that they provide me with positive feedback when I try to improve my exercise abilities.		
16C	I feel that they display confidence in my exercise ability.		
17C	I feel that they help me to improve my exercise abilities		
18C	I feel that they make me feel like I am good at exercise.		
19C	I feel that they support me in achieving my exercise goals.		
20C	They help me to feel like I am able to do challenging exercise activities.		

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21C	They support me to feel confident in my ability to do well at exercise activities/tasks.		
22C	They help me to feel capable of doing challenging exercise activities/tasks.		
23C	They help me to feel competent at doing exercise activities/tasks.		
24C	They help me to feel confident in my ability to achieve personal exercise challenges.		
25C	I feel that they help me to fulfil my exercise potential.		
26R	I feel that they are very supportive of me.		
27R	I feel that they encourage me to work on exercise activities with others.		
28R	I feel that they have respect for me and my exercise engagement.		
29R	I feel that they are interested in me.		
30R	I feel that they are friendly towards me.		
31R	I feel that they treat me with respect.		
32R	I feel that they care about me.		
33R	I feel a sense of being connected with them.		
34R	I feel a sense of trust.		
35R	I feel accepted by them		
36R	I feel that I am valued by them.		
37R	I feel that I can openly talk to them about the exercise activities I want to do.		
38R	I feel a sense of trust in their exercise-related advice.		
39R	They help me to feel important.		

Additional Comments:

APPENDIX

3.2. Demographic questionnaire

We are interested in the people who are answering our questionnaire, so this section is to get some basic information about you.

5) **Date of Birth:**_____

6) **Gender** (please circle)

Male

Female

7) **Ethnicity** (please circle)

White

Mixed

Asian or
Asian British

Black or
Black British

Chinese

Other

8) **Marital Status of Parents** (please circle)

Married

Together but
not married

Separated

Divorced

Other

9) **Number of brothers and sisters:**_____

APPENDIX

3.3. Adolescent Psychological Need Support for Exercise Questionnaire

N.B. Example for PE teacher, also completed for family and friends

	In my interactions with my <i>PE TEACHER</i> about exercise	Strongly Disagree	Neither agree nor disagree	Strongly Agree
1	They display confidence in my exercise ability	1	2 3 4 5 6	7
2	I feel that they understand why I choose to exercise	1	2 3 4 5 6	7
3	I feel that they care about me	1	2 3 4 5 6	7
4	They help me improve my exercise abilities	1	2 3 4 5 6	7
5	I feel that they encourage me to do the exercise activities that I want to do	1	2 3 4 5 6	7
6	I feel accepted by them	1	2 3 4 5 6	7
7	I feel that they listen to me about how I would like to take part in exercise activities	1	2 3 4 5 6	7
8	They help me to feel like I am able to do challenging exercise activities	1	2 3 4 5 6	7
9	I feel that I am valued by them	1	2 3 4 5 6	7

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3.4. Basic Psychological Needs Scale

Think about how you normally feel about exercise. Read each statement and circle the number that best shows how much you agree or disagree with each one. *Please answer these questions even if you don't think you exercise.*

	When I exercise...	Strongly Disagree			Neither agree nor disagree			Strongly Agree
1	I feel a sense of choice and freedom in the exercise I undertake	1	2	3	4	5	6	7
2	Most of the exercise I do feels like 'I have to'	1	2	3	4	5	6	7
3	I feel that the people I care about also care about me	1	2	3	4	5	6	7
4	I feel excluded from the group I want to belong to	1	2	3	4	5	6	7
5	I feel confident that I can do exercise well	1	2	3	4	5	6	7
6	I have serious doubts about whether I can do exercise well	1	2	3	4	5	6	7
7	I feel that my decisions regarding exercise reflect what I really want to do	1	2	3	4	5	6	7
8	I feel forced to do exercise I wouldn't choose to do	1	2	3	4	5	6	7
9	I feel connected with people who care for me, and for whom I care	1	2	3	4	5	6	7
10	I feel that people who are important to me are cold and distant towards me	1	2	3	4	5	6	7
11	I feel capable of doing exercise	1	2	3	4	5	6	7
12	I feel disappointment with many of my exercise performances	1	2	3	4	5	6	7
13	I feel my choices regarding exercise express who I really am	1	2	3	4	5	6	7
14	I feel pressured to do too many types of exercise	1	2	3	4	5	6	7
15	I feel close and connected with other people who are important to me	1	2	3	4	5	6	7
16	I have the impression that people I exercise with dislike me	1	2	3	4	5	6	7
17	I feel competent to achieve my goals in exercise	1	2	3	4	5	6	7
18	I feel insecure about my ability to exercise	1	2	3	4	5	6	7
19	I feel that I have been doing exercise activities that really interest me	1	2	3	4	5	6	7
20	My regular exercise feels like a chain of obligations	1	2	3	4	5	6	7
21	I experience a warm feeling with the people I exercise with	1	2	3	4	5	6	7
22	I feel the relationships I have are just superficial	1	2	3	4	5	6	7
23	I feel I can successfully complete difficult exercise activities/tasks	1	2	3	4	5	6	7
24	I feel like a failure because of the mistakes I make	1	2	3	4	5	6	7

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3.5. Behavioural Regulations in Exercise Questionnaire version 2

We are interested in the reasons why people exercise. Read each statement carefully and think about how true each one is for you. Answer by circling the number that is right for you. *Please answer these questions even if you don't think you exercise.*

	I exercise because...	Not true for me		Sometimes true for me		Very true for me
1	Other people say I should	0	1	2	3	4
2	I feel guilty when I don't exercise	0	1	2	3	4
3	I value the benefits of exercise	0	1	2	3	4
4	It's fun	0	1	2	3	4
5	I don't see why I should exercise	0	1	2	3	4
6	Because my friends/family say I should	0	1	2	3	4
7	I feel ashamed when I miss an exercise session	0	1	2	3	4
8	It's important to me to exercise regularly	0	1	2	3	4
9	I can't see why I should bother exercising	0	1	2	3	4
10	I enjoy my exercise sessions	0	1	2	3	4
11	Because others will not be pleased with me if I don't	0	1	2	3	4
12	I don't see the point in exercising	0	1	2	3	4
13	I feel like a failure when I haven't exercised in a while	0	1	2	3	4
14	I think it is important to make the effort to exercise regularly	0	1	2	3	4
15	I find exercise a pleasurable activity	0	1	2	3	4
16	I feel under pressure from my friends/family to exercise	0	1	2	3	4
17	I get restless if I don't exercise regularly	0	1	2	3	4
18	I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
19	I think exercising is a waste of time	0	1	2	3	4

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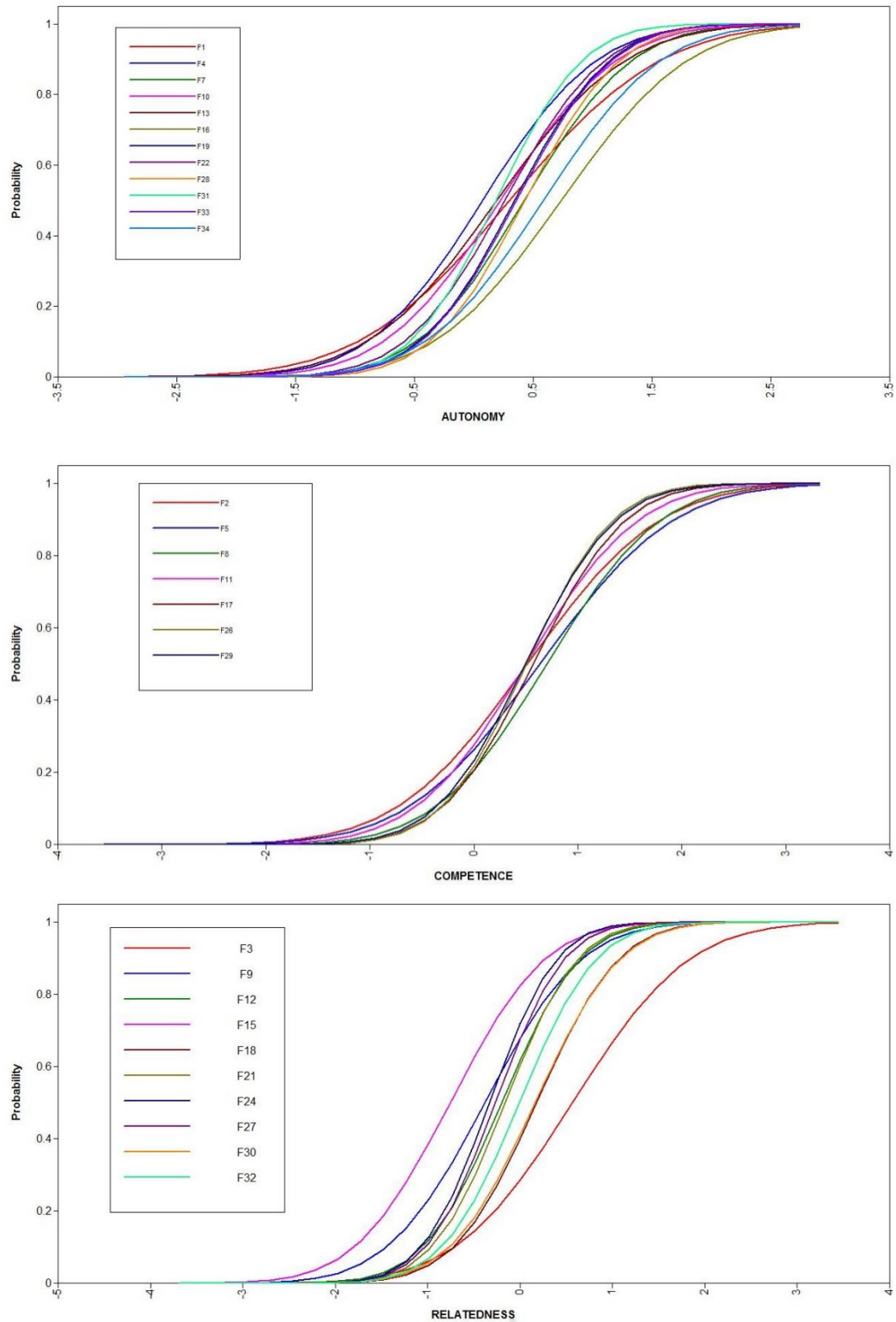


Figure S3.1. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to family.

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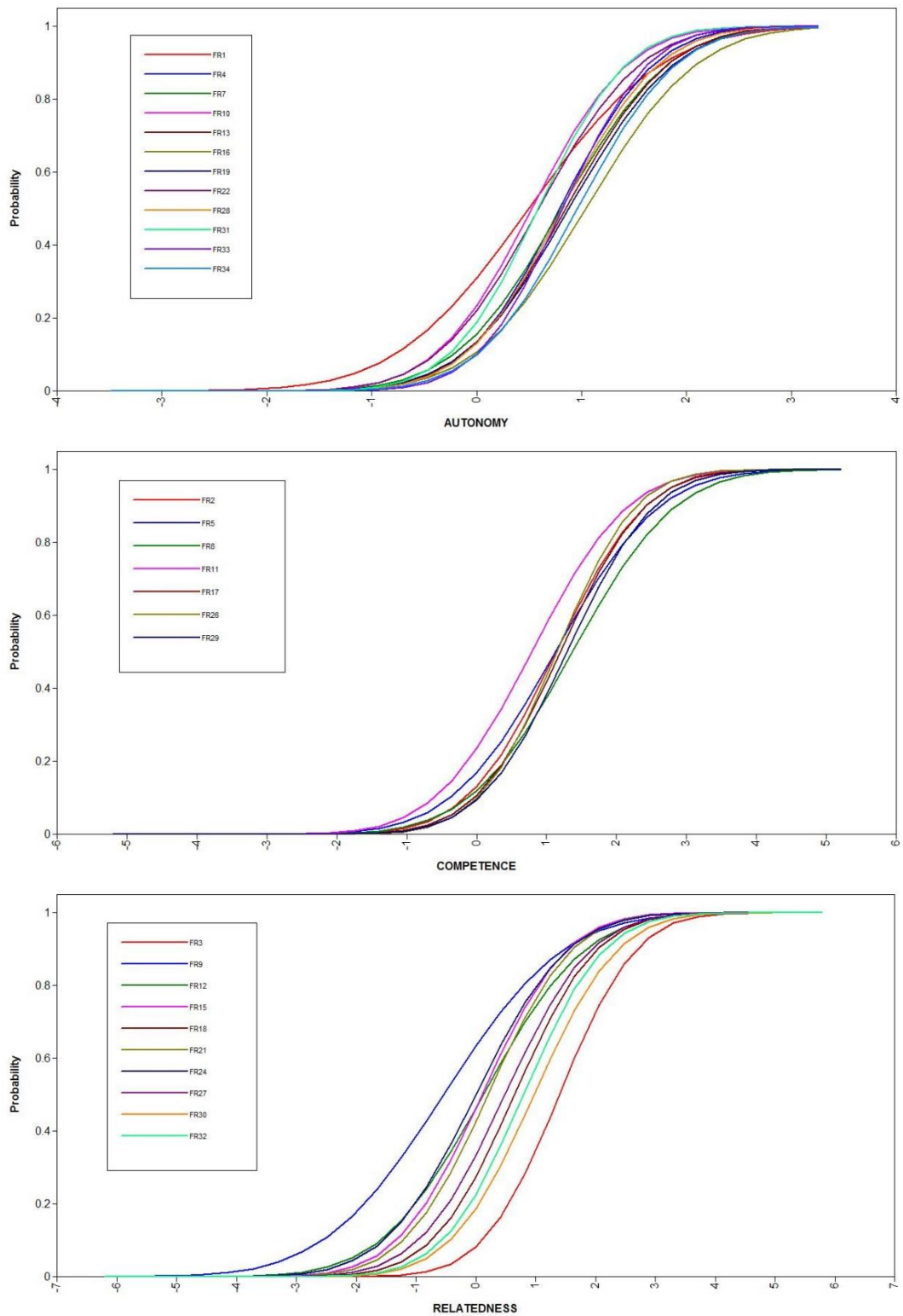


Figure S3.2. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to friends.

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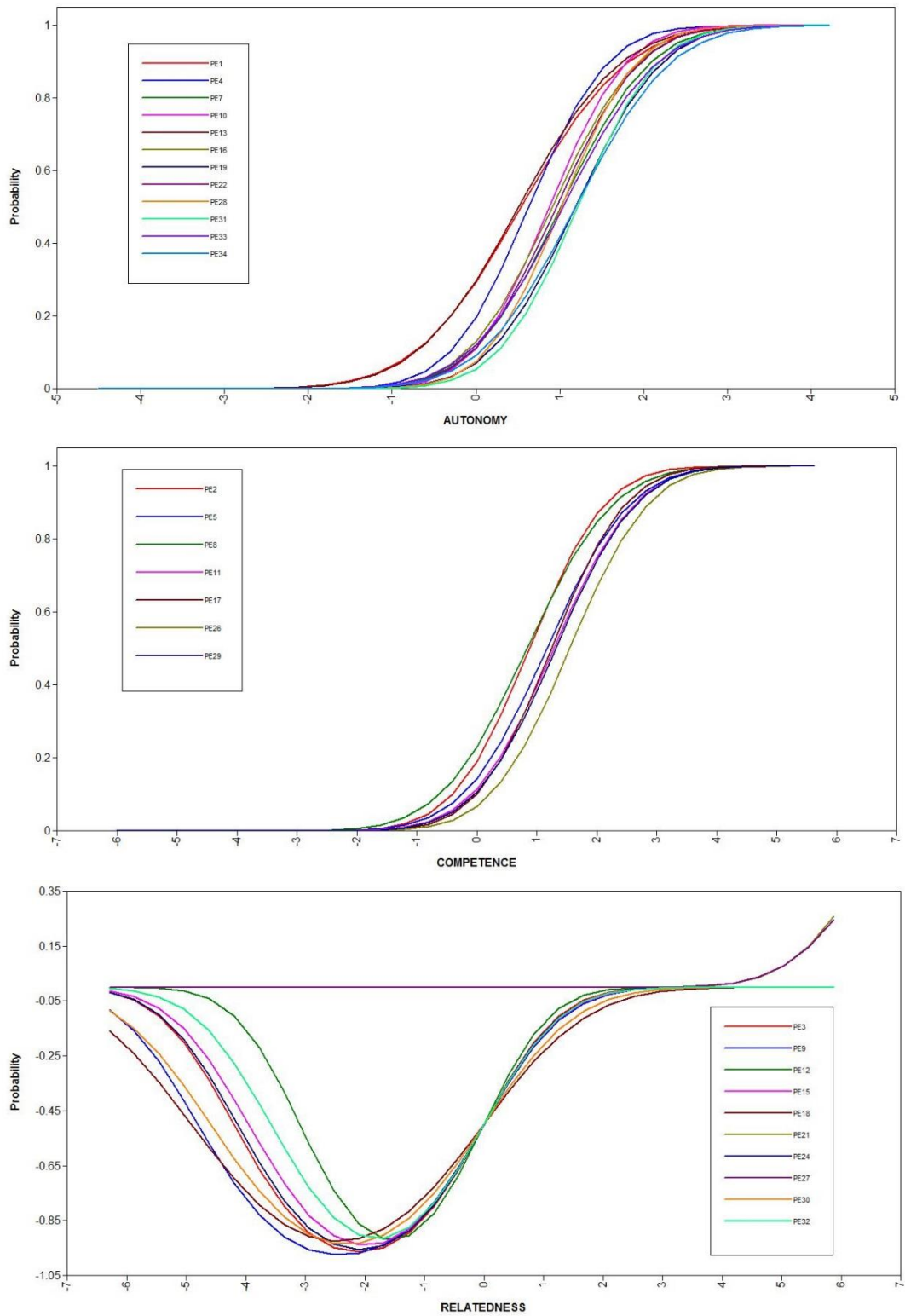


Figure S3.3. Item characteristic curves for autonomy-, competence- and relatedness-support in reference to PE teacher.

Appendix 4

Supplementing Chapter 4: Predicting objectively assessed estimates of adolescents’ exercise and sedentary behaviour:

4.2. Adapted Interpersonal Behaviour Questionnaire

N.B. Example for friends but also completed for family and PE teacher.

Think about how much **YOUR FRIENDS** support you in the exercise you do. Read each statement carefully and show how much you agree or disagree with each by circling the number that is right for you

	In my interactions with <i>MY FRIENDS</i> about exercise	Strongly Disagree		Neither agree nor disagree			Strongly Agree	
1	They pressure me to do things their way	1	2	3	4	5	6	7
2	They point out that I will likely fail	1	2	3	4	5	6	7
3	They do not comfort me when I am feeling low	1	2	3	4	5	6	7
4	They pressure me to adopt certain behaviours	1	2	3	4	5	6	7
5	They send me the message that I am incompetent	1	2	3	4	5	6	7
6	They question my ability to overcome challenges	1	2	3	4	5	6	7
7	They impose their opinions on me	1	2	3	4	5	6	7
8	They do not connect with me	1	2	3	4	5	6	7
9	They doubt my capacity to improve	1	2	3	4	5	6	7
10	I feel they are distant when we spend time together	1	2	3	4	5	6	7
11	I feel they limit my choices	1	2	3	4	5	6	7
12	They do not care about me	1	2	3	4	5	6	7

4.5. Participant accelerometer instruction sheet

Accelerometer Instructions

How to wear the accelerometer:

Using the belt provided, lock the elastic band snugly with the monitor around your waist. Position the monitor so that it rests over your hip bone directly underneath your **RIGHT** armpit (see picture). Make sure the monitor is the right way up.

When to wear the accelerometer:

Wear the monitor for the full **24 hours** a day for **eight days from today**, including when you sleep (if you can). During this time, please carry on doing the things you normally do in a week. Please note that **the light WILL stop flashing** at midnight on the first night - this is good! If the light continues to flash, contact one of the researchers or tell your teacher.



When NOT to wear the accelerometer:

You must take it off when bathing (bath or shower) or swimming, or any other activity that could get the monitor wet. If you are taking part in any contact sports, talk to your coach before playing and it is up to them whether you are allowed to wear it

I am not sure it's working!

If you have any problems with attaching the monitors, or think they may not be working, please call the number listed below and we will call you back.

Please wear the monitor until we return to the school to collect it.

**PLEASE TAKE CARE OF THE ACCELEROMETER AND
DO NOT LOSE IT AS IT IS VERY EXPENSIVE! THANK
YOU!**

If you have any questions please call: Lydia Emm (L.G.Emm@bath.ac.uk)
01225 384168

Appendix 5

Supplementing Chapter 5: The role of conscious and automatic self-regulation in translating motivation to behaviour: A self-determination theory perspective on adolescent exercise

5.1. *Self-reported Habit index*

It is recommended that teenagers exercise regularly. Think about your regular exercise and respond to the following statements by circling the number that best represents you.

	Exercising on at least 3 days a week for at least 20 minutes a day is something...	Totally disagree	Disagree	Neutral	Agree	Totally agree
1	I do automatically	1	2	3	4	5
2	I do without having to consciously remember	1	2	3	4	5
3	That makes me feel strange if I do not do it	1	2	3	4	5
4	I do without thinking	1	2	3	4	5
5	That would require effort not to do it	1	2	3	4	5
6	That belongs to my routine	1	2	3	4	5
7	I start doing before I realise I am doing it	1	2	3	4	5
8	I would find hard not to do	1	2	3	4	5
9	I have no need to think about doing	1	2	3	4	5
10	That is typically me	1	2	3	4	5

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5.2. Action planning

Think about your plans to exercise over the next week (7 days). Read each statement and respond with how true each is for you by circling the appropriate number.

	I have made a detailed plan regarding...	Not at all true					Exactly true
1	When to do my exercise	1	2	3	4	5	6
2	Where to exercise	1	2	3	4	5	6
3	How to do my exercise	1	2	3	4	5	6
4	How often to do my exercise	1	2	3	4	5	6

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5.3. *Self-monitoring*

Think about the exercise you did over the past 7 days. Read each statement and circle the number that is most appropriate for you.

	During the past 7 days, I have...	Totally disagree	Disagree	Neutral	Agree	Totally agree
1	Constantly monitored myself whether I exercise frequently enough	1	2	3	4	5
2	Watched carefully that I did 60 minutes of moderate activity a day	1	2	3	4	5
3	Had my exercise intention often on my mind	1	2	3	4	5
4	Always been aware of my prescribed training programme	1	2	3	4	5
5	Really tried to exercise regularly	1	2	3	4	5
6	Tried my best to act in accordance to my standards	1	2	3	4	5