Psychological and Environmental Contributors to Incidental Physical Activity

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Summary

Recent empirical research and theoretical models have acknowledged that both environmental and psychological characteristics contribute to physical activity behaviour. However, relatively little research has examined how they relate specifically to *incidental* physical activity. Incidental physical activity consists of unstructured activities that occur as part of daily living, and therefore occurs outside of formal exercise settings. Informed by socio-ecological models, self-determination theory and dual process models, the primary aim of this research was to investigate whether environmental and psychological characteristics are associated with incidental physical activity as they are for leisure time physical activity. A secondary aim was to investigate the inter-relationships between these factors with a view to inform future incidental physical activity interventions and strategies to enhance well-being. These two aims were addressed in a series of correlational and experimental studies.

The thesis consists of five empirical studies. Studies 1, 2 and 3 addressed the first aim of the thesis by investigating the inter-relationships between environmental and psychological factors, and how they relate specifically to incidental physical activity. Specifically, Study 1 investigated the contribution of motivational factors to incidental physical activity engagement, in combination with intentions and perceived environmental factors. The findings suggest that walkable neighbourhoods, motivation and intentions together play an important role in guiding incidental physical activity levels, as well as leisure time physical activity levels. However, the exact nature of the inter-relationships differed such that neighbourhood walkability guides incidental physical activity levels for individuals who have the motivation, but lack the intention to be physically active, whereas neighbourhood walkability indirectly contributes to leisure time physical activity by contributing to intentions and motivation. Study 2 investigated how contextual motivation (i.e., motivation differs depending on the circumstances surrounding behaviour engagement) and dispositional motivation (i.e., an individual's trait-like motivation) predict incidental physical activity, compared to leisure time physical activity (i.e., exercise). The findings showed that exercise was positively associated with both contextual and dispositional motivation while incidental physical activity was positively associated only with contextual motivation. Thus findings indicate that exercise and incidental physical activity are associated with different motivational properties. Study 3 examined the combined contributions of automatic processing (attentional, approach and implicit attitudes) and motivation to incidental physical activity engagement. It

was found that autonomous motivation (i.e., when a behaviour is valued, interesting, satisfying and engaged in out of choice) and certain implicit processes (i.e., implicit attitudes and approach-avoid biases) together contributed to incidental physical activity engagement.

The second aim of the thesis was addressed in Studies 4 and 5. Study 4 investigated whether subtly modifying the environment could implicitly guide individuals to engage in incidental physical activity by altering their motivation, while Study 5 investigated the contribution of motivational, environmental and incidental physical activity engagement to well-being. Specifically, Study 4 tested how a subtle change in the environment affects contextual motivation and subsequent engagement in walking for active travel, a form of incidental physical activity. The findings showed that although the presence of a motivational sign did not increase walking engagement, autonomous motivation for active travel predicted walking engagement. In addition, the presence of an autonomously-oriented prompt was associated with higher levels of autonomous motivation for active transportation. The findings suggest that subtly altering the environment can benefit motivation. Finally, Study 5 investigated the combined contribution of incidental physical activity, motivation and the built environment (specifically neighbourhood satisfaction) to subjective well-being. The relationship between autonomous motivation and well-being was moderated by incidental physical activity levels, and neighbourhood satisfaction mediated this relationship. Specifically, the positive contribution of autonomous motivation to well-being was dependent on whether individuals engaged in higher levels of incidental physical activity and whether they were satisfied with their neighbourhoods. Findings indicate that motivation, incidental physical activity and neighbourhood satisfaction together play an important role in increasing overall well-being.

Overall, the findings contribute to emerging research investigating the inter-relationships between psychological and environmental contributors to incidental physical activity. The research presented makes a unique contribution to the literature in that it identifies important inter-relationships between motivational components, implicit processes and environmental factors, and their contribution to incidental physical activity engagement. Additionally, motivational conditions under which incidental physical activity benefits psychological well-being are identified. The results also contribute to the theoretical understanding of incidental physical activity behaviour. In particular, the findings support

specific constructs from self-determination theory, socio-ecological and dual process models, and encourage the adoption of multiple theories in order to understand incidental physical activity behaviour. The findings from the current thesis have the potential to inform the development of interventions to increase such incidental physical activity behaviour, and thus benefit wellbeing.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Stacey Oliver

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CHAPTER 1: GENERAL OVERVIEW

1.1 Chapter overview

The purpose of this introductory chapter is to provide a rationale for investigating incidental physical and its determinants along with a brief overview of the research relevant to the psychological and environmental underpinnings of incidental physical activity engagement. The theoretical perspectives of socio-ecological models, self-determination theory and dual process models which informed the research designs will be discussed. Specifically, empirical research on environmental factors which contribute to physical activity is reviewed, followed by research on motivational contributors to physical activity, and finally research on automatic processing in the context of physical activity is discussed. This chapter concludes with a summary of the main aims of the thesis and an outline of its content.

1.2 Physical Activity Components and Health

Contemporary data demonstrate the prevalence of sedentary lifestyles in Western society (Ng et al., 2014; Walls et al., 2012). Physical inactivity is prevalent among adults, with more than half of the adult population of industrialized nations classified as insufficiently active (Sallis & Owen, 1998; Jensen et al., 2014). Evidence for a positive relationship between physical activity and health, including for the prevention of many non-communicable diseases including type 2 diabetes, certain cancers and a longer life expectancy, is strong in both adults and children (Hu et al., 2001; Lee et al., 2012). Despite the widely known health benefits of physical activity, sedentary lifestyles continue to threaten to physical and mental well-being of mass populations.

Most current approaches that promote physical activity focus on increasing intentional physical activity (i.e., exercise). However, a great deal of physical activity is incidental and occurs during daily activities, outside of formal exercise settings (Levine, 2007; Tudor-Locke et al., 2007). While exercise is typically conceptualized as structured, planned and purposeful, non-exercise related physical activity, or incidental physical activity, does not require special planning or preparation. Although definitions of incidental physical activity vary, this research uses the Australian Institute of Health and Welfare’s definition of incidental physical activity:

> *"Incidental physical activity includes the forms of physical activity done at work and home, and activity in which people take part as they go about their day-to-day lives, generally using large skeletal muscle groups"* (Australian Institute of Health and Welfare, 1999).

Incidental physical activity therefore encompasses a variety of different sub-behaviours (e.g., domestic work, active transportation and work-related activity) that range from walking, stair climbing and domestic chores to fidgeting, toe-tapping and posture correction (Levine, 2007). Accumulating evidence demonstrates that even minor changes in incidental physical activity, such as posture correction (Dickin et al., 2017; Lerma et al., 2016) and toe-tapping (Keopp et al., 2017), can have a substantial impact on energy expenditure (Chung et al., 2018; Levine, Scheusner & Jensen, 2000). Indeed, incidental physical activity is argued to be the main variable component of daily total energy expenditure (Chung et al., 2018; Levine, 2007). Importantly, numerous physical health benefits for adults have been associated with incidental physical activity engagement, including reductions in: cardiovascular risk factors (Gordon-Larsen et al., 2009), ischemic heart disease (Hamer & Chida, 2008), bowel cancer and all-cause mortality (Matthews et al., 2007). Furthermore, incidental physical activity has been found to increase cardiorespiratory fitness (Ross & McGuire, 2011; Stamatakis et al., 2018) and decrease heart rate in overweight adults (Tonello et al., 2015). Previous research has also demonstrated similar outcomes of incidental physical activity in managing chronic pain when compared to intentional physical activity (Alzahrani et al., 2019). Additionally, there is increasing evidence that incidental physical activity has mental health benefits such as a reduction in anxiety and depression, increased functional and cognitive status in older adults (Warburton et al., 2010), and social connectedness in adults (Das & Horton, 2012). Given the barriers many experience to engage in exercise (e.g., cost, time and prohibitive physical environments), combined with the fact that Westernised society promotes opportunities to be sedentary (e.g., screen-based entertainment, motorised transport), more subtle lifestyle approaches that are primarily designed to increase incidental energy expenditure via practical day-to-day tasks have the potential to benefit health on an individual level and as a public health strategy (Brown et al., 2005; Hill et al., 2003; Reiner, Niermann, Jekauk & Woll, 2013). Accordingly, multiple government organizations are implementing policies to increase incidental physical activity engagement (Institute of Medicine, 2013; National Institute for Health Care Excellence, 2010; Department of Health and Ageing, 2013).

Despite the established physical health benefits and government recommendations to increase incidental physical activity, our understanding of what contributes to, and encourages this behaviour is limited. Previous systematic reviews have yielded mixed results regarding the effectiveness of interventions aimed at increasing incidental physical activity, highlighting the need to further investigate contributing factors to incidental physical activity engagement (Reynolds et al., 2014; Baker et al., 2011; Dobbins et al., 2013; Kahn et al., 2002; Malik et al., 2013; Sluijs et al., 2007). A better understanding of the underlying mechanisms to incidental physical activity engagement is important to inform the development of effective and sustainable strategies to increase this behaviour, and thereby promote physical health in an increasingly sedentary society. Collectively, the studies described in this thesis investigated the contributing factors to incidental physical activity in order to assist with the development of effective interventions targeted at incidental physical activity.

Furthermore, despite an accumulating amount of evidence providing support for the physical health benefits of increased incidental physical activity (Villablanca et al., 2015), there has been limited research investigating incidental physical activity and its association with well-being. Although positive associations between intentional physical activities (i.e., exercise) and well-being have been demonstrated, it is recognised that this relationship is complex, as not all individuals who participate in physical activity experience greater well-being (Biddle & Ekkekakis, 2005; O'Connor & Puetz, 2005; Scully et al., 1998). Previous research has highlighted that merely engaging in intentional physical activity (i.e., amount) is insufficient to benefit psychological well-being. High levels of intentional physical activity have been associated with maladaptive dimensions of 'exercise dependence', such as interference with one's social life, which carries implications for active individuals' well-being (Scully et al., 1998). Although the mechanisms and circumstances under which exercise benefits well-being have previously been demonstrated (Guérin & Fortier, 2013), to date, only one study has investigated the specific circumstances that contribute to the relationship between incidental physical activity and well-being (White et al., 2018). Specifically, White et al. (2018) found that different contexts and types of motivation underlying active travel engagement (a form of incidental physical activity) contributed to levels of positive affect experienced in adolescents. As will become evident in the following sections, the quality of one's environment and motivation for engaging in incidental physical activity warrants further investigation to understand incidental physical activity engagement and outcomes in well-being.

Thus, the current thesis investigated how motivational and environmental factors are associated with incidental physical activity engagement and well-being. The research presented makes a significant contribution to the literature in that it identifies key contributing factors to incidental physical activity engagement, as well as some specific circumstances where incidental physical activity is beneficial to psychological well-being. It is important to understand the relationships between psychological mechanisms and the modern urban environment in order to advance incidental physical activity interventions that enhance both physical and mental health (Biddle & Ekkekakis, 2005; Lehnert, Sudeck, & Conzelmann, 2012).

The next section of this chapter (section 1.3) begins with a discussion of the potential role of certain built environments in incidental physical activity levels. Next, section 1.4 provides a description of self-determination theory which gives a motivational perspective of why some individuals may engage in different amounts of incidental physical activity and incur different psychological benefits, followed by an outline of the research on motivation and physical activity. Finally, in section 1.5 Dual-Process Models of behaviour are discussed to provide a theoretical account of how certain cues in the environment may automatically influence incidental physical activity behaviour. The potential interplay between environmental, motivational and automatic processes is also discussed.

1.3 Environmental Contributors of Physical Activity: Socio-Ecological Models of Behaviour

A growing amount of the population resides in urban areas (UN Habitat, 2011; Giles-Corti, Ryan & Foster, 2012; Montgomery, 2007), and the association between the urban environment and physical activity is now widely recognized; however, this relationship is far from being understood (Vlahov & Galea, 2003; McGranahan, 2005). Socio-ecological models have evolved from the psychological and behavioural science domain and focus on people's interaction with their physical and social environment (Sallis, Owen & Fisher, 2015). Specifically, socio-ecological models propose that built environments (any human-modified or man-made environmental feature such as houses, workplaces and roads) can restrict or facilitate behaviour by promoting certain actions and by discouraging others (Sallis, Owen & Fisher, 2015). Until recently, research on predictors or correlates of physical activity behaviours was primarily focused on individual-level factors such as age, gender, perceived self-efficacy and enjoyment (Sallis et al., 2000; Trost et al., 2002). However, there has been a growing interest in the role of the built environment in supporting physical activity, and in particular one's neighbourhood, as this is where the majority of physical activity is undertaken (Giles-Corti

& Donovan, 2003; Sugiyama et al., 2009). Moreover, it has been suggested that the effectiveness of physical activity interventions may be enhanced by considering environmental factors, rather than by simply focusing on individuals (Giles-Corti & Donovan, 2003). For example, previous research has found that people tend to enjoy exercise more and experience greater wellbeing in non-urban, natural, environments (Loureiro & Veloso, 2017). The research presented in this thesis therefore considers the contribution of the neighbourhood environment to physical activity engagement.

Previous research has demonstrated associations between the neighbourhood environment and physical activity engagement (Saelens & Handy, 2008; Forsyth et al., 2007). Moreover, both incidental physical activity and leisure time physical activity have been associated with aspects of the built neighbourhood environment. One important previously identified correlate of physical activity is neighbourhood “walkability” (Saelens et al., 2003; Lake, Townshed & Alvanides, 2010). Walkable neighbourhoods are those that have mixed land use, well-connected streets and high residential density, and have been associated with increased leisure time and incidental physical activity engagement (Owen et al., 2008; Saelens & Handy, 2008). Previous research shows that neighbourhood walkability can promote physical activity in a number of ways, including enhancing the walking experience due to pleasant aesthetics (Ball et al., 2001; Hoehner et al., 2005), fostering feelings of safety due to well-lit streets (Carver et al., 2008; Weir et al., 2006), and increased convenience to destinations due to street connectivity (Cervero & Duncan, 2003; Hoehner et al., 2005; Owen et al., 2007). Another important correlate of physical activity engagement is the overall satisfaction one has with the local neighbourhood (Merom et al., 2009; Hall & McAuley, 2010; Gay et al., 2011). Neighbourhood satisfaction refers to the perception of neighbourhood characteristics such as the amount of green space, access to amenities, traffic load, traffic safety and various aspects of social capital (e.g., social relationships and social norms). Previous research has demonstrated that living in a place a person dislikes is associated with decreased leisure time physical activity engagement as well as poorer physical and mental health outcomes (Leslie & Cerin 2000; Park et al., 2018). Furthermore, it has previously been demonstrated that engaging in exercise in satisfying environments (e.g., green spaces) is associated with increased exercise engagement and enjoyment of exercise (Bowler et al. 2010; Calogiuri & Elliot, 2017; Sugiyama et al., 2009). Therefore, satisfying, walkable neighbourhoods can contribute to intentional physical activity levels, as well as psychological outcomes.

Although evidence is accumulating regarding the association between the neighbourhood environment and physical activity engagement, a number of systematic reviews have highlighted inconsistent findings when assessing the association between environmental determinants and physical activity, with results ranging from significant, to non-significant, and to contradictory (e.g., Wendel-Vos et al., 2007; Bancroft et al., 2015). A possible explanation for the variation in findings regarding environmental attributes and physical activity is the limited research on the interaction between environmental variables and psychological factors. Socio-ecological models describe health behaviours, such as physical activity, as a dynamic process that is simultaneously influenced by aspects of the physical environment and individual attributes (e.g., self- efficacy, perceived enjoyment, and self-determined motivation). However, only a limited number of studies have investigated how both environmental and individual attributes contribute to physical activity levels (Deforche et al., 2010; Ball et al., 2001; Cerin et al., 2008; Giles-Corti & Donovan, 2003). Specifically, reduced access to fitness facilities has been associated with lower self-efficacy and less participation in moderate-to-vigorous physical activity (Cerin et al., 2008). Additionally, self-efficacy has been found to moderate associations between active commuting (a form of incidental physical activity) and environmental features (safety from crime and traffic, and access to local stores) (Deforche et al., 2010). Recently, Park et al. (2018) found that older adults who held more positive perceptions of the neighbourhood environment (higher satisfaction) were more motivated to engage in physical activity and engaged in more light physical activity.

Emerging evidence supports the notion that environmental attributes and psychological mechanisms together contribute to levels of both incidental and leisure time physical activity. However, there are limited investigations into these inter-relationships between environmental and psychological factors and their combined contribution to physical activity engagement. Certain environments, such as walkable neighbourhoods, may provide opportunities for active engagement in physical activity, and psychological constructs may explain why some individuals utilise active options whereas others remain predominantly sedentary. Additionally, where physical activity is undertaken (e.g., the quality of one's neighbourhood) is likely to contribute to the psychological outcomes related to physical activity engagement (Leslie & Cerin 2000; Park et al., 2018). Thus, one of the aims of this research was to gain a better understanding of the combined contributions of environmental and individual factors to incidental physical activity, as well as to psychological well-being. Specifically, the quality of one's motivation, as elaborated in section 1.4, was investigated to assist in explaining why some individuals are physically (in)active in certain environments and how the varying contribution of local neighbourhood environments and activity engagement can predict well-being.

1.4 Physical Activity Motivation: Self-Determination Theory

Self-determination theory is a broad theoretical approach with humanistic and organismic roots that addresses individual differences of motivational quality that occur in different settings (Teixeira et al., 2012; Deci & Ryan, 2008). The conceptualization of motivational quality, rather than quantity, is a unique feature of self-determination theory. Most motivation theories, including self-efficacy theory (Bandura, 1989) and expectancy-value theory (e.g., Eccles & Wigfield, 2002), propose motivation to be a unitary construct in which a higher amount of motivation should yield more optimal outcomes. In contrast, according to self-determination theory, higher levels of motivation do not necessarily result in more desirable outcomes if the motivation is of a poor quality. Instead, actions are performed for different reasons of varying quality, and desirable outcomes occur if motivation is of a high quality.

The main distinction in motivational quality according to self-determination theory is between self-determined (autonomous) motivation and non-self-determined (controlling) motivation. The basic distinction between these two types of motivation is that self-determined motivation occurs when behaviour is valued, satisfying, interesting and performed for autonomous reasons, whereas non self-determined motivation occurs when behaviour is performed due to an external reason often accompanied with a sense of pressure. These two distinct types of motivation reflect the quality of the reasons why individuals engage in behaviour. Motivation to engage in behaviours for self-determined, autonomous reasons are considered to be of high quality and are therefore more likely to persist in the absence of external contingencies or rewards. In contrast to autonomous motivation, behaviours engaged in for controlled reasons, reasons external to the self (e.g., to achieve a reward or to avoid a negative consequence) will cease when the external contingency is not present. It is further proposed that these motivational aspects can influence psychological well-being. It is argued that while autonomous behaviours benefit well-being, controlling behaviours are the cause of distress and behavioural pathology (Ryan & Deci, 2000). Thus, the level of autonomous or controlled motivation helps explain both behavioural and psychological outcomes. Self-determination theory is a macro-theory that consists of four sub-theories: organismic integration theory, causality orientation theory, cognitive evaluation theory and basic needs theory. While descriptions of the latter two are available elsewhere (see Deci & Ryan, 2002), the research presented here pertains specifically to organismic integration theory and causality orientation theory.

What is paramount to this dissertation, is the internalization of motivation which can have consequences for behaviour engagement and wellbeing. Internalization is the process through which individuals progressively transform a value or behaviour so that it becomes closely associated with their own sense of self (Deci & Ryan, 1985). The more internalized a value or behaviour is, the more it is experienced autonomously and the more it contributes to feelings of wellbeing (Ryan & Connell, 1989). The degree of internalization is viewed within organismic integration theory as a continuum, called the perceived locus of causality (Ryan & Deci, 2002). The perceived locus of causality continuum outlines amotivation (i.e., a person's lack of intentionality or lacking value for a behaviour) along with motivations that can vary depending on situational factors (Deci & Ryan, 2002). Next to amotivation, external regulation sits at the lowest end of the continuum and is considered the most controlling form of motivation as it involves behaviours that are prompted only by external forces. External regulation is often associated with lower well-being, engagement, and satisfaction (Ryan & Deci, 2000). An example of this form of motivation would be taking the dog for a walk because someone (e.g., a parent or partner) has said to do so. Next on the continuum is introjected regulation. This form of motivation is also considered controlling; however, the pressure is internal, with control originating from the self. Behaviours performed due to introjected regulation are performed in order to avoid a pressing or undesirable emotion such as guilt or shame. An example of this form of motivation would be walking the dog because one would feel guilty if the dog did not get taken for a walk. Following introjected regulation is identified regulation, a less controlling form of motivation in which behaviour is performed because the outcomes associated with the behaviour are valued by the individual. An example of this type of motivation would be walking the dog because it will result a better-behaved dog. The most autonomous form of extrinsic motivation is integrated regulation. This type of motivation occurs when behaviour is in congruence with other values and behaviours performed by the individual. For example, taking the dog for a walk because one considers themselves an active person, and walking the dog will increase activity levels. Intrinsic, or autonomous, motivation occurs when a behaviour has been completely internalized and the experience of the behaviour is valued and enjoyed. An example of intrinsic motivation would be walking the dog because one enjoys the time spent walking the dog.

An important distinction between identified regulation and intrinsic motivation is that the behavior is instrumental in identified regulation (i.e., people do not act for the sake of the behavior itself, rather for attaining the valued outcomes), while the experience of the behavior itself is the reason for acting for intrinsic motivation. Therefore, according to the perceived locus of causality continuum, autonomous motivation occurs when a physical activity is performed because it is a highly valued behaviour that is perceived as parts of one's 'true self' (Deci & Ryan, 2002). Furthermore, it is important to note that while intrinsic motivation represents a form of optimal experience (Deci & Ryan, 1985b), most human behaviours are extrinsically motivated and represent attempts to accomplish ends not intrinsic to the action. Finally, although the organismic integration theory proposes internalization to be a continuum, behaviour does not need to progress through each stage of motivation in order to become self-determined, or internalized. Therefore, internalization can occur at any stage of the continuum, depending on previous experiences and current situational factors (Deci & Ryan, 2002).

The majority of research based on self-determination theory has emphasized the importance of autonomous motivation to engage in and maintain health behaviours (Banting & Dimmock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012). Certainly, the importance of autonomous motivation for exercise engagement, persistence and well-being has been established (Teixeira et al., 2012; Banting & Dommock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012). Recent research has also found positive associations between controlled forms of motivation to engagement in exercise (Caudwell & Keatley, 2016; Niven & Markland., 2016). By contrast, the relationship between controlled motivation, exercise engagement and well-being is less clear. Some previous studies have reported negative associations between exercising for controlled reasons and well-being, and others have reported null associations (Teixeira et al., 2012; Duncan et al., 2010). In addition, there are claims that exercising due to controlled motives is predictive of short-term engagement but less so of long-term persistence (Ryan, Patrick, Deci & Williams, 2008; Pelletier, Fortier, Vallerad & Briere, 2001).

Given that motivation has been established as a key contributor to intentional physical activity engagement and well-being outcomes (Sherwood & Jeffery, 2000; Guérin & Fortier, 2013), it is surprising that little research has examined the contribution of motivation to incidental physical activity. The limited research that has investigated incidental physical activity and motivation suggests a relationship between these factors. Both autonomous and controlled forms of motivation have been associated with activities related to daily living such as tooth brushing, hand washing and reducing calorie and alcohol consumption (White et al., 2018; Keatley, Clarke & Hagger., 2013; Hagger et al., 2014). In addition, posture correction (a form of incidental physical activity), has been directly associated with autonomous motivation (Keatley, Clarke & Hagger, 2013). Furthermore, recent research found that the type of motivation (i.e., autonomous or controlled) experienced for active travel varied depending on the context (e.g., alone, out of necessity versus with others, out of choice) of such activities (White et al., 2018). Therefore, the limited research on incidental physical activities indicates that motivation plays a role in guiding this behaviour (Keatley, Clarke & Hagger, 2013; White et al., 2018). However, research regarding motivation and incidental physical activity is limited and further investigation is required in order to develop interventions with lasting effects for incidental physical activity engagement (Teixeira et al., 2012)

Self-determination theory further proposes that the motivational quality driving a behaviour is a contributing factor to well-being outcomes (Ryan & Deci, 2008). It is proposed that controlling contexts yield negative effects on wellness, whereas contexts that support autonomy enhance it (Ryan & Deci, 2001). Additionally, behaviours performed for autonomous reasons (e.g., seeking affiliation or challenge) benefit well-being whereas behaviours performed for controlling reasons (e.g., seeking social recognition or appearance improvement) are the cause of distress and behavioural pathology (Ryan & Deci, 2000). Indeed, there is evidence to suggest that autonomous motivation for exercise contributes to feelings of well-being. Autonomous motivation for physical activity has been found to be predictive of greater self-esteem (Thøgersen-Ntoumani & Fox, 2007) which has been linked to positive affect and general well-being (Netz, Wu, Becker, & Tenenbaum, 2005). Autonomous exercise motives have been associated with short-term psychological benefits such as increased enjoyment and positive affect in relation to exercise (Fortier et al., 2012; Raedeke, 2007; Guérin & Puente & Anshel, 2010) Additionally, autonomous forms of motivation have been associated with several indicators of well-being in long-term exercisers, such as lower stress (Maltby &

Day, 2001). On the contrary, controlled forms of motivation have been associated with lower well-being (Ryan & Deci, 2006; Markland & Ingledew, 2007). Specifically, controlling forms of motivation have been linked to body image concerns, eating disorder symptomology and excessive exercise (González-Cutre & Sicilia, 2012; Thorgersen-Ntoumani, & Ntoumanis, 2007). Accordingly, it is possible that autonomous and controlled motivations for incidental physical activity may have similar implications for well-being. Indeed, White et al. (2018) found that experiencing autonomous motivation for active travel contributed to positive affect in adolescents. However, to our knowledge, no study to date has directly examined how the quality of motivation experienced for incidental physical activity contributes to psychological well-being. This was considered worthy of investigation. Considering the established physical health benefits and limited costs of incidental physical activity, it is important to understand how the motivational quality of this form of activity contributes to overall well-being. According to self-determination theory, intervention strategies that aim to increase incidental physical activity levels using controlled forms of motivation (e.g., use of commands or appearance improvement messages) may have detrimental effects on well-being (Ryan & Deci, 2008). Therefore, it is important to investigate this relationship in order for interventions to effectively increase incidental physical activity levels and simultaneously benefit well-being. Additionally, investigating this relationship may provide further support for the generality of self-determination theory.

According to the second motivational sub-theory of self-determination theory, causality orientations theory (Deci & Ryan, 1985), behaviour is also influenced by an individual’s general tendency to interpret behaviours as autonomous or controlled (Deci & Ryan, 1985; Elliot, McGregor & Thrash, 2002). It is proposed that this relatively stable, trait-like, motivation applies to many contexts. Individuals who have a disposition to be more autonomously-orientated participate in activities for enjoyment and interests’ sake, whereas individuals who have a disposition to be more control-oriented participate in activities due to an internal pressure to satisfy their self-esteem (Deci & Ryan, 2008). Therefore, people are influenced by different forms of contextual motivation depending on the situation (i.e., perceived locus of causality), but they also have an enduring tendency to respond in a certain way due to their enduring (dispositional) motivation.

Dispositional motivation has been found to influence physical activity behaviour (Gibson et al., 2008; Ryan, Vallerand & Deci, 1984; Vallerand & Reid, 1984; Frederick & Ryan, 1995; Boyd Weinmann & Yin, 2002). Previous research regarding exercise behaviour has found that an autonomous-disposition is associated with greater participation in moderate to vigorous physical exercise in children (Dempsey, Kimiecik & Horn, 1993; Kimiecik, Horn & Shurin, 1996). Furthermore, Boyd, Weinmann and Yin (2002) found that an autonomous-disposition for exercise was positively related to intrinsic motivation for exercise, indicating that an autonomous-disposition induces greater enjoyment for exercise. Various studies have also found that a high autonomous-disposition is an adaptive characteristic in sport, whereas high a controlled-disposition has been linked to boredom and anxiety (Gibson, Chow & Ewing, 2008; Boyd Weinmann & Yin, 2002). Dispositional motivation has also been found to impact a variety of health-related behaviours such as tooth brushing, fruit and vegetable consumption, and alcohol reduction (Hagger et al., 2014). It is therefore possible that some individuals hold an autonomous-disposition for incidental physical activity, which contributes to higher levels of incidental physical activity. However, the influence of dispositional motivation on incidental physical activity has not yet been directly investigated.

Therefore, although it has been established that motivation plays a key role in influencing exercise behaviour and well-being outcomes, there has been limited investigation of the contribution of motivation to incidental physical activity engagement. Moreover, despite this limited understanding of the contributing factors to incidental physical activity, interventions and policies to increase incidental physical activity engagement are being implemented and having limited success (Institute of Medicine, 2013; National Institute for Health Care Excellence, 2010; Department of Health and Ageing, 2013). This may be, in part, due to the assumption that incidental physical activity is influenced by the same factors that contribute to leisure time physical activity engagement. The research presented in this thesis aimed to address this gap in the literature by exploring the motivational constructs that contribute specifically to incidental physical activity, and whether they differ from the motivations that have been found to be beneficial for leisure-time physical activity.

Furthermore, consistent with socio-ecological models, self-determination theory suggests that certain environments can facilitate or undermine motivation, and influence subsequent behaviour (Sheldon, Ryan, Deci, & Kasser, 2004). Recent research in the physical activity domain supports the notion that motivation for physical activity can be fostered by certain environments (Bowler et al. 2010). In particular, positive perceptions of neighbourhood characteristics and high perceptions of convenience for exercise locations in the neighbourhood have been associated with higher levels of autonomy for, and engagement in, exercise (Gay et al., 2011). The presence of 'green spaces' has also been linked to increased motivation and enjoyment of exercise (Calogiuri & Elliot, 2017). However, it is not clear how these factors together contribute to incidental physical activity engagement and well-being. Thus, the current thesis uniquely investigated the combined contribution of environmental and motivational factors to incidental physical activity, as well as subjective well-being. While motivational quality was considered particularly relevant to the prediction of incidental physical activity engagement, another concept deemed pertinent was the 'automaticity' of behaviour engagement. As discussed next (section 1.5), individuals' automatic tendency to engage in incidental physical activities may moderate the extent to which micro-environments facilitate motivation and subsequent activity engagement.

1.5 Automaticity of Physical Activity: Dual Process Models of Behaviour

The concept of physical activity being regulated by automatic processes is consistent with dual process models. Such models propose two systems of information processing that govern our behaviour: the impulsive system and the reflective system. The impulsive system is characterised by fast, effortless and automatic responses to engage with specific situational and environmental cues (Bargh & Morsella, 2010). Automatic responses occur due to associations between environmental cues or objects being repeatedly paired with certain actions or evaluations. Due to frequent pairing responses become automatic that is, they occur with little thought. The impulsive system can involve cognitive (e.g., attending to, approaching) and affective (e.g., implicit attitudes) responses to cues in the environment. Implicit cognitive responses include attentional biases which occur when certain stimuli in the environment automatically capture and hold individuals' attention (Kemps & Tiggemann, 2009), and approach-avoid biases, which automatically guide an individual to either approach, or avoid certain stimuli (Hofmann, Friese, & Wiers, 2008). Implicit attitudes reflect the affective aspect of the impulsive system and occur because of previous mental associations between an object or a behaviour (e.g., physical activity) and an evaluation (positive or negative) (Fazio & Olson, 2003)

In contrast with the impulsive system, the reflective system requires conscious decision making that uses thought development resulting in slow and effortful responses. Such decisions are based on personal goals, intentions and standards (Strack & Deutsch, 2004). Dual process models propose that people do not have the time or cognitive resources to carefully consider all decisions they make throughout the day, resulting in decisions being influenced by apparently trivial cues in the environment which they are often not aware of, such as a smell, presentation or accessibility of items. For example, the presence of palatable smells can increase food consumption (Fedoroff, Polivy & Herman, 1997), consumers more often buy food products that are placed in the centre of the store than at extremes (North, Hargreaves, & McKendrick, 1999; Valenzuela & Raghubir, 2009) and individuals are more likely to take the stairs when the lift is full (Soler et al., 2010).

Support for the role of automatic processing in guiding physical activity behaviour has come primarily from research examining implicit attitudes and their influence on intentional exercise behaviour (e.g., Craeynest et al., 2005; Keatley, Clarke & Hagger 2013; Banting, Dimmock & Lay, 2009; Greenwald, Poehlam, Uhlmann & Banaji, 2009). Additionally, evidence for an attentional bias for exercise related cues has been found in individuals who engage in high levels of exercise (Berry, Spence & Stolp, 2011; Berry, 2006; Bluemke et al., 2010; Calitri et al., 2009), and automatic approach biases have been associated with moderate to vigorous physical activity (Cheval et al., 2014a). The limited research that has investigated the relationship between the implicit processes and incidental physical activity has found a positive association with implicit attitudes (Conroy et al., 2010), and automatic approach biases (Cheval et al., 2014a; Cheval et al., 2014b) and levels of incidental physical activity.

Importantly, implicit processes and motivation have previously been found to have additive effects on intentional physical activity behaviour in gym attenders (Caudwell & Keatley, 2016). Research investigating health-related behaviours such as eating, and alcohol and nicotine consumption, has also found a combined contribution of implicit attitudes and motivation on consumption behaviour (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008; Ostafin & Palfai, 2006; Sherman, Rose, Koch, Presson, & Chassin, 2003). These findings suggest that implicit processes, along with an individual's level, and/or type of motivation may together guide behaviour (Evans, 2008; Smith & DeCoster, 2000). Thus, the current thesis investigated the combined contribution of implicit processes (i.e., implicit attitudes, approach-avoid biases and attentional biases) and motivation in relation to incidental physical activity.

Recent research has combined socio-ecological and dual process principles in the form of 'nudging' or 'choice architecture' interventions. As previously discussed in section 1.3., the impact of environmental changes on health-behaviour is recognised by socio-ecological models of behaviours. Socio-ecological models propose that physical environments can restrict or facilitate behaviour by promoting certain actions and by discouraging others (Sallis, Owen & Fisher, 2015). The concept of 'nudging' uses ecological principles by implementing a simple change in the environment to guide individuals towards a desired choice, without removing any alternatives (Thaler & Sunstein, 2008). Such approaches involve subtle alterations in small-scale physical or social environments (i.e., micro-environments) to cue healthier behaviour, without removing any alternatives, principally via the engagement of automatic cognitive processes (Thaler & Sunstein, 2008). Micro-environments are settings in which people gather for a specific purpose, such as purchasing or consuming food, alcohol, tobacco or be physically active (Swinburn, Egger & Raza, 1999). Nudging has been successfully applied in numerous micro-environments, namely within buildings such as restaurants, workplaces, schools and shops (Hollands et al., 2013). For example, placing less healthy foods further away from customers in a cafeteria, changing serving utensils, or reducing the size of plates in restaurants has been found to reduce the amount of food consumed (Rozin et al., 2011; Wansink & Ittersum, 2013).

Additionally, nudging interventions acknowledge the automatic nature of decisions and attempt to use automaticity to benefit health behaviour, rather than fight against it as in many traditional health campaigns (Thaler & Sunstein, 2008). As proposed by dual process models, people often use biases and implicit processing as shortcuts when making decisions because consciously reflecting on every alternative would be too time-consuming. While such automatic tendencies can sometimes lead to choices that are disadvantageous because of biases towards unhealthy options, nudging techniques use the automaticity of decisions to benefit people. Specifically, nudging strategies implicitly direct people towards healthier behavioral options by making the healthy options more salient in the environment. Thus, nudging interventions apply concepts from socio-ecological and dual process models by subtly altering micro-environments in order to influence the automaticity of behavior towards healthier options.

Previous research has found nudging to be effective in subtly guiding incidental physical activity behaviour in micro-environments. In particular, nudging in the activity domain has successfully guided participants towards the stairs rather than the escalator by placing coloured footprints on the floor (Marshall et al., 2002; Boutelle, Jeffery, Murray & Schmitz, 2004; Hansen & Jespersen, 2013). Increasing the time taken for elevator doors to close has also been found to increase the likelihood of people using the stairs (Houten, Nau & Merrigan, 2011). Stair use has similarly been increased by increasing the visibility or availability of stairs (Zimring et al., 2005; Olander & Eves, 2011) and improving the ambience of stairs (e.g., playing music or changing the appearance of the stairs) (Boutelle et al., 2004). Point-of-decision prompts are one particular type of nudge which operate as 'cues to action' that motivate people to utilise healthy alternatives (Rosenstock, 1990). Often presented in the form of motivational signs (e.g., stair use signs), point-of-decision prompts are a cost effective, subtle environmental change, that have previously been found to increase physical activity in a number of different settings (Dunn et al., 1998; Foster et al, 2006). Therefore, automatic and environmental factors have been found to be complementary in regards to increasing physical activity behaviour.

Additionally, as highlighted in section 1.4, motivation for physical activity can be fostered by supportive built environments, and influence subsequent behaviour (Bowler et al. 2010; Sheldon, Ryan, Deci, & Kasser, 2004). Indeed, exercise motivations have been found to shift and change depending on the context (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010), and the type of motivation (i.e., autonomous or controlled) experienced for incidental physical activity (e.g., active travel) has also been found to differ in certain environments (e.g., being alone versus with others, out of necessity due to transport restraints versus out of choice) (White et al., 2018). Thus, both motivational quality and automatic responses can vary depending on the context or environment, and influence incidental physical activity behaviour. Yet, previous research has not considered whether motivational quality for incidental physical activity is associated with automatic responses in micro-environments, and how these factors contribute to incidental physical activity engagement. Therefore, the research presented addressed this gap in the literature by investigating the extent to which an environmental modification facilitated motivation and automatically guided subsequent incidental physical activity engagement.

1.6 Aims of the Research

The overarching aim of the research reported in this thesis was to obtain a better understanding of how environmental and psychological (motivation, implicit processes) factors contribute to incidental physical activity behaviour. More specifically, the primary aim of the research was to investigate whether these factors are associated with incidental physical activity, as they are for leisure time physical activity. Chapters 2-4 present the results of Studies 1 (environmental factors), 2 (motivation) and 3 (implicit processes) which investigated the inter-relationships between environmental and psychological factors, and how they relate specifically to incidental physical activity. A further aim of the research was to investigate the inter-relationships between these factors with a view to assist with the development of future interventions. Study 4 investigated whether subtly modifying the environment could implicitly guide individuals to engage in incidental physical activity by altering their motivation (Chapter 5), while Study 5 (Chapter 6) investigated the contributions of motivation, environmental factors and incidental physical activity engagement to well-being.

1.7 Outline of the Thesis

Chapters 2-4 address the first aim of the thesis and contain reports of studies investigating the contribution of environmental, motivational and automatic factors to incidental physical activity. Specifically, Chapter 2 presents the results of Study 1, which considered aspects of socio-ecological models and self-determination theory by investigating the contribution of motivational and built environmental factors to incidental physical activity engagement. Chapter 3 presents Study 2, which investigated whether contextual aspects of motivation and the trait aspect of motivation, as proposed by self-determination theory, contribute to incidental physical activity engagement. Chapter 4 describes the results of Study 3, which aimed to address theoretical propositions of dual-process models together with aspects of self-determination theory, by investigating the combined contributions of implicit attitudes, attentional biases and approach biases with motivation to incidental physical activity engagement.

The next two chapters (Chapters 5-6) address the second aim of the thesis, which was to examine the inter-relationships between motivation and environmental factors, with a view to inform strategies to increase incidental physical activity and enhance well-being. Chapter 5 reports on Study 4, an experiment drawing from self-determination theory, socio-ecological and dual process models, which aimed to investigate the effectiveness of a 'nudging' intervention, as well as the underlying motivational mechanisms involved in guiding incidental physical activity engagement. Finally, Chapter 6 reports on Study 5 which drew on socio-ecological models and self-determination theory to investigate the combined contributions of incidental physical activity, motivation and the built environment (specifically neighbourhood satisfaction) to subjective well-being. The final chapter (Chapter 7) presents a general discussion of the main findings from all of the studies. It also considers theoretical and practical implications with reference to the main aims of the thesis, and provides recommendations for future research directions.

All chapters in the current thesis (except for Chapters 1 and 7) are formatted as manuscripts for publication. Chapter 4 is published in the *British Journal of Health Psychology*, while Chapters 2, 3, 5 and 6 are under review. The formatting of each chapter varies slightly as the manuscripts were prepared according to the requirements of each particular journal. It should be noted that while Studies 1 and 4 had distinct and unique aims these studies were derived from the same data set. Similarly, Studies 2 and 3 had their own specific focus yet drew variables from the same data set. There is some considerable and unavoidable repetition of the background information and methodology in the Introduction and Method sections of each chapter.

1.8 References

1.8 References

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CHAPTER 2: STUDY 1

Environmental and Psychological Contributors to Physical Activity

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Abstract

Objectives: Informed by socio-ecological models, this study investigated how perceptions of one's local built environment, as well as intentions (i.e., the strength of an individual's desire to engage in a behaviour) and motivation (i.e., quality of reason driving the behaviour) to be active contribute to incidental and leisure time physical activity.

Methods: A cross-sectional study (N=212) examined whether built neighbourhood characteristics, intentions and motivation interact to predict leisure time and incidental physical activity. Perceived built neighbourhood characteristics were measured using the Neighbourhood Walkability Scale (NEWS), intentions were measured using 5 point Likert scales, and motivation was measured using the Perceived Locus of Causality Questionnaire. Leisure time and incidental physical activity were both measured by the International Physical Activity Questionnaire (IPAQ-L).

Results: The positive contribution of intentions to leisure time physical activity was dependant on both the level of neighbourhood walkability and the motivation to be physically active. Further, intentions indirectly contributed to incidental physical activity engagement when motivation was present, and this relationship was moderated by levels of neighbourhood walkability.

Conclusions: Although the exact nature of the inter-relationships differed, walkable neighbourhoods, motivation and intentions together play an important role in guiding both leisure time and incidental physical activity levels. The present study adds to the limited research investigating how environmental features and psychological factors together contribute to physical activity engagement.

Key words: *physical activity, neighbourhood walkability, motivation, intentions, socio-ecological models, self-determination theory*

2.1 Introduction

Despite widespread awareness of the health benefits of physical activity, many adults are not active enough to achieve optimal health benefits (Bauman et al., 2009). Physical activity was once a central feature of lifestyles; however, recent societal trends have led to increased sedentariness and physical inactivity, which have harmful physical and mental health impacts (Levine, 2015; Prentice & Jebb, 1995). Physical activity has two main components: leisure time physical activity and incidental physical activity (Levine, 2007). Leisure time physical activity involves intentional physical activities, such as sport, running or going to the gym, and has well-established health benefits such as reducing the risk of obesity as well as a variety of benefits even in the absence of weight loss (i.e., reduced risk of cardiovascular diseases, type two diabetes, and certain cancers) (Durstine, Gordon, Wang & Luo, 2013). By contrast, incidental physical activity consists of unstructured activities that occur as part of daily living, such as domestic work (e.g., household chores, gardening), workplace activity (e.g., physical labour), transport (e.g., cycling to get from A to B) and functional leisurely activities (e.g., walking the dog) (Levine, 2007). It is critically important to understand what influences both leisure time physical activity and incidental physical activity to assist with the creation of sustainable interventions to encourage people to adopt more active lifestyles.

Socio-ecological models have evolved from the psychological and behavioural science domain and focus on people's interaction with their physical and social environment (Sallis, Owen & Fisher, 2015). Specifically, socio-ecological models propose that physical activity engagement is determined by interactions between environmental and individual features. It is proposed that the social and built characteristics of places that individuals reside in can either promote or inhibit opportunities for physical activity (Sallis, Owen & Fisher, 2015). Neighbourhood "walkability" is a key construct among built environmental determinants of physical activity (Saelens et al., 2003; Lake, Townshed & Alvanides, 2010). Walkable neighbourhoods are those that have mixed land use, well-connected streets and high residential density. Although research has demonstrated an association between the built neighbourhood environment and physical activity engagement (Saelens & Handy, 2008, Forsyth et al., 2007), systematic reviews have highlighted multiple inconsistencies between environmental attributes and physical activity engagement with results ranging from significant, to non-significant, and to contradictory when assessing the association between some environmental determinants and physical activity (e.g., Wendel-Vos et al., 2007; Bancroft et al., 2015).

A possible explanation for the variation in findings regarding environmental attributes and physical activity is the limited research on the interaction between environmental variables and psychological factors. Although socio-ecological models propose that a combination of both individual-level and environmental factors contribute to health behaviour change, only a limited number of studies have investigated how both individual and environmental attributes influence physical activity levels (Deforche et al., 2010; Ball et al., 2001; Cerin et al., 2008; Giles-Corti & Donovan, 2003). In one such study, Cerin et al. (2008) found that reduced access to sports and fitness facilities was associated with lower self-efficacy, lower enjoyment of physical activity and lower levels of moderate-to-vigorous physical activity. Furthermore, Deforche et al. (2010) found that associations between active commuting (a form of incidental physical activity) and environmental features (safety from crime and traffic and access to local stores) was moderated by levels of self-efficacy. Therefore, there is emerging evidence to support the notion that environmental attributes and psychological mechanisms together influence levels of both incidental and leisure time physical activity. However, further investigation is required to clarify the nature of this inter-relationship.

It has been suggested that environmental characteristics may influence physical activity by prompting physical activity intentions (the amount of effort individuals intend to invest in engaging in a future behavior) (Ajzen, 2011; Kremers et al., 2009; Giles-Corti & Donovan, 2003). For example, an individual who drives past a gym everyday may become familiar with that gym and due to this familiarity and perceived accessibility (Hoehner et al., 2005), set the intention to attend the gym, resulting in physical activity engagement. Indeed, intentions have previously been found to interact with environmental factors to predict exercise (Giles-Corti & Donovan, 2002), and have been found to independently predict leisure time physical activity engagement (Ajzen, 2011), and incidental physical activities (Hagger & Chatzisarantis, 2009). Previous research has also demonstrated that motivation can be complementary to intentions in explaining health-related behaviour, in particular for leisure time physical activity (Hagger & Chatzisarantis, 2008; Vallerand, 2007). While intentions reflect the strength of an individual’s desire to engage in a behaviour, motivation (according to self-determination theory) reflects the underlying reason driving the behaviour (Deci & Ryan, 1985; Ryan & Connell, 1989). For example, in the statement “I really want to exercise to lose weight” the individual conveys a strong conscious desire (i.e., intention) to exercise, and losing weight is the reason the individual wants to do so (i.e., motivation). Motivation has been consistently associated with exercise engagement and persistence (Hagger & Chatzisarantis, 2008), and has been found to play a mediating role in the relationship between intentions and exercise, indicating that motivation is a critical factor in intentional activity engagement (Lewis et al., 2002; Brassington et al., 2002). Assessing intentions and motivation together will therefore provide a more complete account of the psychological contributors to physical activity behaviour (Sallis, Owen & Fisher, 2015; Teixeira et al., 2012; Deci & Ryan, 2008).

Furthermore, recent research in the exercise domain has demonstrated that motivation for physical activity can be fostered by certain environments (Bowler et al., 2010; Irvine, Warner, Devine-Wright, & Gatson, 2013). For example, participating in outdoor physical activity, particularly in 'green spaces', has been linked to increased motivation and enjoyment of exercise (Calogiuri & Elliot, 2017). Additionally, previous research has found interactions between individuals' motivational quality and responses to environmental cues in predicting incidental physical activity levels (Oliver & Kemps, 2018). Therefore, physical activity levels are associated both with the surrounding environment and underlying psychological mechanisms. However, it is not understood how the built environment, intentions and motivation are inter-related, and how they together contribute to physical activity engagement. Indeed, the need to gain a better understanding of the specific physical environmental attributes that might influence physical activity, and how these attributes interact with known psychosocial influences of activity behaviour (e.g., intentions and motivation) is a known gap in the literature (Sallis, Owen & Fisher, 2015; Bauman, 2012; Trost et al., 2003). Understanding the relationship between the built environment and psychological factors is particularly important as it could guide the development of sustainable, and effective multi-faceted interventions aimed at increasing levels of physical activity.

Thus, the aim of the current study was to investigate the relationship between environmental (i.e., neighbourhood features) and psychological (i.e., intentions and motivation) factors that contribute to leisure time physical activity and incidental physical activity. Based on socio-ecological models, and the limited previous research investigating interactions between the built environment, individual characteristics and physical activity (Sallis et al., 2015), we sought to explore the inter-relationships between these factors. Extrapolating from research in the exercise domain (Brassington et al., 2002; Lewis et al., 2002), we explored the mediating role of motivation on intentions for both leisure time and incidental physical activity.

We expected a mediating role of motivation due to the accumulating body of evidence demonstrating that individual differences mediate the relationship between intentions and health behaviours (Brassington et al., 2002; Lewis et al., 2002). Indeed, although the theory of planned behaviour (Ajzen, 1991) proposes intentions to be proximal predictors of behaviour, it is widely recognized that people often fail to act on their intentions and that post-intentional variables play a crucial role in facilitating behaviour engagement (Cheval et al., 2014; Webb & Sheeran, 2006; Sheeran, 2002). Therefore, based on previous research that has demonstrated a direct relationship between motivation and intentions (e.g., Standage et al., 2003; Vallerand, 2007), as well as between motivation and physical activity engagement (e.g., Fortier et al., 2012; Sylvestor et al., 2018), we expected that motivation would mediate the intention-behaviour relationship.

Socio-ecological models propose that interactions between the built environment and psychological mechanisms guide health related behaviour (Sallis et al., 2015). Furthermore, moderated mediation allows for a deeper understanding of a mediating effect by determining under what conditions the mediation may be significant (Muller, Judd, & Yzerbyt, 2005; Preacher, Rucker, & Hayes, 2007). Accordingly, neighbourhood walkability was proposed to moderate the extent to which motivation mediates the intention-behaviour relationship. We expected that intentions and motivation would predict physical activity engagement depending on one’s neighbourhood environment (i.e., high or low neighbourhood walkability). We expected that a different interaction pattern might occur for incidental physical activity and leisure time physical activity as previous research has demonstrated that leisure time and incidental physical activity are two distinct behaviours, with previous correlations demonstrating only moderate to weak relationships between the behaviours (Biddle & Mutrie, 2007; Blair, Cheng & Holder, 2001; Zwerink, 2013). Additionally, leisure time and incidental physical activity have been shown to be influenced differentially by motivational (Keatley, Clarke, & Hagger, 2013) and environmental factors (e.g., Wendel-Vos et al., 2007).

In summary, we hypothesised that:

1. Motivation would partially mediate the relationship between leisure time physical activity engagement and intentions,
2. Motivation would mediate the relationship between intentions and incidental physical activity, and

3. The mediation in hypotheses 2 and 3 would be moderated by neighbourhood walkability. We sought to explore where in the model this moderation would occur for incidental physical activity and leisure time physical activity.

2.2 Method

Participants and Design.

The study used a cross-sectional design. English speaking participants (N=212; 163 females, 47 males, 2 preferred not to disclose) were recruited from the student population at an Australian University, and the wider community. Participants were aged 17-73 years (M = 22.44, SD = 7.91). Student participants were compensated with course credit; community participants were entered into a lottery to win one of three $50 gift cards. The study was registered on the University's online SONA System, allowing students to select the project voluntarily. Community participants were recruited through online classified, and community and social media websites.

Materials.

Demographic details.

Previous research has found that age, years at current address, highest education level (low—did not complete secondary education; medium—completed secondary education or equivalent; or high—tertiary qualification), marital status (married/de facto union, previously married or never married), employment status (working full time, working part-time or not working) and personal income (categorized as low—$0–299 per week; medium—$300–699 per week; or high—$700+ per week) can all contribute to levels of physical activity (Bauman et al., 2012). Thus these factors were measured and considered as potential co-variates (Ball et al., 2001).

Physical and social environmental factors.

The Neighbourhood Environment Walkability Scale (NEWS) was used to measure perceptions of environmental attributes of participants' local area (Salens, Sallis & Frank, 2003). The NEWS scale is a valid and reliable measure of residents' perceptions of neighbourhood characteristics in Australia (see Cerin et al., 2006 for psychometric properties). The questionnaire addresses the following environmental characteristics which operationalize the larger construct of neighbourhood walkability: a) residential density; b) proximity to non-residential land uses, such as restaurants and retail stores (land use mix-diversity); c) ease of access to non-residential uses (land use mix-access); d) street connectivity; e) walking and cycling facilities such as sidewalks and pedestrian/bike trails; f) aesthetics and neighbourhood surroundings; and g) neighbourhood safety. Items were rated on 4 or 5 point scales, and an overall neighbourhood walkability score was calculated according to the standardised NEWS scoring procedure (Cerin et al., 2006).

Physical activity intentions.

Participants were first provided with definitions of leisure time and incidental physical activity. Leisure time physical activity, termed "exercise" when measuring intentions and motivation, was defined as "physical activity that is planned, structured, and repetitive for the purpose of conditioning any part of the body. Exercise is used to improve health and maintain fitness." Incidental physical activity, termed "daily activity", was defined as "activities that you do as part of everyday life that involve being active (e.g., cleaning, gardening, work related activity, taking the stairs instead of escalator, walking or cycling as a mode of transport). Do not include activities that you consider exercise." Participants then responded to 4 intention stems ("I will try", "I will think about", " I will make an effort" and "I will attempt") for exercise (e.g., "I will try to exercise at least 6 times in the next two weeks") and for daily activity (e.g., "I will try to be active on a daily basis in the next two weeks"). On the basis of the work of Ajzen and Madden (1986) and worded in a manner to correspond to behavioral criteria in time, context, target, and action, participants responded to four intention stems ("I will try", "I will think about", " I will make an effort" and "I will attempt") for exercise (e.g., "I will try to exercise at least 6 times in the next two weeks") and for daily activity (e.g., "I will try to be active on a daily basis in the next two weeks"). Responses made on 5-point scales ranged from "strongly agree" to "strongly disagree". Separate averaged intention scores were calculated for leisure time and incidental physical activity. This was reliable for both exercise ($\alpha = .89$) and incidental physical activity ($\alpha = .94$) in the current study.

Motivation.

An adapted version of Ryan and Connell's (1989) measure of Perceived Locus of Causality was used to measure motivation for both leisure time and incidental physical activity. This self-report measure has previously been modified to assess motivation for leisure time and incidental physical activity (Oliver & Kemps, 2018) and demonstrated acceptable reliability in the current study (intrinsic motivation, $\alpha = .75$;

identified regulation, α = .76; introjected regulation, α = .80; external regulation, α = .80). Previous adaptions of the measure have also been found to reliably assess motivation for health behaviours (Hagger et al., 2014)

Participants were presented with common word stems that related to either leisure time (e.g., "I exercise regularly because…") or incidental physical activity (e.g., "I use the stairs instead of an elevator or escalator because …") followed by eight motives. A total of ten activities were assessed (five leisure time physical activities and five incidental physical activities). In accordance with self-determination theory, the motives reflected forms of controlled or autonomous motivation (Deci & Ryan, 2008). Responses were recorded on 5-point scales ranging from "not true at all" to "very true". To ensure that we only captured behaviours that participants actually engaged in, participants only responded to word stems for activities that were relevant to them. Word stems relating to leisure time or incidental physical activity were analysed separately to provide measures of motivation unique to each behaviour. An autonomous motivational regulation index and controlled motivational regulation index was computed following the procedure of Hagger et al. (2014). To account for the number of activities participants engaged in, this score was divided by the number of activities participants selected to be relevant to them. Overall motivation scores specific for either leisure time or incidental physical activity were calculated by adding the mean of the controlled motivation index and the mean of the autonomous motivational regulation index, and then dividing this score by two (Judge et al., 2005).

Physical activity.

Physical activity was assessed by the long version of the International Physical Activity Questionnaire (IPAQ-L), a well-established seven-day recall of physical activity and inactivity. The IPAQ questionnaire has excellent test-retest reliability (r = .80) and validity when assessed against an accelerometer (r = .30), and is suitable for use in adults aged 18-65 years in diverse settings (see Craig et al., 2003 for detailed psychometric properties). To measure leisure time physical activity, participants reported the amount of time (minutes per week) they spent doing moderate- and vigorous-intensity physical activity in their leisure time during the past 7 days. Similarly, to measure incidental physical activity participants reported the amount of time (minutes per week) spent being active in the workplace, for transportation and during household activities over the past 7 days. Separate overall indices of total leisure time physical activity and total incidental physical activity per day were calculated by multiplying vigorous activity, moderate activity and walking by their estimated intensity in metabolic equivalent (MET) energy expenditure, and summed into a single variable. One MET represents the energy expended while sitting quietly at rest. The MET intensities used to score the IPAQ were vigorous (8 METs), moderate (4 METs) and walking (3.3 METs).

Procedure.

The survey was administered using Qualtrics online computer software; median administration time was 30 minutes. Qualtrics is a web-based survey creation and distribution platform that allowed participants to access the survey using their personal computers or smartphones. Students accessed the survey via an anonymous link on the SONA System. Community participants were emailed an anonymous link following expression of interest in the study. All participants provided written informed consent prior to receiving the link to the questionnaire.

Analytic strategy.

Data were analysed using SPSS Statistics 25.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were examined and Kolmogorov-Smirnov tests and visual inspections of histograms indicated that the independent and dependent variables were normally distributed (Field, 2013). Durbin-Watson statistics indicated independence between the dependent and independent variables, as well as the NEWS subscales. All tolerance levels were >.3, indicating that the level of collinearity among the variables was acceptable. Visual inspection of the regression residual plot for incidental physical activity and neighbourhood walkability indicated that the data were not homoscedastic (Field, 2013). Therefore, to reduce the risk of type 1 error, bootstrapping was used in the analyses. Bootstrapping is a non-parametric analysis method that does not make assumptions about the distribution of data (Preacher & Hayes, 2004).

To test hypotheses 1 and 2, we examined whether motivation mediated the contribution of intentions to leisure time physical activity or incidental physical activity using PROCESS version 3.0 (model 4) with 5000 bootstrap samples. PROCESS is a recommended analysis tool that uses bootstrapping to eliminate bias (Field, 2013). To address hypothesis 3, we examined the relative influence of neighbourhood walkability on leisure time physical activity and incidental physical activity by conducting a hierarchical regression analysis using PROCESS (model 1) with 5000 bootstrap samples. Separate models were estimated with leisure time physical activity or incidental physical activity as the outcome (Hayes, 2017). Any significant interactions were followed up with simple slopes analyses to indicate the nature of the interaction (Field, 2013). As the direct relationship between the built environment and incidental physical activity was found to be significant, we conducted a linear regression using 5000 bootstrap samples to identify which components of the built environment are important in this relationship.

2.3 Results

Sample characteristics.

Descriptive statistics for sample characteristics are reported in Table 1. A power analysis using GPower computer software (Erdfelder, Faul & Erdfelder, 1996) indicated that a total sample of 148 participants would be needed to detect large effects (f =.40) with 90% power using regression analyses with 4 predictors (α = .05). Thus, the current sample (N = 212) had adequate power to detect large effects. Most participants were women, and had completed secondary education. Further, the majority of participants were low income earners who were working part-time, or studying full-time. Respondents reported an average of 1393 MET-minutes of incidental physical activity per week (*SD* = 2234; *Median* = 594) and 1865 MET-minutes of leisure time physical activity per week (*SD* = 4202; *Median* = 558). On average, participants showed high levels of motivation for, and held high intentions to engage in, both incidental and leisure time physical activity. One participant was removed from the final analyses due to incomplete data.

Table 1.
Descriptive statistics for sample characteristics.

Gender	M	SD	%
Male			22.5
Female			76.9
Prefer not disclose			0.9
Educational attainment			
Yr 10 or equivalent			1.4
Yr 12 or equivalent			53.9
Trade/ apprenticeship			0.5
Certificate/diploma			13.1
University degree			29.1
Higher university degree			2.3
Employment			
Working full-time			9.9
Working part-time			44.6
Unemployed			5.2
Keeping house/or raising children full time			0.9
Studying full-time			39
Retired			0.5
Personal Income			
\$0-\$299			63.4
\$300- \$699			25.8
\$700 +			10.8
Marital Status			
Married			7
Single			74.6
Divorced			1.4
Domestic partnership			16.9
Age (years)	22.44	7.8	
Years at current address	8.12	7.49	
Incidental Physical Activity METS	*1393*	*2233*	
Leisure Time Physical Activity METS	*1865*	*4203*	
Motivation for Incidental PA	*26.44*	*9.53*	
Motivation for Leisure Time PA	*25.51*	*14.59*	
Intentions for Incidental PA (5 point scale)	*4.05*	*.97*	
Intentions for Leisure time PA (5 point scale)	*4.1*	*.85*	

*METS denote the metabolic equivalent of physical activity **PA denotes physical activity

Correlation between physical activity, individual characteristics and the built environment.

Table 2 shows the correlations between motivation, intentions, neighbourhood walkability and incidental and leisure time physical activity. Table 3 shows the correlations between leisure time physical activity, incidental physical activity and neighbourhood characteristics. Employment, age, marital status and income did not correlate with either leisure time or incidental physical activity engagement. Therefore, these factors were not included as co-variates in subsequent analyses.

Table 2.
Relationships between physical activity, motivation and intentions

	1	2	3	4	5	6	7
1. Leisure Time PA							
2. Incidental PA	.105						
3. Leisure Time PA Motivation	.255**	.007					
4. Incidental Motivation	.016	.182**	.033				
5. Leisure Time PA Intentions	.256*	.061	.513**	.077			
6. Incidental PA Intentions	.149*	.117	162*	.229**	.434*		
7. Neighbourhood Walkability	.018	203**	.129	.050	.005	.008	

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

Table 3.

Relationship between physical activity and the built environment.

	1	2	3	4	5	6	7	8	9
1. Incidental PA									
2. Leisure time PA	.105								
3. Residential density	.199**	.015							
4. Land mix diversity	-.011	.086	.053						
5. Land mix access	-.12	-.012	.024	.573**					
6. Street connectivity	.049	.064	.122	.368**	.384**				
7. Walking & cycling	-.161*	.031	.024	.357**	.481**	.399**			
8. Aesthetics	-.015	.149*	-.078	.266**	.157*	.143*	.112		
9. Safety	.206**	.008	.169*	-.134	-.235**	-.191**	-.167*	-.355**	

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

Relationship between leisure time physical activity, individual characteristics and the built environment.

Motivation was found to mediate the relationship between intentions and leisure time physical activity. Intentions were significantly associated with leisure time physical activity (pathway *c*, Figure 1), *b* = 4.63, *SE* = .816 *t*(208) = 2.34, *p* = <.001. However, with the mediator, motivation, in the model, intentions no longer significantly predicted leisure time physical activity, *b* =.065, *SE = 4.14, t*(207) = 0.16, *p* = .98, indicating that motivation fully explained the relationship between intentions and leisure time physical activity.

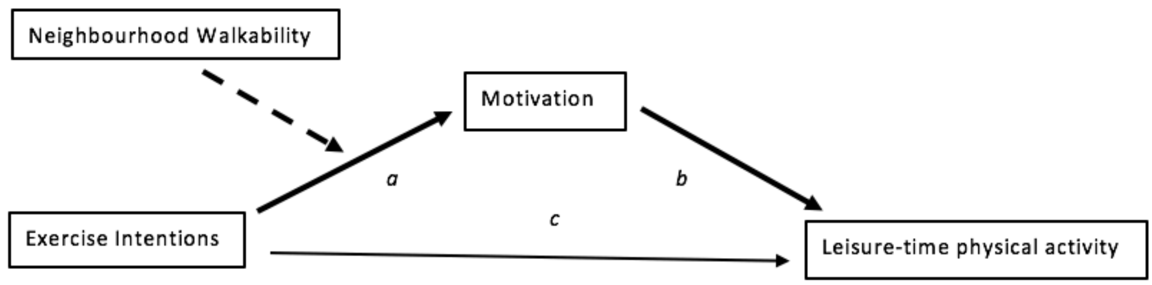

Figure 1. Model of indirect effect of intentions on leisure time physical activity by motivation. *Note.* Bold arrows denote significant relationships; bold dashed arrows denote moderation of adjoining relationship by neighbourhood walkability.

In line with socio-ecological models and other researchers' recommendations (Sallis, Owen & Fisher, 2015; Kremers et al., 2006), we further explored the inter-relationships between individual characteristics and the built environment in predicting leisure time physical activity by investigating pathways *b* and *c*, shown in Figure 1 (Hayes, 2017). A separate model was estimated with leisure time physical activity as the outcome. Neighbourhood walkability did not moderate the relationship between intentions and leisure time physical activity, nor between motivation and leisure time physical activity, and was therefore not included as a moderator of pathways *b* or *c*. However, the interaction term (product of intentions and neighbourhood walkability) was a significant predictor of motivation, *b* = -.034, *SE* = .012*, t(*203) = -2.86 *p* = .005, in the analysis of pathway *a*. This indicates that the contribution of intentions to motivation varied by levels of neighbourhood walkability. As shown in Figure 2, simple slopes indicated that for individuals with high intentions to be active, neighbourhood walkability was not a significant predictor of motivation, (+ 1SD) B = -.013, $t(208) = -.782$, $p = .435$. However, for participants who had low intentions to be active, it was (- 1SD) B = .054, $t(208) = 3.533$, p=.001, indicating that neighbourhood walkability may motivate individuals to engage in leisure time physical activity when intentions are low. Thus, the contribution of intentions to leisure time physical activity depends on both the motivation to be active, and neighbourhood walkability.

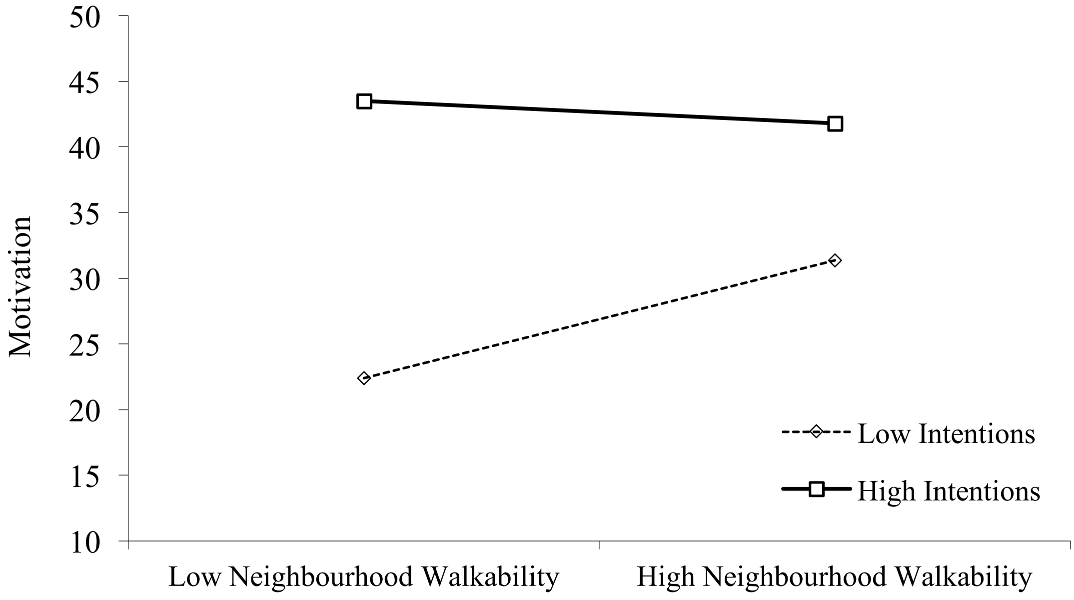

Figure 2. Interaction between intentions and neighbourhood walkability on motivation for leisure time physical activity.

Relationship between incidental physical activity, individual characteristics and the built environment.

Intentions were not significantly associated with incidental physical activity (pathway *c*, Figure 3), *b* = 304.52, *SE*= 177.98, $t(211) = 1.71$, $p = .08$. However, with the mediator, motivation, in the model, we found a significant indirect effect of intentions on incidental physical activity, *b* = 206.78, *SE = 180.91*, $t(210) = 1.14$, $p = .03$, indicating that the contribution of intentions to incidental physical activity is explained by motivation. We further explored these inter-relationships between individual characteristics and the built environment in predicting incidental physical activity by investigating pathways *b* and *c*, shown in Figure 3 (Hayes, 2017). A separate model was estimated using incidental physical activity as the outcome.

Neighbourhood walkability moderated the relationship between intentions and incidental physical activity (pathway c), $b = -5.133$, $SE = 2.114$, $t(208) = -2.43$, $p = .016$, indicating that the contribution of intentions to incidental physical activity varied by levels of neighbourhood walkability. However, neighbourhood walkability did not moderate the relationship between motivation and incidental physical activity, nor the relationship between intentions and motivation, and was therefore not included as a moderator of pathways *a* or *b*.

As shown in Figure 4, simple slopes indicated that for individuals who live in highly walkable neighbourhoods, intentions were not a significant predictor of incidental physical activity, (+ 1SD) $B = -148.74$, $t(208) = -.59$, $p = .557$, indicating that highly walkable neighbourhoods may facilitate incidental physical activity, even when intentions are low. By contrast, for participants who live in less walkable neighbourhoods, intentions were a significant predictor of incidental physical activity (-1SD) $B = 678.25$, $t(208) = 2.91$, $p = <.004$, indicating that intentions are an important contributor to incidental physical activity engagement for people who live in less walkable neighbourhoods.

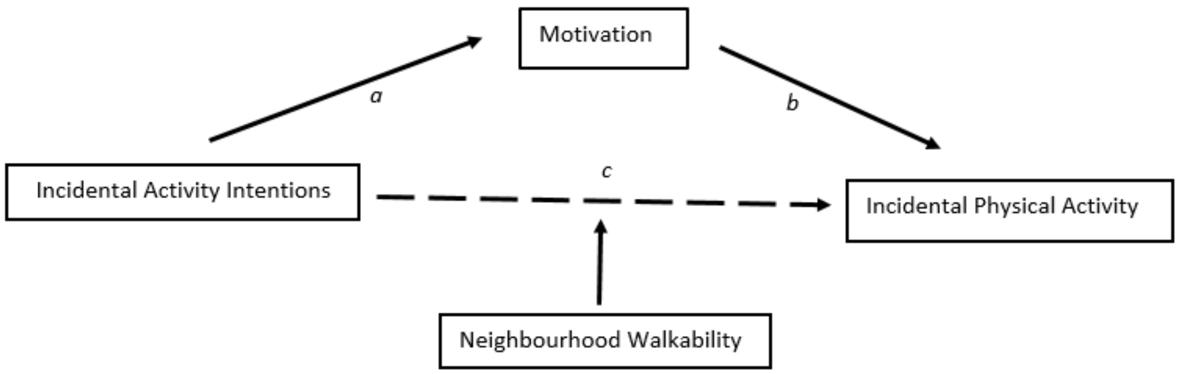

Figure 3. Model of indirect effect of intentions on incidental physical activity by motivation. *Note.* Bold arrows denote significant relationships, bold dashed arrow denotes indirect effect on incidental activity intentions on incidental physical activity

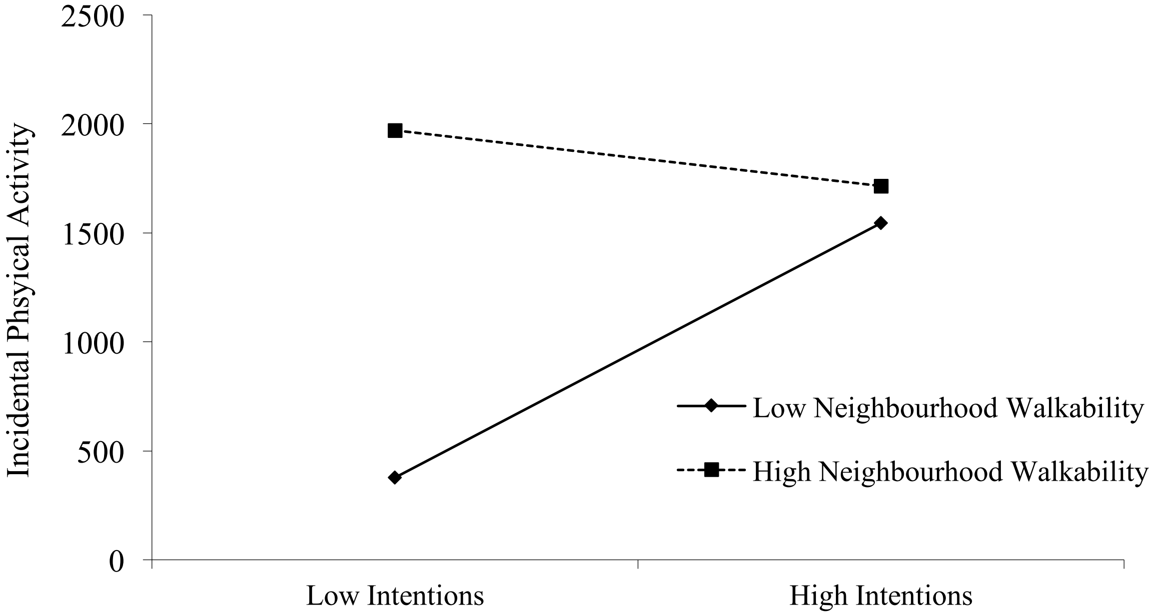

Figure 4. Interaction between intentions and neighbourhood walkability in predicting incidental physical activity.

2.4 Discussion

The current study was the first to explicitly investigate the inter-relationships between environmental (i.e., neighbourhood walkability) and psychological factors (i.e., intentions and motivation) in predicting leisure time and incidental physical activity. Although we found no direct relationship between neighbourhood walkability and leisure time physical activity, results indicate that the built environment may play a role in facilitating motivation for individuals who have low intentions to be physically active. We further found that intentions to be active contribute to levels of leisure time physical activity, but only when individuals are motivated to be physically active. Therefore, an important finding of the current study is that the contribution of intentions to leisure time physical activity is depends both on the level of neighbourhood walkability and the presence of motivation. By contrast, we did find a direct relationship between neighbourhood walkability and incidental physical activity. Furthermore, we found that intentions contribute to incidental physical activity when individuals are motivated to be active, and that neighbourhood walkability is beneficial for incidental physical engagement among individuals with low intentions to be active. Thus, the current study demonstrates for the first time that for incidental physical activity, neighbourhood walkability plays an important role in guiding activity levels for individuals who have the motivation, but lack the intention to be active.

The focus of the current study was to investigate how the built environment and individual characteristics together contribute to physical activity levels. We found that motivation fully accounted for the contribution of intentions to leisure time physical activity levels. Results indicate that the reason intentions are related to incidental physical activity is due to motivation. Although somewhat unexpected, this finding does build upon previous research in the exercise domain that has incorporated intentions and motivation into the same theoretical model and suggests that considering intentions and motivation together will assist in providing a more holistic account of the psychological mechanisms that drive intentional physical activity behaviour (Hagger & Chatzisarantis, 2014; Sallis, Owen & Fisher, 2015; Teixeira et al., 2012; Vallerand, 2007). Furthermore, we found that intentions to engage in leisure time physical activity differentially contributed to motivation depending on neighbourhood walkability. Therefore, the contribution of intentions to leisure time physical activity depends on the walkability of one's neighbourhood as well as the presence of motivation. Accordingly, living in a supportive environment is an advantage as it facilitates motivation for those with low intentions, and thereby contributes to leisure time physical activity engagement. The limited previous research investigating the inter-relationships between environmental factors and psychological factors in relation to physical activity engagement has found a similar pattern of results (Calogiuri & Elliot, 2017; Ball et al., 2001; Cerin et al., 2008). Reduced access to fitness facilities has previously been associated with lower self-efficacy, less enjoyment and less engagement in moderate to vigorous physical activity (Cerin et al., 2008), while 'green spaces' have previously been linked to increased motivation, enjoyment and participation in exercise (Calogiuri & Elliot, 2017). Our research both strengthens and extends this pattern of results, by indicating a positive relationship between a supportive environment, psychological factors and leisure time physical activity engagement. However, the current study further indicates that a supportive environment on its own is not sufficient to facilitate leisure time physical activity, namely when psychological resources (i.e., intentions and motivation) are absent. Therefore, psychological factors such as motivation and intentions are important underlying mechanisms that may assist in explaining the variability in the relationship between the built environment and leisure time physical activity engagement.

To our knowledge, the current study is the first to explicitly investigate the inter-relationships between intentions, motivation, the built environment and incidental physical activity engagement. Motivation mediated the relationship between intentions and incidental physical activity engagement. Intentions contributed to incidental physical activity engagement indirectly, i.e., only when motivation was present, indicating that motivation is a critical factor in determining whether one engages in incidental physical activity. This result is consistent with self-determination theory, which states that quality of motivation positively influences health behaviours, including physical activity (Fortier & Kowal, 2007; Hagger & Chatzisarantis, 2008; Ryan & Deci, 2000). Previous studies have found motivation to be a critical factor for intentional physical activity, including recreational exercise, weight loss programs, in clinical populations and for a variety of ages (Teixara et al., 2012). Results of the present study suggest that motivation may be equally important for incidental physical activity engagement, and thus support and strengthen the limited evidence to date for a link between incidental physical activity and motivation (Oliver & Kemps, 2018; Keatley, Clarke & Hagger, 2013). As for leisure time physical activity, considering intentions and motivation together appears to be beneficial in providing a more holistic account of the psychological mechanisms that drive incidental physical activity behaviour (Sallis, Owen & Fisher, 2015; Teixeira et al., 2012; Deci & Ryan, 2008; Hagger & Chatzisarantis, 2008; Vallerand, 2007).

An interesting finding of the current study is that intentions were not associated with incidental physical activity. Therefore, results suggest that people engage in incidental physical activity without the conscious intention to do so. One possible explanation for this finding is that incidental physical activity is largely habitual and performed without planning or conscious deliberation. Indeed, research in the physical activity domain has found that automatic processes predict a range of health-related behaviours, including intentional physical activity (Banting, Dimmock & Lay, 2009; Greenwald, Poehlman, Uhlmann & Banaji, 2009). Future research would benefit from investigating how automatic processes guide incidental physical activity engagement.

An important finding of the current study is that living in a supportive environment appears to benefit incidental physical activity engagement when individuals lack the intent to be active. We found that intentions to engage in incidental physical activity differentially contributed to such engagement depending on neighbourhood walkability. In particular, we found that individuals with low intentions to be active engaged in higher levels of incidental physical activity if they lived in more walkable neighbourhoods, but not if they lived in less walkable neighbourhoods. This pattern extends upon the few previous observational studies that have examined the built environment and psychosocial variables (Deforche et al., 2010; Ding & Gebel, 2012). For example, Deforche et al. (2010) found that associations between active commuting (a form of incidental physical activity) and environmental features (safety from crime and traffic and access to local stores) was moderated by level of self-efficacy. Specifically, shorter distances to local facilities were positively associated with active transportation among adolescents with low-self efficacy. One interpretation is that an activity-friendly neighbourhood can help people to overcome low psychosocial resources for physical activity (Ding & Gebel, 2012). Our findings support this proposition and more specifically suggest that improving environmental features could be beneficial for those who are motivated, but have no intention to be active.

The current study showed some clear differences between how the built environment and psychological mechanisms together contribute to levels of incidental versus leisure time physical activity engagement. Specifically, neighbourhood walkability and motivation contributed directly to incidental physical activity engagement. However, neighbourhood walkability contributed to leisure time physical activity engagement only indirectly by way of the motivation to be active. These different relationships extend upon previous research that has found incidental physical activity and leisure time physical activity to be determined by unique environmental (e.g., Wendel-Vos et al., 2007; Stewart et al., 2018) and motivating factors (Keatley, Clarke & Hagger, 2013). The different inter-relationships between environmental and psychological mechanisms and incidental versus leisure time physical activity likely reflect the distinct nature of these behaviours. The majority of incidental physical activity is undertaken in one’s neighbourhood, as it typically comprises of activities that occur in, or close to the home (Giles-Corti et al., 2008). Thus, neighbourhood walkability plays an important role in directly contributing to incidental activity engagement, and assists in overcoming low intentions to engage in such activity. By contrast, leisure time physical activity is not necessarily carried out in one’s neighbourhood. For example, going to the gym or participating in team sports may occur closer to the workplace, in friends’ neighbourhoods, or in a location required by a sporting commitment. Thus, living in a supportive environment is not essential for leisure time physical activity engagement, whereas psychological mechanisms such as motivation and intentions are imperative for engagement in such behaviour.

Certain limitations of this study should be acknowledged. First, the current study relied on self-report and may therefore be subject to reporting biases. As individuals may not be aware of their incidental physical activity levels, self-report measures of incidental physical activity may be prone to systemic biases in reporting. Objective measures of incidental physical activity (e.g., pedometers or accelerometers) would benefit future research. Second, the limitations that are inherent in a cross-sectional design do not allow for inferences of a causal relationship between the investigated factors. For example, it may be that people who engage in more incidental physical activity develop more favoured perceptions of the local environment. Similarly, less engagement in incidental physical activity could lead to perceptions of the local environment being “unwalkable”. Although randomized controlled trials in this research field are not feasible, quasi-experimental and longitudinal studies are needed so that we can be more confident in the direction of environment-behaviour relationships. Third, it is possible that the measure of intentions used in the current study did not align with the behavioural outcome of METs (Rhodes & De Bruijn, 2013). Consistent with the theory of planned behaviour, the measure of intention used in the current study was worded in a manner to correspond to behavioural criteria in time, context, target, and action (Ajzen, 2011). However, the specificity of this measure may not have aligned with the IPAQ which produces a more general output of METS. Fourth, previous research has demonstrated that a very strong intention does not always result in a linear effect on behaviour. Some people translate their intentions into behaviour (i.e., successful intenders), whereas others do not (i.e., unsuccessful intenders) (Sheeran, 2002). Future research could consider whether environmental characteristics are associated with people being successful unsuccessful intenders in relation to physical activity engagement.

The current study yields some important theoretical and practical implications. Theoretically, findings provide support for socio-ecological models which propose that physical activity is determined by environmental and individual features (Sallis, Owen & Fisher, 2015). In particular, they highlight the importance of psychological characteristics in facilitating both incidental and leisure-time physical activity, as walkable neighbourhoods, although beneficial, are not sufficient to increase physical activity levels. Results also provide support for self-determination theory, as motivation was found to be an important contributor to both incidental and leisure-time physical activity. Specifically, it appears that without motivation, intentions do not translate into activity engagement. Findings also support the self-determination theory principle that more self-determined, autonomous motivations are associated with higher levels of behaviour engagement, and highlight the potential significance of contextual motivation as an important contributor to both incidental and leisure time physical activity. Additionally, the finding that neighbourhood walkability moderated the extent to which motivation mediated the intention-behaviour relationship suggests that certain environments may facilitate motivation. From a self-determination theory perspective, it may be that autonomy supportive neighbourhood environments (e.g., provide a choice of activity options, have pleasing aesthetics) assist physical activity behaviour in becoming more accepted and valued, and thus ultimately lead to autonomous motives and increased physical activity engagement. On the other hand, environments that are controlling in nature (e.g., provide limited activity options, use health or body image persuasion techniques) are likely to facilitate an internally controlling state that will lead to less engagement in physical activity (Ryan & Deci, 2000). Future research would benefit from investigating how controlling or autonomy supportive neighbourhood environments contribute to motivational quality and physical activity engagement.

In terms of practical implications, our findings highlight the importance of considering both psychological mechanisms and the built environment when developing intervention programs for physical activity. Living in an activity-friendly neighbourhood appears to serve as a buffer when individuals are motivated, but when the intention to be active has fallen by the wayside (e.g., due to busy schedules). Future infrastructure should be developed with this in mind, as creating walkable neighbourhoods will increase the likelihood that individuals will engage in physical activity when psychological resources are low. Our findings further suggest that it would be beneficial to tailor interventions to the type of physical activity that is being targeted. Programs looking to increase levels of incidental physical activity would benefit from infrastructural interventions that aim to increase the perceived walkability and perceived safety of neighbourhoods, for example, by improving street lighting by designing spaces to offer high levels of prospect (clear field of vision), while at the same time evoking lower levels of refuge (places where potential risks may be concealed) (Gatersleben & Andrews, 2013). By contrast, programs that target leisure-time physical activity would benefit from focusing on psychological factors, such as motivation and intentions, and using the built environment as a complementary feature. For example, public health campaign messages could emphasize the convenience of exercising in the neighbourhood to increase individuals' intentions (Ball et al., 2001; Powell et al., 2003), and hint at the fact that neighbourhood environments provide opportunities to meet people and engage in social activities to increase motivation (Deci & Ryan, 2008; Giles-Corti & Donovon, 2002).

In conclusion, the current study clearly demonstrated that walkable neighbourhoods, motivation and intentions together play an important role in guiding activity levels. Specifically, for leisure time physical activity, it appears that the built environment plays an important role in increasing intentions and subsequent motivation, and thus contributes indirectly to increased physical activity levels. For incidental physical activity, it appears that neighbourhood walkability plays an important role in guiding activity levels for individuals who have the motivation, but lack the intent to be active. In so doing, the present study adds to the limited research investigating how environmental features and psychological factors together contribute to physical activity engagement.

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CHAPTER 3: STUDY 2

Contextual and Dispositional Motivation Differentially Contribute to Exercise and Incidental Physical Activity

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Abstract

Exercise involves intentional physical activities, such as sport, running or going to the gym whereas incidental physical activity refers to any activity of daily living that occurs during everyday activities. There is currently little understanding of what motivates individuals to engage in incidental physical activity. Successfully targeting incidental physical activity engagement could be an effective strategy to improve quality of life, therefore a better understanding of the motivations underlying incidental physical activity is required. Two types of motivation that may predict physical activity engagement are contextual motivation (i.e, motivation differs depending on the circumstances surrounding behaviour engagement), and dispositional motivation (i.e., an individual's trait-like motivation). A prospective correlational study investigated how contextual and dispositional motivation contribute to exercise and incidental physical activity levels. Exercise was measured using the International Physical Activity Questionnaire (IPAQ-SF). Incidental physical activity was assessed by a seven-day pedometer step count. Contextual motivation was measured using the Perceived Locus of Causality Questionnaire and dispositional motivation was measured using the perceived choice sub-scale of the Self-determination Scale. Exercise was positively associated with both contextual and dispositional motivation. Incidental physical activity was positively associated only with contextual motivation. Dispositional motivation did not moderate the relationship between contextual motivation and incidental physical activity (nor exercise). Findings provide support for self-determination theory in that both exercise and incidental physical activity were associated with motivation. Findings suggest that exercise and incidental physical activity are influenced by different motivational properties, and thus highlight the importance of tailored physical activity interventions.

Key words: *physical activity, contextual motivation, dispositional motivation, self-determination theory*

3.1 Introduction

Although the health benefits of physical activity are well known, engagement in such activity remains low and is considered a global public health problem (Brownson, Boehmer & Luke, 2005; Irwin, 2004; World Health Organization, 2014). Increasingly sedentary lifestyles and physical inactivity are preventable risk factors that have been associated with poor physical and mental health (Teychenne et al., 2010; Thorp et al., 2011). Although physical activity was once fundamental to daily life, recent societal trends have led to decreased energy expenditure, and despite widespread awareness of the health benefits of being physically active, lifestyles remain largely sedentary (Bauman et al., 2009; Gutholf et al, 2008; World Health Organization, 2014). It is therefore important to better understand the factors that drive people to be physically active to create more targeted and focused interventions (Courneya & McAuley, 1994).

One way to break down physical activity is to make a distinction between exercise and incidental physical activity (Levine, 2007). Exercise involves intentional physical activities, such as sport, running or going to the gym whereas incidental physical activity refers to any activity of daily living other than exercise and often occurs during everyday activities, outside of formal exercise settings. It involves unstructured activity, such as walking for transport, housework and performing everyday activities (e.g., walking to the printer, standing instead of sitting) (Tudor-Locke et al., 2007; Levine, 2007). Increasing incidental physical activity offers an important alternative to help overcome common barriers to exercise engagement (e.g., not having enough time; finding exercise inconvenient) (Lathia et al., 2017; Kolt et al., 2017), particularly for those who live predominantly sedentary lifestyles, or are not able to engage in regular exercise. Furthermore, increased daily activity and reduced sedentary behaviour has been associated with decreased stress, anxiety, depressive symptoms, and increased mood (DeMello et al., 2017; Mammen & Faulkner 2013). As a result of the accumulating evidence associating incidental physical activity with higher quality of life, a growing number of programmes that focus on the promotion of daily activities have been developed (Aoyagi et al., 2010; Kremer, Eves & Anderson, 2012). However, as there is currently little understanding of what motivates individuals to engage in incidental physical activity, many programmes do not result in sustained increases in incidental physical activity participation (Marshall et al., 2002; Digdill et al., 2008). Thus, a better understanding of what motivates incidental physical activity is required.

Self-determination theory (Deci & Ryan, 1989), and more recently the hierarchical model of motivation that embraces several elements of self-determination theory (Vallerand, 1997), are comprehensive models of motivation which propose that individuals can experience different motivations of varying quality for different behaviours, and in different contexts. Accordingly, motivation is viewed as multifaceted and having different forms depending on the situation or the individual. Central to both theories is that the underlying reason why individuals engage in behaviour is due to the amount of autonomous or controlled motivation driving the behaviour. Individuals express autonomous reasons for doing a behaviour when the behaviour is valued and individuals feel a sense of choice, interest and satisfaction with the behaviour. Individuals acting for autonomous reasons are more likely to initiate and persist with the behaviour, even without any external reward or contingency (Deci & Ryan, 2000). Controlled motivation, in contrast, is evident when a behaviour is engaged in for externally reinforced reasons, such as to gain rewards, approval from others, or to avoid feelings of guilt. Individuals engaging in behaviour for controlled reasons feel a sense of pressure and obligation, and are therefore only likely to persist with the behaviour for as long as the external contingency is present. Thus, the amount of autonomous or controlled motivation determines whether individuals will engage in and persist with a behaviour (Deci & Ryan, 2000). However, as motivation is not a unitary concept, the quality of motivation experienced (i.e., whether motivation is autonomous or controlled) can differ depending on the individual's trait-like motivation (i.e., at a global level) or on the context (i.e., the circumstances surrounding behaviour engagement) (Deci & Ryan, 2000).

The hierarchical model of motivation (Vallerand, 1997; Vallerand & Ratelle, 2002) suggests that motivation operates hierarchically. Global motivation sits at the highest level of the hierarchy and is akin to a personality trait, and therefore applies the most broadly across situations. For example, if a person is generally autonomous toward physical activity, they will likely experience feelings of autonomy while engaging in a specific exercise activity. Thus, this type of motivation is proposed to operate on a global level, where the individual interacts with the environment in an autonomous or controlled way (Vallerand, 1997; Ryan & Deci, 2008). Indeed, the sub-theory of self-determination, the causality orientations theory (Deci & Ryan, 1985) also posits that behaviour is influenced by an individual's general tendency to interpret behaviours as autonomous or controlled (Deci & Ryan, 1985; Elliot, McGregor & Thrash, 2002). Individuals who have a disposition (i.e., global motivation) to be more autonomous tend to participate in activities for enjoyment and interest's sake, whereas individuals who have a disposition to be motivated by controlled reasons, participate in activities due to external pressures or an internal pressure to satisfy their self-esteem

(Deci & Ryan, 2008). The general utility of this motivational construct is reflected in the General Causality Orientations Scale, which has been applied as a general measure of motivation across domains (e.g., Hodgins & Deci, 1999; Knee & Zuckerman, 1996, 1998).

The hierarchical model of motivation also proposes that motivation occurs at a contextual level (Vallerand, 1997). Contextual motivation refers to a specific life context or domain, such as exercise or incidental physical activity. This form of motivation is thought to be moderately stable but susceptible to change depending on circumstances (Vallerand, 1997). Therefore, people have an enduring tendency to respond in a certain way due to their dispositional motivation, which occurs at a global level, but they are also influenced by different forms of motivation depending on the context (i.e., perceived locus of causality regulations) (Vallerand, 1997). Furthermore, self-determination theory proposes that there are motivational regulations which are contextual and differ depending on the activity or behaviour. Motivational regulations, known as the perceived locus of causality, underpin autonomous and controlled forms of contextual motivation. From the most autonomous to the most controlled form of motivation they are: intrinsic motivation, identified regulation, introjected regulation and external regulation. Although the perceived locus of causality is conceived of as a continuum, research has demonstrated that individuals can identify with varying levels of autonomous and controlled reasons for acting, and that individuals can endorse more than one form of motivation at the same time (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010; Stephan, Boiche & LeScanff, 2010).

Research in the exercise domain has found support for motivation at the global, dispositional level and the contextual level influencing behaviour. Dispositional motivation has been found to influence physical activity behaviour (Gibson et al., 2008; Ryan, Vallerand & Deci, 1984; Vallerand & Reid, 1984; Frederick & Ryan, 1995; Boyd Weinmann & Yin, 2002). In line with causality orientations theory (Deci & Ryan, 1985), previous research regarding exercise behaviour has found that an autonomous-disposition is associated with greater participation in moderate to vigorous physical exercise in children (Dempsey, Kimiecik & Horn, 1993; Kimiecik, Horn & Shurin, 1996). Furthermore, Boyd, Weinmann and Yin (2002) found that an autonomous-disposition for exercise was positively related to intrinsic motivation for exercise, indicating that an autonomous-disposition induces greater enjoyment for exercise. Various studies have also found that a high autonomous-disposition is an adaptive characteristic in sport, whereas high a controlled-disposition has been linked to boredom and anxiety in sport (Gilson, Chow & Ewing, 2008; Boyd Weinmann & Yin, 2002). Dispositional motivation has also been found to impact a variety of health-related behaviours such as tooth brushing, fruit and vegetable consumption, and alcohol reduction (Hagger et al., 2014). Posture correction has also been associated with an autonomous-disposition, suggesting that one's dispositional motivation may influence levels of incidental physical activity (Hagger et al., 2014).

In regards to contextual motivation, it has been demonstrated that people can experience different, sometimes competing, forms of motivation for exercise simultaneously, which can shift and change depending on contexts (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010; Stephan, Boiche & LeScanff, 2010). This supports the notion that motivation can change depending on contexts and behaviour. Certainly, the importance of autonomous forms of motivation for engaging in and maintaining exercise has been well established, as contextual autonomous motives are consistently positively associated with exercise engagement, and persistence (White et al., 2018; Teixeira et al., 2012; Banting & Dommock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012; Fortier et al. 2007). However, more recent research has also linked contextual controlled forms of motivation to engagement in exercise (Caudwell & Keatley, 2016; Niven & Markland., 2016). Similarly, there is some evidence to suggest that both autonomous and controlled motivation could influence levels of incidental physical activity (White et al., 2018; Keatley, Clarke & Hagger., 2013; Hagger et al., 2014). For example, Keatley, Clarke and Hagger (2013) found autonomous and controlled motivational regulations to predict a number of activities associated with health-related behaviours. Specifically, autonomous and controlled motivation were found to directly predict health behaviours related to daily living such as tooth brushing, hand washing, and reducing calorie, caffeine and alcohol consumption. Similar to findings for dispositional motivation, contextual autonomous motivation directly predicted posture correction behaviour, a form of incidental physical activity (Keatley et al., 2013; Levine, 2007). Similarly, recent qualitative research has found that the type of motivation (i.e., autonomous or controlled) reported by adolescents for incidental physical activity engagement differs depending on the context of such activities (White et al., 2018). Thus, individuals rely on different forms of motivation depending on the context or type of behaviour, and the limited research on incidental physical activity indicates that contextual motivation also plays a role in influencing this behaviour (Keatley, Clarke & Hagger, 2013).

According to the hierarchical model of motivation, motivation has a top down effect with motivation at the higher level (i.e., global motivation) affecting motivation at the lower level (i.e., contextual motivation) and ultimately influencing behaviour. Previous research has investigated the top-down effect in the health domain. William et al. (1998) measured patients' global and contextual motivation toward medical treatment. Autonomous motivation at the global level was found to predict contextual autonomous motivation toward the medical treatment at a later time point. Similar findings have also been found in the sport and exercise context (Blanchard, Vallerand and Provencher, 1998; Banchard & Vallerand, 1998). Specifically, Blanchard and Vallerand (1998) investigated the motivational effect for individuals engaging in an exercise program and found that global motivation influenced contextual motivation towards exercising and multiple time points. Thus, the literature to date indicates that both dispositional (i.e., global motivation) and contextual (i.e., perceived locus of causality) motivational processes each contribute to exercise behaviour. Previous research has found that dispositional motivation and contextual motivation complement each other in explaining behaviour in general, and in specific contexts (Hagger et al., 2014). Specifically, dispositional motivation has a more generic influence on health behaviors which applies to a variety of contexts, whereas contextual motivation has a more immediate influence on health behaviors which applies to specific situations (Hagger et al., 2014; Deci & Ryan, 2008). However, it is not clear how these motivational factors are associated with incidental physical activity levels. Understanding the contributions of both contextual and dispositional motivation to incidental physical activity is important as it will provide valuable information for creating tailored physical activity interventions. Therefore, the aim of the current study was to investigate the different motivating factors that contribute to exercise and incidental physical activity.

Based on self-determination theory, specifically cognitive evaluation theory, as well as on previous research in the sport and exercise domain (Gibson et al., 2008; Ryan, Vallerand & Deci, 1984; Vallerand & Reid, 1984; Frederick & Ryan, 1995; Boyd Weinmann & Yin, 2002), we expected that exercise engagement would be positively associated with both dispositional and contextual motivation. Specifically, we predicted that exercise would be positively associated with an autonomous-disposition, rather than a controlled-disposition (Dempsey, Kimiecik & Horn, 1993; Kimiecik, Horn & Shurin, 1996; Ryan & Deci, 2005). Similarly, we predicted that exercise would be positively associated with autonomous forms of contextual motivation (i.e., intrinsic motivation and identified regulation). In view of recent physical activity research (e.g., Teixeira et al., 2012; Caudwell & Keatley, 2016; Niven & Markland., 2016), we predicted that controlled forms of contextual motivation (i.e., introjected regulation and external regulation) would also be positively associated with levels of exercise. Drawing from the hierarchical model of motivation (Vallerand, 1997), we further predicted that contextual motivation would have a mediating effect on the relationship between dispositional motivation and physical activity. Extending upon recent research in the exercise domain (Gibson et al., 2008; Ryan, Vallerand & Deci, 1984; Vallerand & Reid, 1984; Frederick & Ryan, 1995; Boyd Weinmann & Yin, 2002) and based on the limited research to date on incidental physical activity and contextual motivation (White et al., 2018; Keatley, Clarke & Hagger., 2013), we expected to find a similar pattern of results for incidental physical activity.

Incidental physical activity was operationalized as a seven-day step count recorded on commercial pedometers. Pedometers provide a reliable, accurate and objective measure of daily steps taken (Bassett et al., 1996; Kilanoski et al., 1999; Oliver, Schofield, & McEvoy, 2006). Participants wore the pedometers at all times, except when engaging in intentional physical activity (i.e., exercise), to capture a broad range of activities, and thus provide a pure and comprehensive measure of incidental physical activity. Exercise was measured using the leisure time physical activity component of the International Physical Activity Questionnaire (short-form) (Craig et al., 2003). Contextual motivation was assessed using the Perceived Locus of Causality Questionnaire (Hagger et al., 2014), and dispositional motivation was measured using the perceived choice sub-scale of the Self-determination Scale (Sheldon & Deci 1996).

3.2 Method

Participants.

One hundred and three participants (71 women, 32 men) were recruited from the student population at Flinders University and the wider Adelaide metropolitan community. Participants were aged between 17 and 68 years (M = 26.54, SD = 11.17) and were within the healthy weight range (BMI M= 23.6 kg/m^2, SD = 3.9).

Procedure.

The study was approved by the University's human research ethics board. Informed consent was obtained from all participants prior to data collection. The study took place in a psychology laboratory at Flinders University and consisted of two sessions. The first session took approximately 5 minutes. Detailed written and verbal instructions on how and when to wear the pedometers over the following week were provided. Participants were given the option to record their daily step count via text message, email or a Qualtrics online survey. They were informed that they would receive daily text messages reminding them to wear their pedometer. Participants returned to the laboratory 7 days later for the second session, during which they completed the leisure-time activity component of the IPAQ – SF, as well as the Perceived Locus of Causality, and the perceived choice sub-scale questionnaires. These took approximately 15 minutes to complete, and up to two participants were tested at one time, in separate cubicles.

Materials.

Exercise.

Exercise was measured using the leisure-time activity component of the International Physical Activity Questionnaire – Short Form (IPAQ – SF). The IPAQ-SF is suitable for use in adults and has excellent test-retest reliability and validity (Craig et al., 2003). Participants were asked to indicate on how many days, and for how long (hours and minutes/day), they engaged in moderate exercise (e.g., bicycling at a regular pace, swimming at a regular pace, and playing doubles tennis), vigorous exercise (e.g., aerobics, running, fast bicycling or fast swimming), and walking (e.g., in bouts of at least 10 minutes) in their leisure time during the 7 days preceding assessment. To calculate total exercise per day, vigorous intensity, moderate intensity and walking were multiplied by their estimated intensity in metabolic equivalent (MET) energy expenditure, and summed into a single variable to indicate overall level of leisure time physical activity (Craig et al., 2003). One MET represents the energy expended while sitting quietly at rest. The MET intensities used to score the IPAQ were vigorous (8METs), moderate (4METs) and walking (3.3 METs) (Craig et al., 2003).

Incidental physical activity.

Incidental physical activity was operationalized as a seven-day step count recorded on commercial pedometers. Pedometers were chosen as they provide a reliable, accurate and objective measure of daily steps taken (Bassett et al., 1996; Kilanoski et al., 1999; Oliver, Schofield, & McEvoy, 2006; Puhl, Greaves, Hoyt, & Baranowski, 1990). Participants were provided with a G-Sensor Accelerometer Pedometer to record their daily step count. Participants were provided with written and verbal directions on how to use the pedometers, and were instructed to wear the pedometers for the following 7 days within all waking hours except when engaging in exercise. Exercise was defined to participants as structured, repetitive physical activity that has the final or intermediate objective of conditioning the body, or the improvement/maintenance, of physical fitness (Caspersen, Powell & Christenson, 1984). Participants were instructed to remove the pedometer when working out at the gym, participating in a team sport or going for a run, as well as walking for the purpose of exercising. However, they were instructed to keep the pedometer on when walking to the shops, riding a bike to work, or engaging in activity for other transport related reasons. Daily text messages were sent to participants to remind them to wear their pedometers and to record their step count. Participants began wearing the pedometers the day following the initial testing session, and ceased wearing them the day before their second session to obtain a complete 7-day step count.

Contextual self-determined motivation (perceived locus of causality).

An adapted version of Ryan and Connell's (1989) measure of Perceived Locus of Causality was used to measure contextual forms of motivation for both exercise and incidental physical activity. This self-report measure has previously been modified to assess motivation for leisure time and incidental physical activity (Oliver & Kemps, 2018) and demonstrated acceptable reliability in the current study (incidental phsycial activity item: α = .78; exercise items: α = .89). Previous adaptions of the measure have also been found to reliably assess motivation for health behaviors (Hagger et al., 2014).

Participants were presented with common word stems that related to either exercise (e.g., "I exercise regularly because…" ; "I participate in team sports because…") or incidental physical activity (e.g., "I walk to get from A to B because…"; "I use a bicycle as a mode of transport because..."). The selected activities represented in the word stems were based on previous research measuring motivation for exercise (Hagger et al., 2014) and incidental physical activity (Oliver & Kemps, 2018) and aimed to capture a range of physical activities. These word stems were followed by eight reasons, two for each of the four regulation styles: external regulation (e.g. "… I feel under pressure to…."), introjected regulation (e.g. "…. I will feel guilty if I do not …."), identified regulation (e.g. "… I value the benefits of ...") and intrinsic motivation (e.g. "… I enjoy…."). A 5-point scale ranging from (1) "not true at all" to (5) "very true" was used to record responses. Participants were able to select activities that were relevant to them, and therefore only responded to word stems that were applicable to them. This ensured we only captured behaviours that participants actually engage in. All participants reported at least one activity that was relevant to them, with 82% of participants reporting engaging in at least one exercise behaviour. Specifically, 64% of participants reported exercising regularly and 18% reported playing team sport. In regards to incidental physical activity, 98% of participants reported engaging in at least one relevant behaviour, with 89% reporting walking to get from a to b, 73% reporting taking the stairs, 37% reporting walking the dog, 18% reporting gardening and 11% reporting using a bicycle as transport. Word stems relating to exercise or incidental physical activity were analysed separately to provide measures of contextual motivation unique to each behaviour.

Following Ryan and Connell (1989), an autonomous motivational regulation index was calculated using the sum of the intrinsic motivation item weighted by a factor of two, plus the identified regulation item. To account for the number of activities participants engaged in, this score was divided by the number of activities participants selected to be relevant to them. Likewise, a controlled motivational regulation index was calculated using the sum of the external regulation item weighted by two, plus the introjected regulation scale, and divided by the number of relevant activities. Overall motivation scores specific for either exercise or incidental physical activity was calculated by adding the mean of the controlled motivation index and the mean of the autonomous motivational regulation index, and then dividing this score by two (Judge et al., 2005).

Dispositional self-determined motivation.

Dispositional motivation was assessed using the perceived choice sub-scale of the Self-determination Scale. This scale measures trait levels of autonomy regarding general behavior and is a valid and reliable (α= .855) measure of motivation (Sheldon & Deci, 1996). Participants were presented with a series of five pairs of statements, labelled "A" and "B" (e.g., A. I always feel like I choose the things I do. B. I sometimes feel that it's not really me choosing the things I do"). For each pair, participants were required to indicate the extent to which they agree with one of the statements on a five point scale with 1 ("only A feels true") and 5 ("only B feels true") as endpoints. Items were coded such that higher scores represent greater autonomous-orientation and lower scores represent greater controlled-orientation.

Analytic strategy.

Data was analysed using SPSS Statistics 25.0 (IBM Corporation, Armonk, NY, USA). When assessing autocorrelations between the dependent (exercise and incidental physical activity) and independent variables (dispositional and contextual motivation), all Durbin-Watson statistics were between 1.5 and 2.5, indicating independence between variables. Additionally, all tolerance levels were >.3, indicating that the level of collinearity among the variables was acceptable. Visual inspections of histograms and regression residual plots for the dependent (exercise and incidental physical activity) and independent variables (dispositional and contextual motivation), indicated that the data were normally distributed and not homoscedastic (Field, 2013). We examined whether contextual motivation mediated the contribution of dispositional motivation to exercise or engage in incidental physical activity using PROCESS version 3.0 (model 4) with 5000 bootstrap samples. PROCESS is a recommended analysis tool that uses bootstrapping to eliminate bias (Field, 2013). Bootstrapping is a non-parametric analysis method that does not make assumptions about the distribution of data (Preacher & Hayes, 2004).

3.3 Results

Sample characteristics.

A power analysis using GPower computer software (Erdfelder, Faul & Erdfelder, 1996) indicated that a total sample of 89 participants would be needed to detect small effects (f =.15) with 95% power using regression analyses with 4 predictors (α = .05). Thus, the current sample (N = 103) had adequate power. Table 1 shows descriptive statistics and correlations for exercise, incidental physical activity, contextual and dispositional motivation. These show that participants engaged in high levels of exercise (Craig et al., 2003) and incidental physical activity (Tudor-Locke & Bassett, 2004; Tudor-Locke et al., 2008). The majority of our participants exceeded the global recommended guidelines for physical activity which advises to do approximately 1000 METS per week (Brown et al., 2013).

Incidental physical activity and exercise were significantly positively correlated. Furthermore, exercise was significantly positively correlated with both contextual and dispositional motivation. Incidental physical activity was also significantly positively correlated with contextual motivation, but was unrelated to dispositional motivation.

Relationships between contextual motivation constructs.

Tables 2 shows the correlations between the contextual motivation constructs, i.e., the perceived locus of causality variables. Correlations tended to be higher between the variables adjacent to each other on the continuum (e.g., identified regulation and intrinsic motivation) and weaker among more distant variables on the continuum. Similarly, correlations tended to be higher between motivation variables for the same physical activity construct, and weaker among motivation variables for alternate physical activity constructs. Both autonomous and controlled forms of motivation (except external regulation) were positively correlated with incidental physical activity, whereas only intrinsic motivation was correlated with exercise.

Relationship between dispositional motivation, contextual motivation and physical activity.

Exercise was significantly positively associated with dispositional, $b = 843.18$, $SE = 406.08$, $t(100) = 2.076$, $p = .04$, and contextual motivation, $b = 52.61$, $SE = 20.54$, $t(100) = 2.56$, $p = .012$. However, we found no relationship between dispositional motivation and contextual motivation for exercise, $b = 2.42$, $SE = 1.95$, $t(101) = 1.24$, $p = .2177$, and no indirect effect of dispositional motivation on exercise with the mediator, contextual motivation, in the model, $b = 970.55$, $SE = 413.96$, $t(101) = 2.345$, $p = .021$ (95% CI: -20.582 to 434.841). Results suggest that both autonomous dispositional (i.e., global) and autonomous contextual motivation are directly positively associated with exercise engagement.

Incidental physical activity was significantly positively associated with contextual motivation $b = 34.3$, $SE = 9.55$, $t(100) = 3.59$, $p = .001$. However, we found no relationship between incidental physical activity and dispositional motivation $b = 147.01$, $SE = 318.34$, $t(100) = .46$, $p = .645$, no relationship between dispositional motivation and contextual motivation for incidental physical activity, $b = 2.42$, $SE = 3.31$, $t(101) = .73$, $p = .46$, and no indirect effect of dispositional motivation on incidental physical activity with the mediator, contextual motivation, in the model, $b = 230.3$, $SE = 335.5$, $t(101) = .686$, $p = .494$ (95% CI: -

132.113 to 369.795). Results suggest that autonomous contextual motivation, but not autonomous dispositional motivation, is directly positively associated with incidental physical activity engagement.

Table 1
Descriptive statistics and correlations for exercise, incidental physical activity, contextual and dispositional motivation

	M (SD)	Exercise	Incidental Physical Activity	Contextual Exercise Motivation	Contextual Incidental Activity Motivation
Exercise	3742.35 (3450.74)				
Incidental physical activity	6072.87 (2730.30)	.255**			
Contextual exercise motivation	26 (20.33)	.264**	.069		
Contextual incidental activity motivation	64.05 (31.45)	.160	.355*	.105	
Dispositional orientation	3.78 (0.81)	.227*	.068	.087	.044

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

Table 2
Correlations between perceived locus of causality variables for exercise and incidental physical activity

	1	2	3	4	5	6	7	8	9
1. Exercise									
2. Incidental physical activity	.255**								
3. Intrinsic motivation for IPA	.232*	.249*							
4. Identified regulation for IPA	.124	.252*	.808**						
5. Introjected regulation for IPA	.031	.279**	.410**	.503**					
6. External regulation for IPA	.116	.094	.210*	.260**	.576**				
7. Intrinsic motivation for exercise	.268**	.082	.248*	.201*	.132	.09			
8. Identified regulation for exercise	.191	.148	.392**	.444**	.257**	.235*	.693**		
9. Introjected regulation for exercise	.18	.225*	.310**	.373**	.540**	.413**	.624**	.875**	
10. External regulation for exercise	.16	.182	.254**	.316**	.391**	.578**	.567**	.839**	.892**

*p <.05, **p<.01, ***p<.001, IPA = incidental physical activity

3.4 Discussion

The current study aimed to investigate how different motivating factors contribute to different types of physical activity. Incidental physical activity is an important and under researched target for physical activity promotion which has a substantial impact on both physical and mental health. This study is the first to investigate how dispositional and contextual forms of motivation contribute to levels of incidental physical activity. As predicted, exercise was positively associated with autonomous contextual and dispositional (i.e., global) motivation. By contrast, incidental physical activity was positively associated only autonomous contextual motivation. These results indicate that autonomous motivation is an important contributor to both types of physical activity, and that exercise and incidental physical activity are influenced by different motivating factors. Importantly, findings suggest that a more autonomous dispositional motivation is beneficial for exercise, but not for incidental physical activity. This study contributes to the limited research investigating the psychological mechanisms involved in incidental physical activity, and indicates that autonomous contextual motivation is a significant contributor to incidental activity engagement. These findings are important as incidental physical activity is vital for increased physical health (i.e., reducing the risk of non-communicable diseases) and mental health (i.e., quality of life) (Lathia et al., 2017; Kolt et al., 2017; Katzmaryk et al., 2009; Geroge, Rosenkranz & Kolt, 2013).

The main focus of the present study was to investigate how contextual and dispositional forms of motivation contribute to exercise and incidental physical activity levels. As predicted, we found that autonomous contextual motivation, as well as autonomous dispositional motivation, were positively related to levels of exercise. These findings support previous research which has found both autonomous contextual motivation (Teixeira et al., 2012; Banting & Dommock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012; Fortier et al. 2007; Caudwell & Keatley, 2016; Niven & Markland., 2016) and autonomous dispositional motivation to be associated with exercise engagement (Dempsey, Kimiecik & Horn, 1993; Kimiecik, Horn & Shurin, 1996). Our findings indicate that having motivation specific for exercise is beneficial for exercise engagement. Given that there are a large range of exercise behaviours one can participate in, it is not surprising that specific contextual motivation (e.g., motivation specifically for playing in a team sport) influences exercise levels. Additionally, in line with previous research (Dempsey, Kimiecik & Horn, 1993; Kimiecik, Horn & Shurin, 1996), our findings suggest that having an autonomous-disposition is also beneficial for exercise engagement. This may be due to the high demands of exercise, such as the amount of physical effort, time and commitment necessary to participate in the behaviour. Thus, ongoing autonomy is required to engage in and persist with exercise (Ryan & Deci, 2005).

We further found that autonomous contextual motivation for daily activities was positively related to levels of incidental physical activity. In support of our prediction, individuals who had higher levels of autonomous contextual motivation engaged in higher levels of incidental physical activity. This finding is in line with previous research on autonomous contextual motivation and health related behaviours (Keatley, Clarke & Hagger., 2013; Hagger et al., 2014). However, dispositional motivation did not directly or indirectly contribute to levels of incidental physical activity. To our knowledge, this is the first study to investigate the relationship between contextual motivation, dispositional motivation and incidental physical activity. Our findings suggest that incidental physical activity is indeed influenced by motivation, specifically autonomous contextual motivation, and that this influence is different to that of exercise. Specifically, while both autonomous contextual and autonomous dispositional motivation are beneficial for exercise behaviour, it appears that only autonomous contextual motivation is beneficial for incidental physical activity levels. These findings support research in the exercise domain which has found that different forms of motivation influence different exercise behaviours, and that motivation can change depending on contexts (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010; Stephan, Boiche & LeScanff; 2010; Georgiadis, Biddle, Chatzisiantis; 2001).

Our findings suggest that a more autonomous dispositional motivation is beneficial for exercise, but not for incidental physical activity. A further interesting finding of the current study is that exercise and incidental physical activity demonstrated only a weak positive relationship, indicating that they are separate behaviours (Taylor, 1990). Therefore, it is not all that surprising that these behaviours are associated with different motivating factors. Indeed, although exercise provides physiological and psychological rewards upon completion, it is a highly demanding behaviour, in terms of amount of physical effort, time and commitment required (Friemuth, Moniz & Kim, 2011). Further, exercise is a health-behaviour that is performed largely due to choice, as it done outside of essential work or household commitments. Therefore, individuals require a trait-like sense of autonomy to engage in exercise. Indeed, it has recently been suggested that exercise may be a more autonomous, or self-determined behaviour than incidental activities (e.g., active travel) (Kull et al., 2012; White et al., 2018). In addition, previous research has linked exercise to enduring personality traits such as openness and conscientiousness (Ingledew & Markland, 2008; Cooper, Agocha & Sheldon, 2000). It has further been proposed that certain personality traits influence self-regulatory behaviour such as motives, which in turn drive exercise engagement (Ingledew & Markland, 2008; Rhodes & Smith, 2006).

In contrast to exercise, incidental physical activity is a broad construct that consists of several different sub-behaviours, some of which simply have to be done and are not necessarily intrinsically motivating (e.g., household chores). Indeed, recent research has found that different sub-behaviours involved in incidental physical activity (e.g., active travel) have different underlying determinants and motives (White et al., 2018). Consequently, autonomous contextual motivation that is specific to certain behaviours is most beneficial for incidental physical activity engagement, rather than trait-like feelings of autonomy (i.e., dispositional motivation). Future research could usefully focus on specific sub-behaviours within the broader construct of incidental physical activity to further investigate the influence of dispositional motivation.

Further evidence that incidental physical activity and exercise are influenced by motivation in distinct ways comes from examining the specific contextual motivation variables of the perceived locus of causality. In line with previous research, the correlations between perceived locus of causality variables tended to be higher between the variables adjacent to each other on the continuum (e.g., identified regulation and intrinsic motivation) and weaker among more distant variables on the continuum (Georgiadis, Biddle, Chatzisiantis; 2001; Vlachopoulos, Karageorghis & Terry, 2000). Additionally, in line with emerging research in the sport and exercise domain, autonomous and controlled forms of regulations were positively correlated (i.e., external regulation and intrinsic motivation) (e.g., Lindwall et al., 2017). The perceived locus of causality variables were also related to exercise and incidental physical activity in different ways. Only intrinsic motivation was directly associated with exercise engagement, whereas both autonomous and controlled forms of motivation (except external regulation) were positively associated with levels of incidental physical activity. Our findings for exercise support a growing body of evidence which shows that individuals experience multiple forms of motivational regulations at the same time; however, only certain types of motivation influence actual behaviour engagement (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010; Stephan, Boiche & LeScanff, 2010; Georgiadis, Biddle, Chatzisiantis; 2001; Vlachopoulos, Karageorghis & Terry, 2000). Specifically, although individuals may experience multiple forms of motivation at once, it may only be intrinsic motivation that influences exercise behaviour. Similarly, results indicate that multiple forms of motivational regulations are experienced simultaneously for incidental physical activity, and that both autonomous and controlled forms of motivation can be beneficial for incidental physical activity engagement. This finding extends upon previous research in the sport, exercise, and health domain that has found autonomous (Teixeira et al., 2012; Banting & Dommock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012; Fortier et al. 2007) and controlled forms of motivation to positively influence behaviour engagement (Caudwell & Keatley, 2016; Niven & Markland., 2016; Keatley, Clarke & Hagger., 2013; Hagger et al., 2014). These findings suggest that contextual motivation is not only a contributing factor to incidental physical activity, it is also beneficial to incidental physical activity in a way that is distinct from exercise.

A clear strength of the current study was the use of a seven-day step count obtained from pedometers as an objective measure of incidental physical acitivity. Addditionaly, the current study utilised the IPAQ-SF, a highly reliable and well validated measure to assess exercise (Craig et al., 2003). However, our endeavour to assess incidental physical activity as comprehensively as possible by using an objective measure, may have resulted in a discrepancy between the two outcome measures. Although the IPAQ-SF has been validated against objective forms of exercise (Craig et al., 2003), future research would benefit from using accelometers that can objectively differentiate between high intensity physical activity (i.e., exercise) and incidental physical activity, or movement trackers that can record horizontal or upward body motions, to ensure consistency amoung the outcome measures. Furthermore, in an attempt to provide a comprehensive assessment of exercise and incidental physical activity, we included a range of sub-behaviours in the contextual motivation measure. However, considering the variety of incidental physical activity behaviours one can engage in, there is a risk that the measure of motivation for incidental activity missed the most relevant behaviour(s) for that person. Additionally, the current study utilised a retrospective design which can be subject to bias. Specifically, the current study is susceptible to reporting bias as the self-report motivation measures were adminsitered after having monitored participants' incidental physical activity for a week. There are also limitations regarding the generalizability of the relationships between motivation and physical activity due to the correlational nature of the current study. For example, it is possible that engaging in more incidental physical activity leads to greater contextual motivation. Thus, the current study provides a basis for further research to investigate the causality of the relationship.

The present study provides useful theoretical insights. In particular, the results provide support for self-determination theory in that autonomous contextual and dispositional motivation were found to directly influence components of physical activity behaviour. Our finding that exercise and incidental physical activity were both directly associated with contextual motivation suggests that self-determination theory is applicable to both intentional and circumstantial behaviours. Therefore, an important implication of the current research is that it lends support to the generality of self-determination theory across various behaviours (Hagger et al., 2014; Ng et al., 2012; Williams et al., 2002).

The findings of the current study lend limited support for the hierarchical model of motivation (Vallerand, 1997). Specifically, findings lend limited support to the notion that global motivation applies broadly across situations, as although we found a positive association between dispositional (i.e., global) motivation and exercise, we found no direct or indirect relationship between dispositional motivation and incidental physical activity. The hierarchical model of motivation further proposes that motivation has a top down effect, with motivation at the higher level (i.e., global motivation) affecting motivation at the lower level (i.e., contextual motivation) and ultimately influencing behaviour (Vallerand, 1997). However, the current study found no relationship between dispositional (i.e., global) motivation and contextual motivation for exercise or incidental physical activity. Current findings indicate that levels of motivation have a more direct relationship with physical activity behaviour. Indeed, findings from the current study provide support for the specificity of contextual motivation, as we found positive associations between contextual motivation and the relevant physical activity behaviour (i.e., exercise or incidental physical activity). This is not surprising considering that incidental physical activity consists of several different sub-behaviours that have previously been found to have different underlying determinants and motives (White et al., 2018). Accordingly, it is possible that while someone may be motivated to exercise for its own sake, they may be motivated for incidental activity for a different goal (e.g., getting to the shops, cleaning the house). Future research could usefully focus on the underlying motivating factors of specific sub-behaviours within the broader construct of incidental physical activity.

Our findings also have some more specific theoretical implications. Traditionally, self-determination theory suggests that optimal results occur when autonomous forms of motivation are present and controlled forms of motivation are not (Ryan & Connell, 1989). As a more autonomous dispositional motivation, and intrinsic contextual motivation, were associated with higher levels of exercise, results support the notion that autonomous motivation is important for exercise engagement (Ryan & Connell, 1989). However, findings regarding contextual motivation (i.e., the perceived locus of causality constructs) for incidental physical activity suggest that individuals can experience more than one form of motivational regulation simultaneously, and that both autonomous and controlled forms of motivation may be valuable for behaviour engagement. Indeed, when applied to physical activity behaviour, a more recent account of self-determination theory posits that “sustained exercise is most likely when a person has both intrinsic motivation and well-internalized extrinsic motivation, as both facilitate what is, normatively speaking, a precarious endeavour” (Ryan & Deci, 2007, p. 5). As both autonomous and controlled forms of motivation were directly related to incidental physical activity levels, our findings suggest that this premise extends to incidental physical activity. However, future research is required to investigate the long-term contributions of contextual and dispositional motivation to incidental physical activity.

Self-determination theory further suggests that autonomous motivation results in long-term behaviour persistence, as well as increased psychological wellbeing (Ryan & Deci, 2005). Therefore, although autonomous and controlled motivations may both contribute to incidental physical activity engagement, it may be that only autonomous forms of motivation for incidental physical activities benefit mental wellbeing. Indeed, White et al. (2018) found that adolescents reported both autonomous and controlled reasons for engaging in various types of incidental physical activity, but only autonomous motivation was associated with a greater positive affect. However, no study has yet examined the contribution of motivation to the relationship between incidental physical activity and wellbeing, and thus further research is required.

The present study also has some important practical implications. It would appear that both contextual and dispositional motivation are important contributors to an active lifestyle. This finding offers potential scope for individuals who want, or need, to increase their levels of physical activity. Specifically, interventions could be tailored to increase either dispositional or contextual motivation, depending on which component of physical activity is being targeted. Individuals wishing to increase levels of incidental physical activity should focus on increasing levels of contextual motivation, as targeting one’s dispositional motivation may be futile for incidental physical activity engagement. However, those wishing to increase levels of exercise, may benefit from increasing either or both contextual and dispositional motivation. Thus, our findings highlight the importance of tailored physical activity interventions.

Our findings suggest that interventions based on self-determination theory could benefit those who wish to increase their levels of physical activity. Such interventions use motivational interviewing to enhance autonomous motivation by building choice and congruence between values (such as being active) and lifestyle. Previous studies have demonstrated the efficacy of such interventions for increasing exercise (Fortier et al. 2012; Levy & Cardinal, 2004), and other health related behaviours (Patrick & Williams, 2012). Our findings indicate that these interventions could similarly increase levels of incidental physical activity by focusing on contextual motivation.

Because of their mobility, smartphones and smart-watches may be ideal platforms for the administration of incidental physical activity interventions targeting contextual motivation. Such devices are widely used and are able to incorporate personalized, flexible strategies that are modifiable depending on individuals' day-to-day circumstances (Pew Internet, 2015). Preliminary evidence indicates that interventions using mobile phones are able to increase physical activity (King et al., 2015). However, further research is required to investigate the efficacy of technology-based interventions to increase individuals' contextual motivation, and subsequent incidental physical activity engagement.

Additionally, nudging techniques, which target contextual motivation, may provide an alternative strategy for increasing levels of exercise and incidental physical activity in microenvironments (e.g., shopping centres). Nudging techniques automatically guide people towards making healthier choices by enhancing the visibility of favourable options in the environment (Thaler, Sunstein & Balz, 2014). For example, previous research has shown that placing coloured footprints on the floor can guide participants towards the stairs rather than the escalator, and consequently increase levels of physical activity (Boutelle, Jeffery, Murray & Schmitz, 2004; Marshall et al., 2002; Hansen & Jespersen, 2013). Similar techniques may be valuable for increasing levels of incidental physical activity more generally.

The aim of the current study was to investigate how different motivating factors contribute to different types of physical activity. Our findings provide support for Self-determination theory, as both exercise and incidental physical activity were influenced by motivation. Our findings suggest that contextual motivation is an important factor in incidental physical activity engagement, and that individuals can experience multiple forms of motivational regulations at the same time. They further suggest that exercise and incidental physical activity are two distinct behaviours which are determined by unique motivational influences, and therefore highlight the importance of tailored physical activity interventions. This study adds to the limited research on the psychological contributors to incidental physical activity engagement, which is an important and under researched target for physical activity promotion.

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CHAPTER 4: STUDY 3

Motivational and Implicit Processes Contribute to Incidental Physical Activity

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Abstract

Objectives: Physical activity can prevent health risks and even a slight increase in physical activity benefits health. This study investigated potential contributing factors to incidental physical activity.

Design: A two-part correlational study examined whether motivational properties (autonomous and controlled motivation) and implicit processes (implicit attitudes, attentional and approach-avoid biases) interact to predict incidental physical activity.

Methods: Participants (N=103) recorded a seven-day step count to measure incidental physical activity. Implicit attitudes, attentional and approach-avoid biases were measured using the SC-IAT, dot probe and manikin tasks, respectively. Autonomous and controlled motivation were measured using the Perceived Locus of Causality Questionnaire.

Results: Implicit attitudes and autonomous and controlled motivation independently predicted incidental physical activity. Both autonomous and controlled motivation (when controlling for the other motivation-type) interacted with approach bias to predict incidental physical activity levels; motivation was positively associated with step count in participants with low approach bias scores. Motivational processes did not interact with attentional bias to contribute to levels of incidental physical activity when controlling for motivation-type.

Conclusions: Findings support Self-Determination Theory, which proposes that autonomous motivation is an important contributor to activity engagement. They also support dual process theories, in that implicit processes appear to contribute to incidental physical activity behaviour. Findings have practical implications for interventions to increase incidental physical activity.

Key words: *incidental physical activity; self-determination theory; dual process theory; motivation; implicit processes*

4.1 Introduction

Increasingly sedentary lifestyles and physical inactivity are modifiable risk factors that have been associated with a number of health problems including poor mental and physical health (Teychenne et al., 2010; Thorp et al., 2011). In particular, physical inactivity is associated with an increased risk of various conditions (cardiovascular diseases, type two diabetes, obesity and certain cancers) that shorten disease-free and quality adjusted life expectancy (World Health Organization, 2014). It is therefore important to live an active lifestyle. Current approaches that promote physical activity focus on increasing intentional physical activity (i.e., exercise). However, a great deal of physical activity is incidental and occurs during daily activities, outside of formal exercise settings, such as walking the dog, gardening or doing household chores (Levine, 2007; Tudor-Locke et al., 2007). Incidental physical activity can account for substantial energy expenditure, and even a slight increase in physical activity has been found to benefit mental and physical health for sedentary people (Brown et al., 2005; Hill et al., 2003; Reiner, Niermann, Jekauk & Woll, 2013). Indeed, the existence of associations between incidental physical activity and higher quality of life has now been established (Aoyagi et al., 2010; Ross & Mcguire, 2011). However, there is a lack of research investigating the psychological mechanisms that influence incidental physical activity. It is important to investigate these influences in order to develop effective strategies to increase levels of incidental physical activity.

A motivational perspective may be valuable in explaining the variability in incidental physical activity (Teixeira et al., 2012). One theory of human motivation that has been applied to a range of behaviours, including physical activity, is Self-Determination Theory (Deci & Ryan, 2008). According to this theory, actions are performed for different reasons, or goals. These goals act as incentives that create two types of motivation: self-determined (autonomous) and non-self-determined (controlled) motivation. Self-determined motivation occurs when behaviour is valued and performed for autonomous reasons whereas non-self-determined motivation occurs when behaviour is performed due to external pressure. Behaviour performed for self-determined, autonomous reasons is more likely to persist in the absence of external contingencies or rewards. In contrast, behaviours performed for controlled reasons external to the self (e.g., to achieve a reward or to avoid a negative consequence) will cease when the external contingency is not present. Thus, the level of autonomous or controlled motivation that is experienced when engaging in behaviour determines the persistence of that behaviour in the future.

The majority of research based on Self Determination Theory has emphasized the importance of autonomous motivation to engage in and maintain health behaviours (Banting & Dommock, 2009; Hagger & Chatzisarantis, 2009; Ntoumanis et al., 2012). Research in the exercise domain has shown that autonomous motivation is positively related to exercise engagement. In particular, autonomous motivation has been associated with greater exercise engagement over time (Chatzisarantis & Hagger, 2009; Chatzisarantis et al., 2003), and intentions to exercise (Hagger & Chatzisarantis, 2008; Hagger et al., 2003). However, recent research has also linked controlled motivation to engagement in health-related behaviours (Caudwell & Keatley, 2016; Niven & Markland., 2016). While autonomous motivation has been found to be important for behavioural engagement, persistence and wellbeing (Deci & Ryan, 2000; Hagger et al., 2014), controlled motivation may influence behaviour when external pressures remain (Caudwell & Keatley, 2016). For example, individuals who are ashamed of, or are unhappy with, their body may engage in physical activity, for as long as the external pressure to change their body exists (Chatzisarantis & Hagger, 2009; Moreno et al., 2008). A recent systematic review of 53 exercise studies provided some support for the influence of controlled motivation on physical activity behaviour (Teixeira et al., 2012). Although less clear cut than the findings for autonomous forms of motivation, which in line with Self-Determination Theory, were consistently positively related to exercise behaviour, some studies did report a positive relationship also between controlled forms of motivation and exercise behaviour; however, others reported a negative relationship or no relationship. Thus, further research is required to clarify the influence of controlled motivation on activity behaviour. The role of autonomous and controlled motivation in incidental physical activity has not yet been investigated. Investigation into the role of motivation on incidental physical activity is important, as for sedentary individuals, incidental physical activity is an important factor for increasing daily energy expenditure and improving health.

Along with one's motivation, individuals' implicit processes may also play an important role in regulating aspects of incidental physical activity (Conroy et al., 2010). The idea of physical activity being regulated by implicit processes is consistent with dual process models of impulse and self-control (e.g., Strack & Deutsch, 2004). These models propose that behaviour is regulated by two different systems: the impulsive system and the reflective system. The impulsive system governs behaviour in a fast, implicit and effortless way. This includes responses to relevant stimuli (e.g., cues for physical activity) that are affective (e.g., implicit attitudes and preferences) as well as motivational (i.e., attentional and approach-avoid biases). Implicit attitudes are preferences that individuals may not be aware of (or are unwilling to report) which occur because of previous mental associations between an object or a behaviour (e.g., physical activity) and an evaluation (positive or negative) (Fazio & Olson, 2003). Attentional biases occur when certain stimuli in the environment automatically capture and hold individuals' attention (Kemps & Tiggeman, 2009). Approach-avoid biases are the behavioural component of an impulse which automatically guides an individual to either approach or avoid certain stimuli (Hofmann, Friese & Wiers, 2008). In contrast to the impulsive system, the reflective system involves conscious behavioural decisions, resulting in slow and effortful responses. Such decisions are based on personal goals, intentions and standards.

The impulsive and reflective systems operate independently and can produce conflicting signals. For example, the presence of stairs and escalators may elicit a conflict between the two systems; that is, automatically attending to and approaching the escalators while maintaining the goal of being active. If insufficient cognitive resources are available, the impulsive system may implicitly guide behavior towards the escalator, resulting in lower levels of incidental physical activity (Hofmann, Friese & Strack, 2009; Strack & Deutsch, 2004; Smith & DeCoster, 2000). Therefore, individuals may engage with, or disengage from, incidental physical activity cues without much conscious awareness, resulting in some individuals unintentionally expending minimal energy on daily activities (Hofmann, Friese & Strack, 2009; Strack & Deutsch, 2004).

Research in the physical activity domain suggests that implicit processes play a role in guiding physical activity behaviour. For example, implicit attitudes have been found to predict a range of health-related behaviours, and are thought to be important in motivating engagement in physical activity (Banting, Dimmock & Lay, 2009; Greenwald, Poehlam, Uhlmann & Banaji, 2009). However, previous research has mostly focused on implicit attitudes and their influence on intentional exercise behaviour (e.g., Craeynest et al., 2005; Keatley, Clarke & Hagger 2013). To date, only one study has demonstrated a link between implicit attitudes and incidental physical activity. Specifically, Conroy et al., (2010) showed that implicit attitudes prospectively predicted levels of both incidental and intentional physical activity, such that individuals with more positive implicit attitudes towards physical activity had higher daily step counts, as measured by a pedometer. Further, individuals with higher levels of intentional physical activity (i.e., exercise) have been found to automatically direct attention towards physical activity cues more so than those with lower levels of physical activity, providing evidence for an attentional bias for exercise related cues (Berry, Spence & Stolp, 2011; Berry, 2006; Bluemke et al., 2010; Calitri et al., 2009). Additionally, two studies have shown that automatic approach biases for physical activity cues can prospectively predict moderate to vigorous physical activity, as well as incidental physical activity, determined by self-report (Cheval et al., 2014a) or grip force on a hand dynamometer (Cheval et al., 2014b).

Thus, the literature to date indicates that both motivational processes (autonomous or controlled) and implicit processes (implicit attitudes, attentional biases and approach-avoid biases) each contribute individually to incidental physical activity behaviour. However, recent research in the physical activity domain that has investigated motivation and implicit processes together suggests that implicit processes and motivation may interact to guide behaviour (Caudwell & Keatley, 2016; Niven & Markland, 2016). This echoes research on other health behaviours such as eating, and alcohol and nicotine consumption, which has shown that implicit processes (e.g., implicit attitudes) and motivation together exert influence on consumption behaviour (Hofmann et al., 2008; Ostafin & Palfai., 2006; Sherman et al.,2003). These findings suggest that individuals may rely on implicit processes to guide behaviour, depending on their level, and/or type, of motivation (Evans, 2008; Smith & DeCoster, 2000). However, no study has yet investigated the contribution of these factors together in relation to incidental physical activity. Understanding the contributions of both implicit processes and motivation together could provide valuable information for developing interventions focussed on increasing incidental physical activity.

The aim of the present study was to investigate how motivational and implicit processes interact to predict levels of incidental physical activity. Incidental physical activity was operationalized as a seven-day step count recorded on commercial pedometers. In contrast to self-report measures, which are subject to reporting error (Cleland et al., 2011; Aoyagi et al., 2010), pedometers provide a reliable, accurate and objective measure of daily steps taken (Bassett et al., 1996; Kilanoski et al., 1999; Oliver, Schofield, & McEvoy, 2006; Puhl, Greaves, Hoyt, & Baranowski, 1990). Participants wore the pedometers at all times, except when engaging in intentional physical activity (i.e., exercise), to provide a purer measure of incidental physical activity. We examined three implicit processes: implicit attitudes, attentional bias and approach-avoid bias. These were measured using the single-category association task, dot probe task and manikin task, respectively. Autonomous and controlled motivation were measured using the Perceived Locus of Causality Questionnaire.

4.2 Method

Participants.

One hundred and three participants (71 women, 32 men) were recruited from the student population at an Australian University, and the wider Adelaide metropolitan community. Power analyses revealed that power to detect significant interaction effects at the .05 level was .99 for implicit attitudes, .94 for attentional biases and .99 for approach-avoid biases for the regression analyses predicting incidental physical activity. Participants were aged between 17 and 68 years (M = 26.54, SD = 11.17) and were within the healthy weight range (BMI M = 23.8 kg/m^2, SD = 3.9). Participants were included if they spoke English fluently and were able and willing to wear a pedometer for seven days.

Materials.

Stimuli.

The same stimuli were used for each of the implicit attitudes, attentional bias and approach-avoid bias tasks. The stimuli were 15 images of daily incidental physical activities (e.g., walking upstairs, riding a bicycle, gardening), and 15 images of sedentary activities (e.g., standing on an escalator, driving a car, reading). The pictures were coloured photographs sourced from the internet. An additional 15 pictures of plants were used for practice trials to familiarise participants with the tasks. For the dot probe task, picture pairs included images of physical activity that were paired with images of sedentary activity. Each of the picture pairs were individually matched so that the activities reflected real life choices, for example walking upstairs or standing on an escalator

Implicit Attitudes.

Following the procedure of Conroy et al. (2010), the Single Category Implicit Association Task (SC-IAT) was used to measure implicit evaluative attitudes toward incidental physical activity. The SC-

IAT is a timed sorting task. Participants were instructed to indicate, as quickly as possible, whether stimuli belonged to one of two categories. The target category was ‘activity’, and the evaluative categories were ‘I like’ and ‘I dislike’. The evaluative category labels “like/dislike” were chosen over traditional "positive/negative" or "pleasant/unpleasant" category labels because they better reflect personal evaluations and avoid the influence of bias stemming from normative social evaluations of target stimuli (Olson & Fazio, 2004). A subset of six images were chosen to represent incidental physical activity, covering the different sub-behaviours. The evaluative stimuli were selected from previous IAT studies (e.g., Karpinski & Steinman, 2006; Olson & Fazio, 2004). The ‘I like’ category included pleasant pictures (e.g., puppies, a butterfly, a smiling baby) and the ‘I dislike’ category included unpleasant pictures (e.g., a crying child, road kill, a growling dog), and were selected from the International Affective Picture System[1].

The task consisted of three blocks. In all three blocks the category labels “I like” and “I dislike” were displayed in the top left and right hand corners of the screen, and remained on the screen throughout the entire block. Preceding each block, a set of instructions outlining the steps of the categorization task and the appropriate key responses appeared on the computer screen. For each participant, the stimuli appeared in a different random order.

Block 1 and block 2 were practice blocks to familiarise participants with the task. Block 1 consisted of 24 trials that included only ‘positive’ and ‘negative’ stimuli. These were presented one by one in the centre of the screen. Participants were instructed to categorise each stimulus by pressing the corresponding left (‘Z’) or right (‘/’) keys. Stimuli remained on screen until the participant responded or for 1,500ms. Block 2 consisted of 36 trials and included the category label ‘activity’. The category label ‘activity’ appeared with the ‘I like’ category for 50% of the trials. For the remaining 50% of the trials the category label appeared with the ‘I dislike’ category. The position of the category label switched randomly between trials, so that 50% of trials were ‘I like + activity’ and 50% of trials were ‘I dislike + activity’. The location of the ‘I like’ and ‘I dislike’ labels was counterbalanced across participants. The

[1] IAPS: Puppies [slide no. 1710], Seal [1440], Butterfly [1603], Nature [5760], Baby [2070], Mother [2311], Pitbull [1300], Gun [2811], Boy Crying [2900], Toilet [9301], Garbage [9373], Dog [9570]

test block (block 3), was the same as block 2 except with a new randomisation and was lengthened to 144 trails. Halfway through the test block participants were given a short break. Categorisation ('Z' or '/' key press) response times from the test block (block 3) were used in analyses. The SC-IAT analysis excluded erroneous responses (9.8%), as well as response times less than 350ms and more than 10,000ms (0.5%), as they were considered anticipatory and delayed, respectively.

The task was scored using the SC-IAT D-score algorithm (Karpinski & Steinman, 2006). The average response time for trials from block 3 with categories "activity + like" was subtracted from the average response time for trials of the block with categories "activity + dislike". That score was then divided by the standard deviation of all trials. The resulting D-score was the measure of strength of evaluative attitudes toward incidental physical activity. Higher scores indicate stronger associations between physical activity and 'like' than between physical activity and 'dislike' (i.e., a more favourable attitude).

Attentional Bias.

Following Berry, Spence and Stolp (2011), attentional bias for incidental physical activity was measured using the dot probe task. Each trial began with an orienting cross ('+') appearing on the screen for 500ms. This was followed by the presentation of a picture pair for 500ms. The images appeared simultaneously, side by side, 2cm apart against a neutral grey background. Immediately after the picture pair disappeared, a probe (small dot) appeared in the location of one of the pictures and remained on the screen until the participant responded. Participants were instructed to indicate as quickly and as accurately as possible the location of the dot by pressing the corresponding key (the "Z" key was labelled "L" for left and the "/" key was labelled "R" for right) on the keyboard. All 15 image pairs were shown four times (with activity-related images and sedentary behaviour images on both the left and on the right, and for each of these the probe on the left and right) for a total of 60 experimental trials. These picture pairs were presented in a different random order for each participant. Accuracy and reaction times (ms) of pressing the relevant key ('Z" key or 'L' key) on the keyboard were recorded. Incorrect responses (1%), as well as responses below 150ms and above 1500ms (0.5%) were excluded as outliers (Kemps & Tiggemann, 2009). Following standard protocols, an attentional bias score was computed by subtracting mean reaction times to the dot probes replacing activity-related images from the mean reaction times to the dot probes replacing sedentary behaviour images (Kemps et al., 2014; Kemps & Tiggeman, 2009). Therefore, positive scores indicate an attentional bias towards incidental physical activity images and negative scores indicate an attentional bias towards sedentary behaviour images.

Approach-Avoid Bias.

Consistent with Krieglmeyer and Deutsch (2010) and Cheval et al., (2014), approach-avoidance bias for incidental physical activity was assessed using a manikin task, a reliable and well-validated measure of approach-avoidance bias (De Houwer et al., 2001; Krieglmeyer & Deustch, 2010). Participants were asked to move a manikin (a schematic image of a human figure) toward an incidental physical activity image, and away from a sedentary behaviour image, or vice versa. To move the manikin (upwards or downwards) on the computer screen, participants were instructed to repeatedly press the "8" key (upwards) or "2" key (downwards) on the numeric keypad, with their middle finger. Each trial started with a fixation cross in the middle of the screen. On seeing the cross, participants pressed the "5" key. This initial key press triggered the manikin to appear, in either the upper or lower half of the screen. The manikin appeared on either half of the screen with equal frequency. After 750ms an image of an incidental physical activity behaviour, or a sedentary-behaviour was presented in the centre of the screen.

Participants were instructed to respond as fast and as accurately as possible by pressing the "8" or "2" key three times to move the manikin across the screen. After the third key press there was an inter-trial break of 1000ms. The time between the onset of the image and the first key press ('8' for upwards, or '2'for downwards) was used in the analyses. Participants completed two blocks, each consisting of two practice trials and 60 test trials (i.e., each of the 15 images appeared twice in the upper and twice in the lower half of the screen). In one block participants were instructed to approach incidental physical activity images and to avoid sedentary behaviour images, and vice versa in the other block. The order in which the blocks were completed was counterbalanced.

As recommended by Krieglmeyer and Deutsch (2010), incorrect responses (14.5%) as well as responses below 150ms and above 1,500ms were excluded (7.75%). An approach bias towards incidental physical activity was calculated by subtracting the mean approach reaction time toward sedentary activity images from the mean approach reaction time toward physical activity images (Cheval et al., 2014; Kriegleyer et al., 2013). A positive score indicates a tendency to approach incidental physical activity and a negative score indicates a tendency to avoid incidental physical activity.

Motivation.

An adapted version of Ryan and Connell's (1989) measure of perceived locus of causality was used to measure autonomous and controlled motivation towards physical activity. Participants were presented with a common word stem specifically related to incidental physical activity such as "I use the stairs instead of an elevator or escalator because …" To capture a range of daily activities, five word stems representing the different sub-behaviours of incidental physical activities were used ("walking to get from A to B", "using a bicycle as a mode of transport", "walking the dog", "gardening", "using stairs instead of an elevator or escalator"). These word stems were followed by eight reasons, two for each of four regulation styles: external regulation (e.g. "… I feel under pressure to use the stairs instead of an elevator or escalator"), introjected regulation (e.g. "…. I will feel guilty if I do not use the stairs instead of an elevator or escalator"), identified regulation (e.g. "… I value the benefits of using the stairs instead of an escalator or elevator") and intrinsic motivation (e.g. "… I enjoy using the stairs instead of an escalator or elevator"). Responses were recorded on a 5-point scale ranging from (1) "not true at all" to (5) "very true". To ensure that we only captured behaviours that participants actually engaged in, participants only responded to word stems for activities that they selected to be relevant to them. All participants reported at least one activity that was relevant to them, with 10% of participants reporting engaging in one behaviour, 30% in two behaviours, 41% in three behaviours, 18% in four behaviours, and 2% in all five behaviours. Following the procedure of Hagger et al. (2014), an autonomous motivational regulation index was computed as the sum of the intrinsic motivation scale weighted by a factor of two, plus the identified regulation item. To account for the number of activities participants actually engaged in, this score was divided by the number of activities participants selected to be relevant to them. Similarly, the controlled motivational regulation index was computed as the sum of the external regulation scale weighted by two, plus the introjected regulation scale, and divided by the number of relevant activities.

Incidental physical activity.

Participants were provided with a G-Sensor Accelerometer Pedometer to record their daily step count. Participants were instructed to wear the pedometer for the following 7 days within all waking hours except when engaging in intentional physical activity, i.e., exercise. To obtain a complete 7-day step count, participants began wearing the pedometers the day following the initial testing session, and ceased wearing them the day before their second session. Participants were sent daily text message reminders to wear their pedometers and to record their step count.

Procedure.

The study took place in a laboratory in the School of Psychology at Flinders University and consisted of two sessions. The first session took approximately 5 minutes. Written and verbal instructions on how and when to wear the pedometers over the following week were provided. Participants were given the option to record their daily step count via text message, email or a Qualtrics online survey. They were informed that they would receive daily text messages reminding them to wear their pedometer. Participants returned to the laboratory 7 days later for the second session. This session took approximately one hour, and up to two participants were tested in separate cubicles. Participants completed the SC-IAT task, dot probe task and manikin task in counterbalanced order, followed by the motivation questionnaire.

4.3 Results

Sample characteristics.

Table 1 summarizes the descriptive statistics for implicit attitudes, attentional bias, approach-avoid bias, autonomous motivation, controlled motivation and step count. One sample t-tests were conducted to determine whether implicit attitude, attentional bias and approach-avoid bias scores differed significantly from zero. Results revealed that participants had a significant positive implicit attitude towards incidental physical activity behaviour, and a significant tendency to avoid incidental physical activity cues, but they showed no significant attentional bias toward incidental physical activity cues. One participant was removed from the analyses due to incomplete step count data.

Table 1.

Summary of descriptive statistics, correlations and on-sample t-tests for study variables

	M (SD)	Implicit attitude	Attentional bias	Approach-avoid bias	Autonomous motivation	Controlled motivation	*t*
Implicit attitude	0.26 (0.52)						5.07*
Attentional bias	1.99(16.48)	-.019					1.22
Approach-avoid bias	-188.19 (264.21)	-.042	.072				-7.23*
Autonomous motivation	52.90 (26.91)	.052	.122	.047			
Controlled motivation	29.16 (17.58)	-.091	-.069	.002	.733***		
Step count	6072.87 (2730.3)	-.278*	-.046	.030	.346**	.336**	

df =102, *p <.05*,* ** p <.01*,* *** p <.001.

Relationships between implicit attitudes, attentional bias, approach bias, motivation and incidental physical activity.

Table 1 provides the inter-correlations between implicit attitudes, attentional bias, approach bias, motivation and step count. Step count was significantly positively correlated with both autonomous and controlled motivation. Step count was also significantly correlated with implicit attitudes but in a negative direction. In addition, autonomous and controlled motivation were significantly positively correlated.

Interaction between motivational and implicit processes in predicting incidental physical activity.

Separate hierarchical regression analyses were conducted to examine the interaction between each of the motivational (autonomous and controlled) and implicit processes (implicit attitudes, attentional bias, and approach-avoid bias) in predicting incidental physical activity. For each regression, centred motivation (autonomous or controlled) was entered in step 1, to control for its potential influence. Centred motivation type of interest (autonomous or controlled) and centred implicit process (implicit attitude, attentional bias or approach-avoid bias) scores were then entered in step 2. Finally, the two-way product term was entered in step 3 (motivation x implicit process). Table 2 summarizes the outcomes of these regression analyses. Any significant interactions were followed by simple slopes analysis, using unstandardized coefficients one standard deviation above and below zero, to determine the form of the interaction. The slopes were graphed following procedures outlined by Aiken and West (1991) and Dawson (2014), and are shown in Figure 1.

Implicit Attitudes.

As can be seen in Table 2(a), when controlling for controlled motivation in step one of the regression analyses, we found a significant negative main effect of implicit attitudes in step two. Similarly, as can be seen in Table 2(b), when controlling for autonomous motivation in step one, we found a significant negative main effect of implicit attitudes in step two. However, step three did not show any significant two-way interactions between motivation-type and implicit attitudes.

Attentional bias.

We found no significant main effects of motivation-type or attentional bias in step two of the regression analyses when controlling for either autonomous or controlled motivation in step one. Step three of the regression analysis did not show any significant two-way interactions.

Table 2a.
Interactions between autonomous motivation and implicit processes in predicting incidental physical activity

Step	Motivation and Implicit Process	Model			Step Count			
		R^2	R^2 Change	F Change	B	SE	b	b_0
1	Controlled motivation	.095		(1,101) 10.66*	37.75	11.56	.309*	
2	Autonomous motivation	.186	.090	(2,99) 5.49*	18.56	10.37	.230	
	Implicit attitude				-1463.32	485.73	-.277*	
3	Implicit attitude x autonomous motivation	.188	.002	(2,98) .216	-6.15	13.25	-.043	6077
1	Controlled motivation	.95		(1,101) 10.66**	37.75	11.57	.309**	
2	Autonomous motivation	.114	.019	(2,99) 1.04	16.10	11.23	.2	
	Attentional bias				-9.43	16.53	-.057	
3	Attentional bias x autonomous motivation	.141	.027	(1,98) 3.02	-.885	.51	-.17	6140
1	Controlled motivation	.095		(1,101) 10.66**	37.75	11.56	.309**	
2	Autonomous motivation	.113	.017	(2,99) .96	13.89	10.74	.172	
	Approach-avoid bias				.406	.982	.039	
3	Approach-avoid bias x autonomous motivation	.256	.143	(1,98) 18.91***	-.100	.023	-.387***	6079

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

Table 2b.
Interactions between controlled motivation and implicit processes in predicting incidental physical activity

Step	Motivation and Implicit Process	Model			Step Count			
		R^2	R^2 Change	F Change	B	SE	b	b_0
1	Autonomous motivation	.094		(1,101) 10.44*	24.68	7.64	.306*	
2	Controlled motivation	.186	.092	(2,99) 5.6*	15.17	15.75	.124	
	Implicit attitude				-1463.32	485.73	-.277*	
3	Implicit attitude x controlled motivation	.189	.003	(1,98) .411	15.1	23.56	.059	6087
1	Autonomous motivation	.094		(1,101) 10.44**	24.68	7.64	.306**	
2	Controlled motivation	.114	.020	(2,99) 1.141	19.91	16.93	.163	
	Attentional bias				-9.43	16.53	-.057	
3	Attentional bias x controlled motivation	.14	.105	(1,98) 2.95	-1.05	.61	-.174	6032
1	Autonomous motivation	.094		(1,101) 10.44**	24.68	7.64	.306**	
2	Controlled motivation	.113	.086	(2,99) 1.06	23.25	16.29	.19	
	Approach-avoid bias				.406	.982	.039	
3	Approach-avoid x controlled motivation	.267	.154	(1,98) 20.58***	-0.170	.038	-.417***	6017

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

Approach-avoid bias.

When controlling for motivation-type in step one of the regression analyses, we found significant main effects of the target motivation-type in step two. Further, step three showed a significant two-way interaction between motivation-type and approach bias. As can be seen in Figure 1(a), when controlling for controlled motivation, autonomous motivation was positively associated with step count in participants with high avoid bias scores (+1SD), R^2 Change = .16, *B* = 49.1, t(98) = 3.84 , p < .001, b_0 = 6000, but was unrelated to step count in participants with high approach bias scores (-1SD), R^2 Change = .16, *B* = -3.77, t(98) = -.35, p = .73, b_0 = 6158. Similarly, as shown in Figure 1(b), when controlling for autonomous motivation, controlled motivation was positively associated with step count in participants with high avoid bias scores (+1SD), R^2 Change = .17, *B* = 44.17, t(98) = 2.83 , p = .006; b_0 = 5885.53. By contrast, controlled motivation was negatively associated with step count in participants with high approach bias scores (-1SD), R^2 Change = .17, B = -.45.767, t(98) = 2.15, p = .034, b_0 = 6150.31.

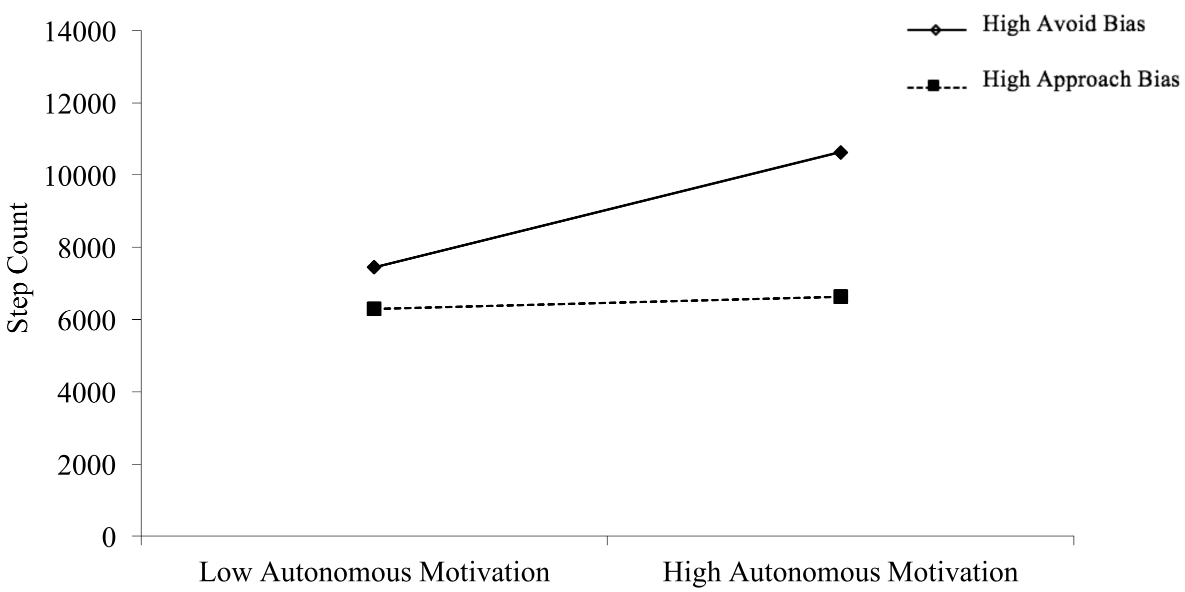

Figure 1a. Interaction between autonomous motivation and approach-avoid bias while controlling for controlled motivation

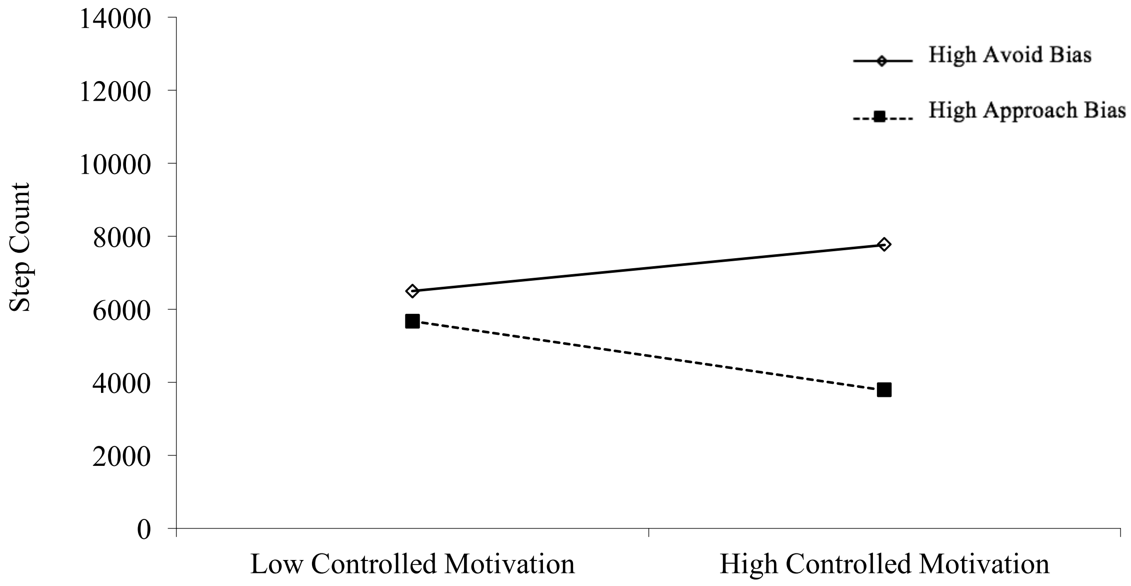

Figure 1b. Interaction between controlled motivation and approach-avoid bias while controlling for autonomous motivation

4.4 Discussion

The current study aimed to investigate the relationships between motivational and implicit procceses in predicting incidental physical activity. Both autonomous and controlled motivation, as well as certain aspects of implicit processing, contributed to levels of incidental physical activity. In particular, we found combined and interactive effects between motivational and implicit processes in predicting levels of incidental physical activity. The results indicate that motivation is an important contributor to incidental physical acitivity. They further suggest a role for implicit processes in incidental physical activity enagagment.

Individuals who were high in autonomous motivation, as well as those who were high in controlled motivation, engaged in higher levels of incidental physical activity than individuals who were low in either autonomous or controlled motivation. To our knowledge, the present study is the first to investigate the relationship between motivation and incidental physical activity, rather than intentional physical activity. Previous studies have found that autonomous motivation is associated with higher levels of intentional physical activity than controlled motivation, although controlled motivation has also been associated with engagement in health related behaviours (Niven & Markland, 2016; Chatzisarantis & Hagger, 2009; Chatzisarantis et al., 2003; Hagger & Chatzisarantis, 2008; Hagger et al., 2003; Webber et al., 2010). Our finding here for incidental physical activity suggests that autonomous motivation and controlled motivation both contribute to behaviour. Thus, motivation, regardless of whether it is autonomous or controlled, may be beneficial for engagement in incidental physical activity. This finding runs counter to the traditional Self Determination Theory which suggests that optimal results occur when autonomous forms of motivation are present and controlled forms of motivation are not (Ryan & Connell, 1989). Autonomous and controlled motivation are often conceptualised as two ends of a continuum of relative autonomy. Accordingly, it is a commonly held belief that autonomous and controlled motivation types should be unrelated or negatively correlated. However, when applied to physical activity behaviour, Self Determination Theory posits that "sustained exercise is most likely when a person has both intrinsic motivation and well-internalized extrinsic motivation, as both facilitate what is, normatively speaking, a precarious endeavor" (Ryan & Deci, 2007, p. 5). Our findings support this notion and suggest that it may extend to incidental physical activity behaviour. Our results further support recent research that has linked controlled motivation to engagement in health related behaviours (Caudwell & Keatley, 2016; Niven & Markland., 2016; Guay et al., 2015; Tiexeira et al., 2012). Indeed, Self Determination Theory based measures often show that individuals endorse more than one form of motivation for a behaviour at the same time (Guay et al., 2015; Gagné, 2014). Our findings support the idea that autonomous motivation and controlled motivation can coexist, and each contribute to behaviour engagement. Indeed, in the context of incidental physical activity, it is plausible that one can be motivated by autonomous reasons and controlled reasons simultaneously. For example, an individual may walk to the supermarket because they enjoy walking and getting outside, but also because they want the added benefit of burning calories.

In line with dual process models, we found a role for implicit processes in incidental physical activity (Strack & Deutsch, 2004). Specifically, participants showed a positive implicit attitude towards incidental physical activity, but an avoidance bias away from incidental physical activity cues (and no attentional bias). These findings indicate that although individuals may implicitly like incidental physical activity, they have a tendency to avoid physical activity cues in the environment. This seemingly contradictory finding is further reflected by the negative correlation between implicit attitudes and incidental physical activity, in contrast with the previously shown positive correlation between implicit attitudes and intentional physical activity (i.e., exercise) (Calitri et al., 2009; Conroy et al., 2010). Thus, although individuals may implicitly like incidental physical activity, they do not necessarily engage in such activity. These results suggest that the affective component (i.e., implicit attitudes) may operate differently from the motivational component (i.e., attentional and approach biases) within the impulsive system when it comes to incidental physical activity behaviour. They further reflect the contrasting nature of incidental versus intentional physical activity. Previous research on attentional and approach biases has focused on intentional behaviours that are desirable, or even addictive (i.e., alcohol, cigarette and chocolate consumption) (Kemps, Tiggemann, Martin & Elliott, 2013; Wiers et al., 2013; Wiers et al., 2010). The limited research that has investigated attentional and approach biases in the physical activity domain has focused on intentional physical activity, or exercise (Berry, Spence & Stolp, 2011; Berry, 2006; Calitri et al. 2009). Compared to incidental physical activity, intentional physical activity is a more deliberate behaviour, performed because of its rewarding physiological responses and sense of accomplishment upon completion (Aidman & Woollard, 2002; Friemuth, Moniz & Kim, 2011). Thus, because of its unintentional nature, people may not be automatically drawn to incidental physical activity. Indeed, we found no attentional bias for incidental physical activity, as has been shown for exercise (Berry, Spence & Stolp, 2011; Berry, 2006; Bluemke et al., 2010; Calitiri et al., 2009).

The main focus of the present study was to investigate how motivational and implicit processes together contribute to incidental physical activity levels. Individuals who had higher levels of either autonomous or controlled motivation, and implicitly liked incidental physical activity, engaged in more incidental physical activity. In addition, motivational processes interacted with approach biases in predicting incidental physical activity levels. In particular, when controlling for the other motivation-type, both autonomous and controlled motivation were positively associated with step count in participants with low approach bias scores. Thus, individuals who were less likely to approach physical activity cues in the environment, and yet were highly motivated to be active, engaged in higher levels of incidental physical activity. By contrast, individuals who were more likely to approach physical activity cues did not engage in high levels of incidental physical activity, despite being motivated to do so. It is possible that the latter individuals have the intention of being more physically active, and are therefore automatically drawn to physical activity cues, yet fail to translate this intention into a behavioural outcome. Indeed, intentions often do not result in active behaviour (Hagger, Chatzisarantis, & Biddle, 2002). However, habits have been consistently found to be related to physical activity engagement (Garder, de Bruijn & Lally; 2011). Repeated behavioural responses to environmental cues results in habit formation. Habits then guide behaviour autonomously with minimal conscious awareness (Oullette & Wood, 1998). Research on intentional physical activity has found that habit strength moderates the relationship between intentions and behaviours, such that the impact of intention on behaviour is diminished as habit strength increases (Garder, de Brijn & Lally; 2011; Ouellette & Wood, 1998). It is possible that individuals who, despite being highly motivated and drawn to physical activity cues in the environment, do not engage in higher levels of incidental physical activity because they have not yet established the habit of being active. By contrast, highly motivated individuals who are less likely to approach physical activity cues in the environment, may engage in higher levels of incidental physical activity because they have developed the habit of being active. Such individuals may not be drawn to activity cues in the environment because their behaviour is largely habitual, and thus more reflective of incidental physical activity. These findings suggest that habit strength may be an important contributor to incidental physical activity engagement.

In contrast to approach bias, attentional bias did not interact with either autonomous or controlled motivational processes to predict incidental physical activity (when controlling for the other motivation-type). This finding is perhaps not surprising given the inconsistency in findings regarding a link between attentional bias and behavioural outcomes, with some studies finding no association between attentional bias and (consumption) behaviour **(**Fadardi & Cox, 2009**;** Mufano et al., 2003; Field et al., 2006**;** Hardman et al., 2013). Although attentional and approach biases are both components of automatic processing, they are nevertheless two distinctive types of cognitive bias, which have been shown to differentially predict behaviour (i.e., consumption) in the alcohol and food domains (Sharbanee et al., 2013; Kakoschke, Kemps & Tiggemann, 2015). The current findings suggest that approach bias may be more important in understanding the association between environmental cues and incidental physical activity engagement. This may be because approach bias, unlike attentional bias, includes a behavioural component (i.e., moving towards or away from cues), in addition to a cognitive one. However, future research is required to investigate this further.

The present study has some important practical implications. It would appear that both autonomous and controlled motivation are important contributors to an active lifestyle. This finding offers potential scope for individuals who want, or need, to increase their levels of incidental phsyical activity. Specifically, increasing levels of incidental physical activity could be achieved by increasing either internal or external motivation, and these interventions could be tailored to individuals' particular motivation. In particular, interventions based on Self-Determination Theory could benefit those who wish to increase their levels of incidental physical activity. These interventions consist of motivational treatment programs that use motivational interviewing to encourage choice and build congruence between values (such as being active) and lifestyle to enhance autonomous motivation. Previous studies have demonstrated the efficacy of such interventions for increasing intentional physical activity (i.e., exercise) (Fortier et al. 2010; Levy & Cardinal, 2004). Thus, future research could usefully determine if these motivational interventions could similarly increase levels of incidental physical activity.

Our findings suggest that in addition to targeting motivation, interventions should also target implicit processes. For example, implicit attitudes towards incidental physical activity could be re-trained by evaluative conditioning, or a modified IAT. Such techniques would involve training individuals to associate incidental physical activity cues with positive stimuli (Hofmann et al., 2010), and have been shown to be successful for other health related behaviours, such as alcohol consumption (e.g., Baeyens, Field & De Houwer, 2005) and eating behaviour (Hollands, Prestwich & Marteau, 2011). Likewise, cognitive bias modification tasks (e.g., modified manikin task) that attempt to decrease individuals' biases for incidental physical activity cues, used in conjunction with motivational techniques, may also be effective in increasing activity engagement. Such tasks have been found effective in reducing cognitive biases for various substances (e.g., alcohol and chocolate) (Wiers et al., 2011; Schumacher, Kemps & Tiggemann, 2016). In addition, nudging techniques, which tap into both implicit processes and motivation, may provide an alternative strategy for increasing levels of incidental physical activity in microenvironments (e.g., shopping centres). Nudging techniques implicitly guide people towards a more desirable choice by making favourable options more salient in the environment (Thaler, Sunstein & Balz, 2014). For example, research that has used nudging in the activity domain has shown that placing coloured footprints on the floor can guide participants towards the stairs rather than the escalator (Boutelle, Jeffery, Murray & Schmitz, 2004; Marshall et al., 2002; Hansen & Jespersen, 2013). Similar techniques may therefore be valuable for increasing levels of incidental physical activity more generally.

A clear strength of the current study was the use of a seven-day step count obtained from pedometers as an objective measure of incidental physical acitivty. To obtain a pure measure of incidental physical activity, particants were requested to remove the pedometers when engaging in intentional exercise. This relied on participants adhering to these instructions. Future research should inspect and verify whether monitors were in fact removed during periods of intentional physical activity.

The present study has demonstrated contributions of both motivational and implicit proccesess in predicting incidental physical activity. In so doing, we identifed two targets for future interventions to increase levels of incidental physical activity. Such interventions are particularly important in contemporary Western environments characterised by predominently sedentary lifestyles.

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CHAPTER 5: STUDY 4

Do Point-of-Decision Prompts motivate walking on a University Campus?

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Abstract

Objective: Physical inactivity is a global public health issue associated with negative physical and psychological outcomes. We examined the effectiveness of two motivational signs to increase individuals' motivation and active travel engagement.

Design: A mixed-methods experimental design investigated the effect of different motivational Point-of-Decision Prompts (PDP) on motivation and decision to use active transportation (i.e., walk) on a university campus. Autonomously-oriented and control-oriented PDPs were compared to a control group in which no motivational sign was present.

Measures: Transportation choice (walk vs bus) was assessed via observation. Motivation for transportation choice was measured by a qualitative response, and coded as autonomous or controlled motivation. Motivation for incidental physical activity more generally was measured using the Perceived Locus of Causality Questionnaire.

Results: There was no effect of PDP on transportation choice. However, autonomous motivation for active travel predicted walking engagement. In addition, the presence of an autonomously-oriented PDP was associated with higher levels of autonomous motivation for active transportation.

Conclusions: Findings suggest that an autonomously-oriented PDP is beneficial for individuals' motivation. Findings support self-determination theory as autonomous motivation for active travel predicted walking engagement. This study contributes to the limited research investigating the motivational component of PDP messages and the relationship between motivation and active travel.

Key words: *Point-of-Decision Prompt, active transport, physical activity, motivation, self-determination theory*

5.1 Introduction

Increasing physical activity is an international public health priority (Sallis et al., 2016). With sedentary lifestyles responsible for more than 5 million deaths per year, increasing physical activity is a primary goal to reduce non-communicable diseases (e.g., cardiovascular illnesses, type 2 diabetes) (Lee et al., 2012). It is well documented that an increase in physical activity has positive effects on physical and psychological health, and that physical inactivity is associated with morbidity and mortality (Schuch et al., 2017). Despite this, in contemporary Western society, a sedentary lifestyle is the norm, and the majority of the population still does not meet the recommended levels of physical activity for health benefit (30 minutes of moderate activity on most days of the week) which can be accumulated in short bouts (i.e., <10 min.) across the day (Hoare et al., 2017). Efforts to engage individuals in structured exercise have proven problematic, as many programmes do not result in sustained exercise engagement (Marshall et al., 2002; Dugdill et al., 2008). Therefore, increasing incidental energy expenditure via practical day-to-day tasks has substantial potential for both individual health and public health (Marshall, 2004).

Incorporating short bouts of activity is a sustainable strategy to overcome common barriers to exercise engagement (e.g., not having enough time; finding exercise inconvenient), and increase daily energy expenditure (Kremers, Eves & Anderson, 2012). Increasing incidental physical activities such as incorporating walking, climbing stairs, gardening, or cycling for transport into a daily routine are undemanding ways to increase activity levels that most people can incorporate into their daily life. Walking has been recognised as a particularly beneficial activity behaviour, and has long been associated with improved physical health such as a decreased risk of diabetes and cardiovascular disease, and has a favourable effect on body fat and body mass gain (Hamer and Chida, 2008). Walking also has known psychological benefits such as increased mood, cognitive function and creativity, as well decreased stress and depressive symptoms (Gidlow et al., 2016; Heesch et al., 2015). Furthermore, walking is often reported as individuals' most preferred method of physical activity (Booth et al., 1997). Alongside the physiological and psychological benefits, walking is a freely available activity, which does not require special skills or facilities, and can be done in a variety of settings. Therefore, typical barriers to physical activity engagement do not apply. Although a growing number of programmes focus on the promotion of daily activities such as walking, there is currently little understanding of what encourages and motivates individuals to engage in such activities. It is important to understand the underlying mechanisms involved in daily physical activity in order to create interventions that result in sustained increases in physical activity.

It is increasingly recognized that physical and social environments contribute to health-related behaviours, and in particular to physical activity (Sallis, Owen & Fisher, 2015). Accordingly, altering these environments is an important facilitator for behaviour change. The impact of environmental changes on health-behaviour is recognised by ecological and socio-ecological models of behaviours (Sallis, Owen & Fisher, 2015). These models propose that physical environments can restrict or facilitate behaviour by promoting certain actions and by discouraging others. The concept 'choice architecture', and the related term 'nudging', uses ecological principles by implementing a simple change in the environment to guide individuals towards a desired choice, without removing any alternatives (Thaler & Sunstein, 2008). Additionally, nudging interventions acknowledge the automatic nature of decisions and attempt to use automaticity to benefit health behaviour, rather than fight against it as in many traditional health campaigns (Thaler & Sunstein, 2008). As proposed by dual process models, two cognitive systems guide behavior: the impulsive system which guides behaviour in an automatic manner derived from learned responses to situational and environmental cues, and the reflective system which regulates these impulses through conscious deliberation based on long-term standards and goals (Strack & Deutsch, 2004). Accordingly, people often respond to cues in the environment impulsively, with little thought, because consciously reflecting on every alternative would be too time-consuming (Bargh & Morsella, 2010). While automatic tendencies can sometimes lead to choices that are disadvantageous because of a predisposition towards unhealthy options, nudging techniques use the automaticity of decisions to benefit people. Specifically, nudging strategies aim to implicitly direct people towards healthier behavioral options by making the healthy options more salient in the environment.

Point-of-decision prompts (PDPs) are a type of nudge that are thought to operate as 'cues to action' which motivate and guide people towards healthy alternatives (Rosenstock, 1990). PDPs employ persuasive signs to influence health-related behaviours (Boen et al., 2010; Dolan et al., 2006). Therefore, PDPs can be seen as an environmental modification that promote physical activity, and discourage sedentary behaviour. PDPs are found in many public spaces (stair-use signs, food-waste prompts in canteens) and on packaging of certain items (nutrition labels, tobacco warning messages on cigarettes), and have been found to be effective in increasing physical activity in a variety of different settings (Dunn et al., 1998; Foster et al, 2006). In particular, PDPs have been found to be effective in increasing physical activity by encouraging stair-use in workplaces (Blake et al., 2008; Eves, Webb & Mutrie, 2006), shopping centres (Webb, Eves & Kerr, 2011), train stations (Boen et al, 2010; Eves et al., 2009), health-care facilities (Marshall et al., 2002) and universities (Grimsvelt et al., 2010; Ford & Torok, 2008). Despite the accumulating amount of evidence supporting PDPs to increase stair-use, to date, no study has evaluated the impact of PDPs on walking as active travel. Therefore, the first aim of the current study was to investigate the effectiveness of a simple PDP to increase walking as a form of active travel. Given the many benefits and limited costs of walking, it is important to explore the applicability of PDPs on this form of physical activity.

Although a growing amount of evidence supports the efficacy of PDPs for increasing physical activity, several inconsistent results have previously been reported (Hollands et al., 2013). Several studies have found no significant increase in stair use from PDPs in community (Engelen et al., 2017; Nocon et al., 2010) and university settings (Adams & White, 2002), and some studies have even observed a negative effect of PDPs on physical activity engagement (Coleman & Gonzalez, 2001). However, most previous research has not considered how messages displayed on PDPs influence the underlying mechanisms that guide physical activity engagement. One such mechanism is motivation.

According to self-determination theory, there are two types of motivation: autonomous motivation and controlled motivation (Ryan & Deci, 2000). The basic distinction is that autonomous motivation occurs when behaviour is valued or enjoyed, whereas controlled motivation occurs when behaviour is performed due to an external pressure. suggests that one's social or environmental context may facilitate (or undermine) autonomous motivation (Ryan & Deci, 2000). Therefore, messages that emphasize autonomy should more effectively promote sustained behaviour engagement, compared to messages that do not emphasize autonomy (Deci & Ryan, 2008). In order for PDPs to effectively guide people to be more active, it is important to understand which types of messages are most effective in promoting activity behaviour. The limited previous research that has investigated the efficacy of certain communications on PDPs has focused on the stair/escalator context. Suri et al. (2014), conducted a series of studies to investigate the efficacy of messages that promote autonomy compared to messages that use commands, and therefore promote controlled motivation. In line with self-determination theory, PDP messages which promoted autonomy were more likely to result in sustained stair use, compared to messages which promoted controlled motivation (Suri et al., 2014). However, PDPs that featured commands, and therefore endorsed controlled motivation did also demonstrate efficacy for increasing immediate stair use (Suri et al., 2014). Furthermore, previous research has found that both autonomous and controlled motivation can operate on an implicit, or automatic, level (Evans, 2008; Keatley, Clarke & Hagger, 2013; Smith & DeCoster, 2000). Thus, individuals' tendencies to be active may be implicitly facilitated by the motivational message of a PDP. However, research on the motivational content of PDPs is limited, with most previous research neglecting psychological factors that influence nudging efficacy (Marchiori et al., 2017). Therefore, the second aim of the current study was to address this gap by investigating the effects of two different types of motivational PDP messages on walking engagement. We sought to investigate whether tapping into one's autonomous motivation by subtly nudging participants to be more active, or tapping into one's controlled motivation by using an explicit command telling participants to be more active, is more effective in increasing walking for active travel.

Self-determination theory further proposes that there are multiple motivational regulations which underpin motivation and guide behaviour differentially depending on the context of the behaviour or activity. These motivational regulations, known as the perceived locus of causality, vary in degrees of autonomous and controlled motivation and are perceived as a continuum. The most controlled form of motivation is external regulation (i.e., seeking external reinforcements and avoiding punishments), followed by introjected regulation (i.e., avoiding guilt or anxiety). Next on the continuum is an autonomous form of motivation, identified regulation (i.e., valuing the benefits of the activity), and lastly, the most autonomous form of motivation, intrinsic motivation (i.e., enjoying and valuing the activity). In relation to physical activity, autonomous motives have been consistently associated with sustained exercise engagement, and recent research has linked controlled forms of motivation to engagement in exercise (Caudwell & Keatley, 2016; Niven & Markland., 201; Teixeira et al., 2012). Autonomous and controlled motivational regulations have also previously been associated with a number of health-related behaviours, including incidental physical activities such as posture correction and active travel (Keatley, Clarke & Hagger, 2013; White et al., 2018). Furthermore, motivations for exercise have been found to shift and change depending on contexts, with people experiencing different, sometimes competing, forms of motivation for exercise simultaneously (Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010). Recent qualitative research has also demonstrated that the type of motivation (i.e., autonomous or controlled) experienced for incidental physical activity engagement (e.g., active travel) differs depending on the context (e.g., alone, out of necessity versus with others, out of choice) of such activities (White et al., 2018). Thus, motivation is subject to change depending on situations or contexts, and the limited research on incidental physical activities indicates that contextual motivation plays a role in influencing this behaviour (Keatley, Clarke & Hagger, 2013). However, no study has investigated how a situational change, such as being prompted by a PDP, affects individuals' motivation and behaviour. Therefore, the final aim of the current study was to investigate whether the presence of a PDP influences individuals' motivation for active travel, and guides subsequent activity engagement.

The current study used an experimental procedure to slightly modify the environment (i.e., nudge) in order to increase levels of walking. As nudging respects individuals' need for autonomy by not removing possible options, the current study placed a motivational PDP at a bus stop to subtly guide participants towards being more active by walking instead of catching the bus. Participants were asked to deliver a questionnaire to a location across campus, and were not aware that their chosen transportation option was being observed. Based on previous research utilizing PDPs (Dunn et al., 1998; Foster et al, 2006), it was hypothesised that more people would choose to walk across campus than take the free bus when a motivational PDP was present. Further, the current study investigated whether tapping into one's autonomous motivation by subtly encouraging participants to be more active, or tapping into one's controlled motivation by explicitly telling individuals to be more active, would be more effective at increasing walking. To test this, the efficacy of two signs were compared to a no-sign control group at increasing motivation and subsequent walking engagement. Individuals' motivation for their chosen mode of transportation was assessed by utilising an open ended singular question asking why participants chose their selected method of transportation (Bowling, 2005b). When exploring a new relationship, combining qualitative and quantitative data can enhance the interpretation of findings (Onwuegbuzie & Leech, 2004). As such, a quantitative measure was also incorporated to assess individuals' motivation for incidental physical activity more generally using a brief version of the Perceived Locus of Causality Questionnaire. Thus, the current study sought to provide insight into the influence of PDPs on motivation specific to the context of walking for active travel, as well as whether such motivation generalized to other incidental physical activities. Based on the limited previous research investigating motivational message content (Suri et al., 2014), it was hypothesised that the presence of an autonomously-oriented PDP would increase autonomous motivation specific for active travel, as well as autonomous motivation for incidental physical activity more generally. It was further anticipated that the presence of a control-oriented PDP would increase controlled motivation for active travel, and that this would generalize to controlled motivation for incidental physical activity. Finally, as proposed by self-determination theory, it was hypothesized that significantly more people would walk across campus if they were motivated by autonomous reasons for active travel and incidental physical activity, compared to being motivated by controlled reasons.

5.2 Method

Participants.

Ninety undergraduate students (31 males, 59 females) were recruited from the student population at an Australian University. Participants were aged between 17 and 57 years (M = 23.3, SD = 8.2). Participants were included if they spoke English fluently and were physically able and willing to travel to a location across campus. Three participants were removed from analyses due to incomplete data.

Study Design.

The study used a between-participants experimental design to test whether different types of PDPs (autonomous PDP, controlled PDP, no PDP) influence motivation (autonomous motivation, controlled motivation) and subsequent transportation choice (walk, bus).

Materials.

Individual characteristics and environmental factors.

Participants' age (in years), gender (male or female) and weight status (underweight/ normal weight/ overweight) were measured as these variables are known to influence physical activity levels (Kerr et al., 2001b; Webb & Eves, 2005; Webb & Eves, 2007). A standardized scale was used to code individuals' weight status (Webb & Cheng, 2010). The scale consisted of nine silhouettes of men and women, respectively, progressing from underweight to normal weight to overweight (Thompson & Gray, 1995). The end point for normal weight status was the fifth figure and the starting point for overweight status was the sixth figure. Weight status was coded by the researcher selecting the silhouette that most closely resembled that participant's. Copies of the silhouettes were attached to the researcher's clipboards; these were not seen by the participants. Choice of silhouette has been shown to be valid when compared to objectively measured BMI for both men (r = 0.63) and women (r = .074), and to have good test-retest reliability (men: r = 0.60), women (r = 0.66) (Thompson & Gray, 1995). Weather conditions (degrees Celsius, chance of rain and wind strength), time of day (in 24-hour time), luggage (none, a little, a lot) and traffic conditions (none, quiet, moderate, busy) were also measured.

Point-of-Decision Prompts.

A point-of–decision prompt was placed at the decision point to walk or catch the bus. The prompt was stuck to a wall, in clear view of the bus stop, and positioned so that the sign was integrated naturally in the environment (i.e., the PDP did not appear to be part of an experiment). Because previous studies have found that the visibility and size of the sign could influence the intervention (Kerr et al., 2001; Webb and Eves, 2005), a large sign, measuring 33.5in X 24in (A1 format), was used. Two different prompts promoting the active option (walking) rather than the sedentary option (catching the bus) were created for the experiment. In the autonomously-oriented condition the sign showed a picture of people enjoying walking across campus. In the control-oriented condition the sign explicitly told individuals to be more active (be active, walk!"). A control condition was also included, where no sign was present at the point of decision. To control for any order-effects, the PDP conditions (autonomously-oriented, control-oriented, no-sign) were displayed in a counter balanced order.

Transport choice.

Participants' chosen transportation choice to either walk across campus or take the loop bus, was observed by a researcher who was not visible to participants.

Motivation for transport choice.

Although interviews are perhaps the most common method of qualitative data collection, they can often lead to high levels of social desirability bias and can be impractical to incorporate into an experimental design (Bowling, 2005a). Self-administered questionnaires can increase respondents' willingness to answer honestly and reduce social desirability bias due to the absence of an investigator (Bowling., 2005a; Richman, Weisband, Keisler & Drasgow, 1999). As such, we incorporated an open-ended question into the questionnaire to encourage honest responses.

Participants were asked why they chose the mode of transport they selected at the end of the questionnaire. As exploring the role of motivation was driven by Self-determination theory, we coded participants' qualitative responses founded on self-determination theory tenets. Responses were coded as either an autonomous or controlled form of motivation based on Perceived Locus of Causality variables. Specifically, reasons that reflected identified regulation (e.g., "… I value the benefits of …"), and intrinsic motivation (e.g., "… I enjoy …") were coded as autonomously motivated. For example, reasons such as "walking is fun", "I like being outside", "I've never tried it before", or "I like walking (or taking the bus)", were coded as autonomous motivation as they reflected selecting the chosen transportation option for internal reasons of value and enjoyment. Reponses were coded as controlled motivated if they reflected external regulation (e.g., "… I feel under pressure to …"), or introjected regulation (e.g., "… I will feel guilty if I do not …"). For example, reasons such as "I will be late", "someone told me to" or "I feel guilty for not exercising today" were coded as controlled motivation as they reflected selecting the chosen transportation option for external pressures or constraints. Responses that related to injuries (e.g., “I have a sprained ankle”) were coded separately as physical restrictions and were excluded from analyses.

Motivation for incidental physical activity in general.

A modified Perceived Locus of Causality questionnaire (Ryan & Connell, 1989) was used to quantitatively measure autonomous and controlled forms of motivation for incidental physical (daily activity, walking, household activities, taking the stairs). Participants were presented with common word stems that related to incidental physical activity (i.e., “I use the stairs instead of an elevator or escalator because …”) that were followed by eight reasons for participating in that physical activity. Four of the reasons reflected autonomous forms of motivation, with two reasons reflecting identified regulation (e.g., “… I value the benefits of …”), and two reflecting intrinsic motivation (e.g., “… I enjoy …”). Responses were recorded on 5-point scales ranging from (1) “not true at all” to (5) “very true”. The remaining four reasons reflected controlled forms of motivation. Specifically, two reasons reflected external regulation (e.g., “… I feel under pressure to …”) and two reasons reflected introjected regulation (e.g., “… I will feel guilty if I do not …”). Following the procedure of Hagger et al. (2014), an autonomous motivational regulation index was computed as the sum of the intrinsic motivation scale weighted by a factor of two, plus the identified regulation item. Similarly, the controlled motivational regulation index was computed as the sum of the external regulation scale weighted by two, plus the introjected regulation scale.

Procedure

Most previous studies investigating PDP effects have predominantly been conducted in the community where many extraneous variables (e.g., individual time pressure, traffic flow, physical restrictions and environment familiarity) occur. To account for these confounding factors, the current study was conducted on a university campus, with the following inclusion criteria: physically able to commute across campus (eliminating physical restrictions), a 30-minute time commitment (eliminating individual time pressure), and a current university student (ensuring environment familiarity). Additionally, the study was held between 10am and 4pm, reducing the effect of peak hour traffic.

The experiment took place at the main campus of an Australian University and ran across eight weeks on weekdays during university semester. Participants met the researcher at the free University Loop Bus stop where they were provided with an information sheet about the experiment and a consent form to complete if they chose to participate. The University Loop Bus stop was chosen for the location of the experiment for a number of reasons. First, this particular bus stop was chosen as walking and catching the bus to deliver the questionnaire took an equal amount of time. Second, the individual was faced with a binary choice, which was easily observable and measurable. Third, the location was central to the campus and therefore familiar to participants, who were all students. Finally, as the walk to the questionnaire delivery location was uphill and involved some stairs it required adequate energy expenditure; however, the walk was manageable and un-daunting. Participants were scheduled so that each session began 10 minutes before the next bus was due to arrive, providing participants with enough time to complete the questionnaire and then promptly decide whether to take the loop bus, or walk across campus to deliver the questionnaire.

Upon reading the information sheet and completing the consent form, participants were provided with the short questionnaire, as well as written and verbal instructions on how to reach the delivery location for the questionnaire. Participants were provided with two transport options: walk across campus, or catch the free loop bus. A map with a clearly outlined walking route, as well as a loop bus timetable, were provided in counterbalanced order. Participants were thanked for their time and informed that the researcher had to go set up for the next participant, and were left to complete and deliver the questionnaire in private. The researcher relocated to a position that was not visible to participants from where their transportation choice was directly observable. Once the questionnaire was complete, participants delivered the questionnaire to a location across campus. When the participants had reached the location, they placed the questionnaire in a clearly signed and securely locked letterbox.

5.3 Results

Participants.

Table 1 presents the socio-demographic information of the sample (age, gender and weight status) as well as environmental factors (weather, time of day, luggage and traffic condition). There were no significant differences between conditions on any of these variables, as shown in Table 2. There were also no significant differences between the socio-demographic and environmental factors between conditions (Table 2). Therefore, these variables were not included in subsequent analyses as covariates (Ball et al., 2001). A one sample t-test revealed that significantly more participants chose the active transport option (68%) compared to the sedentary transport option across all conditions $t(89, N = 90) = 33.87$, $p = .000$. Power analyses revealed that power to detect significant effects at the .05 level was .87 for the regression analysis predicting transportation choice, .94 for the analysis of variance of autonomous motivation predicting transportation choice .81 for the analysis of variance of controlled motivation predicting transportation choice.

Effect of point-of-decision prompts on transportation choice.

A chi-square test of independence was performed to examine the effect of PDP type (autonomous, controlled, no sign control) on transportation choice (bus or walk). Results showed no significant of effect of PDP type on transportation choice, $X(2, N = 90) = .677$, $p = .713$, indicating that neither the autonomous nor the controlled PDP had a significant effect on participants' choice of transportation. Interestingly, across conditions the majority of participants chose the active transport option, with 67% selecting to walk in the presence of an autonomously-oriented PDP, 73% in the presence of a control-oriented PDP, and 63% in the no sign control group.

Table 1.
Descriptive statistics for sample characteristics.

	M	SD	%
Gender			
Male			35
Female			65
Age (years)	23.3	8.2	
BMI			
Underweight (1)			0
Healthy (2-5)			83
Overweight (6-7)			17
Degrees	17.8	3.34	
Wind			
Calm (0km/h)			38
Light (<19km/h)			57
Moderate (20-39km/h)			3
Fresh (30-39km/h)			2
Strong (40-50 km/h)			0
Above 50 km/h			0
Rain			
Yes			3
No			97
Luggage			
None			80
A little			20
A lot			0
Traffic			
None			3
Quiet			90
Moderate			4
Busy			2
Time			
Morning (9am - 12pm)			49
Afternoon (12-4pm)			51
Transport choice			
Bus			33
Walk			67
Autonomous motivation for transport			63
Controlled motivation for transport			37
Autonomous motivation for incidental physical activity	25.1	12.1	
Controlled motivation for incidental physical activity	20.4	12.8	

Table 2.

Inferential tests of differences between conditions and transportation choice

Variables	Condition f(2)	Transport t(88)
Age	1.12, p = .33	1.35, p = .18
Gender	0.63, p = .54	0.994 p = .32
Weight Status	0.052, p = .95	1.42 p = .16
Degrees	0.338, p = .71	0.368, p = .714
Wind	0.079, p = .92	0.453, p = .651
Rain	0.50, p = .61	1.296, p = .20
Time of Day	0.043, p = .96	0.526, p = .60
Luggage	0.057, p = .96	0 .451, p = .65
Traffic Conditions	0.818, p = .46	0 .014, p = .99

Relationship between motivation and transportation choice.

A chi-square test of independence was performed to examine the relationship between transportation choice (bus or walk) and individuals' specific motivation for transportation (i.e., autonomous reason or controlled reason). The relationship between transportation choice and motivation type was significant, $X(1, N = 90) = 23.76, p < .05$. Participants who chose to walk were motivated by autonomous reasons (88%), whereas participants who chose to take the bus were motivated by controlled reasons (68%).

Separate linear regression analyses were conducted to examine the relationship between transportation choice (walk or bus) and autonomous motivation and controlled motivation for incidental physical activity more generally. We found no significant relationship between transportation choice and autonomous motivation, $B = 3.644$, $t(1, 88) = 1.36$, $p = .18$, or controlled motivation, $B = 2.49$, $t(1, 88) = .792$, $p = .430$, indicating that participants' type of motivation for incidental physical activity in general did not influence their decision to choose the active option and walk, or the sedentary option and take the bus.

Effect of point-of-decision prompt on motivation for transport and transportation choice

Separate analyses were conducted to independently investigate the effect of each PDP on autonomous and controlled motivation for transportation and individuals' subsequent transportation choice. Specifically, separate chi-square tests of independence were performed to investigate whether autonomously-oriented or controlled-oriented PDPs affected individuals' motivation for transportation and walking engagement.

For the autonomously-orientated PDP group, the relationship between transportation choice and autonomous motivation was significant, $X(1, N = 90) = 4.62$, $p = .03$, whereas the relationship between transportation choice and controlled motivation was not, $X(1, N = 90) = 1.79$, $p = .181$. Figure 1 shows the percentage of people who chose to walk or take the bus for autonomous or controlled reasons in the autonomously-orientated PDP group. As can be seen, a significantly higher number of participants reported walking for autonomous reasons, compared to controlled reasons, when an autonomously-oriented PDP was present.

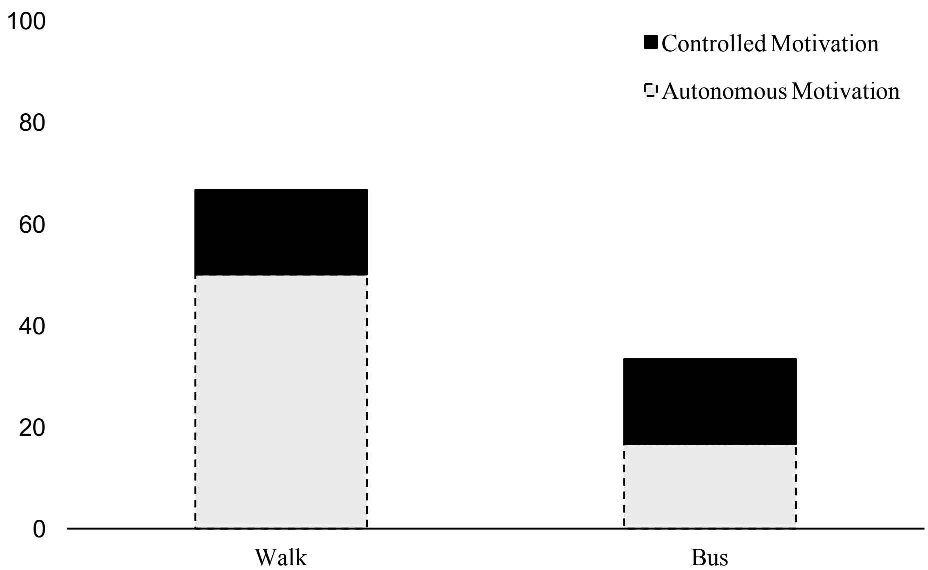

Figure 1. Percentage of people who chose the active or sedentary transport option due to autonomous motivation or controlled motivation in the autonomously-oriented PDP group.

By contrast, for the control-oriented PDP group, we found no significant relationship between transportation choice and either autonomous motivation, $X(1, N = 90) = .081$, $p = .775$, or controlled motivation, $X(1, N = 90) = 1.09$, $p = .296$. Therefore, the presence of a controlled PDP did not influence participants' motivation for transportation or their transportation choice.

Finally, in the no-sign control group, the relationship between transportation choice and autonomous motivation fell just short of significance, $X(1, N = 90) = 3.68$, $p = .057$, and the relationship between transportation choice and controlled motivation was statistically significant, $X(1, N = 90) = 5.3$, $p = .021$. Figure 2 illustrates the percentage of people who chose to walk or take the bus for autonomous or controlled reasons in the no-sign control group. As shown, controlled motivation was a significant predictor of individuals' transportation choice, in that individuals who selected to take the bus did so because of controlled reasons.

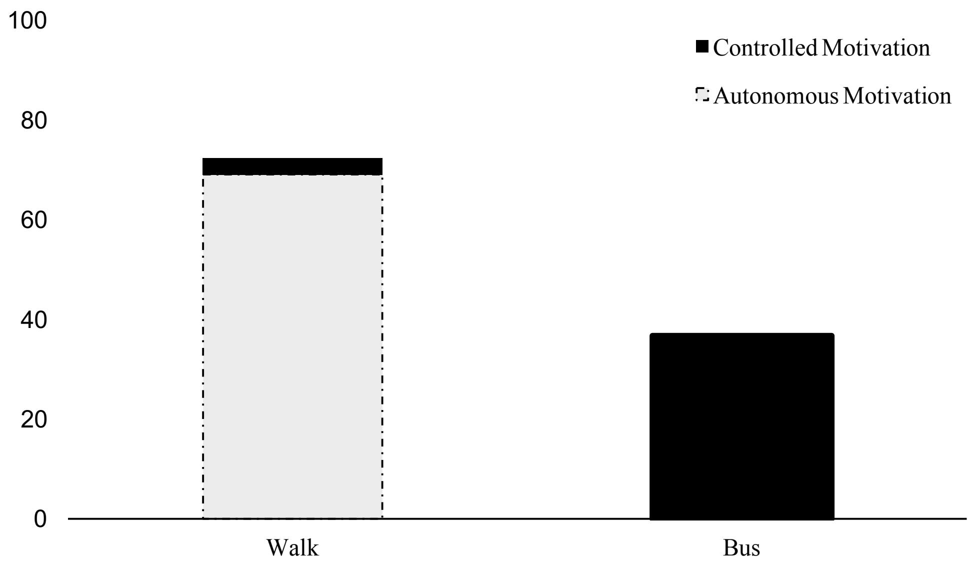

Figure 2. Percentage of people who chose the active or sedentary transport option due to autonomous motivation or controlled motivation in the no-sign control group.

Effect of point-of-decision prompt on motivation for incidental physical activity and transportation choice.

Separate analyses of variance were conducted to independently investigate the effect of each PDP on levels of autonomous and controlled motivation for incidental physical activity in general and participants' subsequent transportation choice. Specifically, 2 (PDP type: autonomous, controlled) by 2 (transport choice: bus, walk) between-groups analyses of variance were conducted to assess the effectiveness of PDPs at increasing levels of autonomous or controlled motivation for incidental physical activity, and at guiding subsequent walking engagement. Preliminary checks were conducted to ensure that there was no violation of normality, linearity, homogeneity of variances, homogeneity of regression slopes and reliable measurement of the covariate.

In the analysis of the effect of PDPs on autonomous motivation for incidental physical activity, there was a main effect of PDP type that trended towards significance, $F(5,84) = 2.92$, $p = .057$. However, the main effect of transport choice, $F(5,84) = .865$, $p = .355$, and the interaction effect between PDP type and transport choice $F(5,84) = .257$ $p = .774$, were not significant. Thus, although there was a trend for autonomous motivation to differ depending on the type of PDP that was present, the effect of the PDPs on autonomous motivation was not associated with transportation choice.

Simple main effects analysis was conducted to further investigate the effect of PDP type on autonomous motivation for incidental physical activity. As can be seen in Figure 3, autonomous motivation was significantly higher for participants who were exposed to the autonomously-oriented PDP ($M=29.59$, $SD = 13.27$) compared to the no-sign control ($M = 22.77$, $SD= 11.83$), $t(58)= 2.007$, $p =.049$. The difference in autonomous motivation between those exposed to the autonomously-oriented PDP and the control-oriented PDP fell just short of significance, ($M= 17.52$, $SD= 11.47$), $t(58) = 1.966$, $p = .054$. There was no significant difference between those exposed to the control-oriented PDP and the no-sign control, $t(58) =.157$, $p= .876$. Results suggest that autonomous motivation was significantly higher for those exposed to an autonomously-oriented PDP compared to those not exposed to an autonomous PDP.

In the analysis of the effect of PDPs on controlled motivation for incidental physical activity, there was a significant main effect of PDP type, $F(5, 84) = 3.151$, $p = .048$, but no significant main effect of transport choice $F(5,84) = .237$, $p = .628$, or interaction, $F(5,84) = .575$, $p =.656$. Thus the type of PDP displayed influenced controlled motivation for incidental physical activity, but the effect of the PDPs on controlled motivation was not associated with transportation choice. As can be seen in Figure 4, simple main effects analysis showed that controlled motivation was significantly higher when participants were

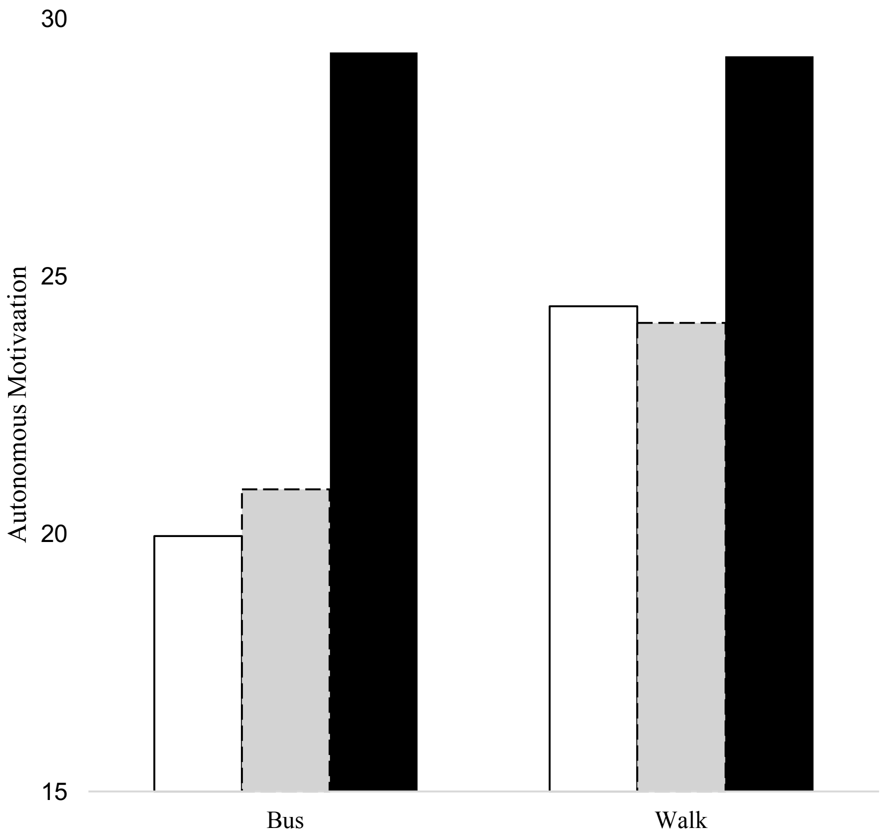

Figure 3. Main effects plot of autonomous motivation for incidental physical activity and transportation choice by point-of-decision prompt condition

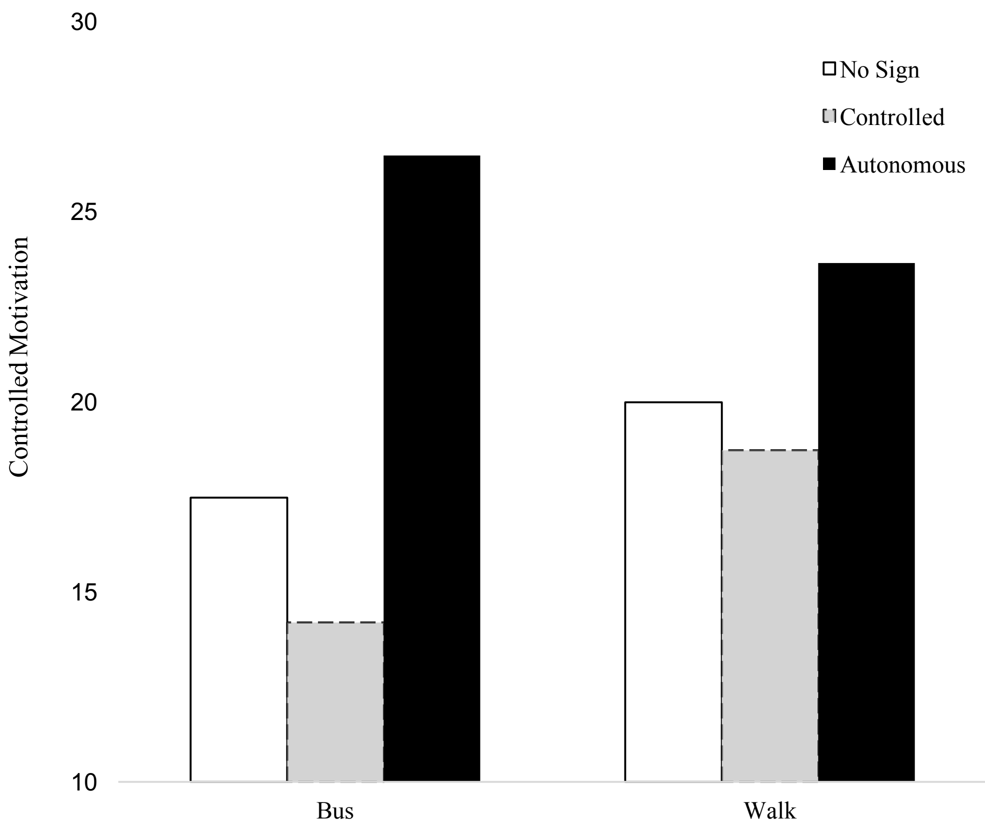

Figure 4. Main effects plot of controlled motivation for incidental physical activity and transportation choice by point-of-decision prompt condition

exposed to the autonomously-oriented PDP (M = 24.59, SD = 14.57) compared to the control-oriented PDP (M= 17.52, SD= 11.47), $t(58)$= 2.086, p =.041. However, there was no significant difference in controlled motivation between those exposed to the autonomously-oriented PDP and the no-sign control (M = 19.06, SD= 11.45), $t(58)$ = 1.632, p = .108, or between those exposed to the control-oriented PDP and the no sign control, $t(58)$ = .520, p =.605. Results suggest that controlled motivation was significantly higher for those exposed to an autonomously-oriented PDP compared to a control-oriented PDP.

5.4 Discussion

The current study investigated the effectiveness of two simple Point-of-Decision Prompts (PDP) at increasing individuals' motivation and subsequent engagement in walking for transportation. Although the presence of neither an autonomously-oriented nor a control-oriented PDP determined choice of active transportation, individuals displayed higher levels of autonomous motivation when an autonomously-oriented PDP was present. Furthermore, motivation for transportation predicted transport choice, such that individuals who chose to walk were motivated by autonomous reasons whereas individuals who chose to take the bus were motivated by controlled reasons. Findings suggest that PDPs may not directly increase active transportation engagement; however, autonomously oriented PDPs may be beneficial for individuals' motivation, which in turn influences behaviour.

The current study uniquely investigated the effectiveness of two motivational PDPs to promote walking as active travel on a university campus. The effect of the motivational PDPs to promote walking were not clear-cut. We observed no effect on walking engagement. Across all conditions, significantly more participants chose to take the active transport option compared to the sedentary transport option of taking the bus. Considering that the rate of participants' decisions to walk was high across conditions, it is perhaps not all that surprising that the presence of a PDP did not further increase walking engagement. This lack of effect on walking engagement is in accordance with some previous studies that have found no significant increase of stair use from PDPs in community (Engelen et al., 2017; Nocon et al., 2010; Coleman & Gonzalez, 2007) and university settings (Adams & White, 2002). Furthermore, previous studies comparing signs with different message content (e.g., positive vs negative messages; individual oriented vs group oriented) have found no significant difference regarding the efficacy of the signs at increasing activity engagement (Cooley, Foley & Magnussen, 2008; Coleman & Gonzalez, 2001). However, in contrast to the current study, these studies did not consider the specific motivational basis of the message content. Here, we specifically compared PDPs displaying an autonomous message versus a controlled message. We found that the presence of an autonomously-oriented PDP was effective at increasing autonomous motivation for active transportation, whereas a control-oriented PDP had no effect on motivation for active transportation.

The finding that the autonomously-oriented PDP increased feelings of autonomy towards active transportation is of particular importance. One of the main objectives of nudging is for individuals to ultimately increase their intrinsic motivation and form a positive attitude towards the target behaviour (Elliot & Covington, 2001). Our findings indicate that this may be possible in the presence of an autonomously-oriented PDP. Furthermore, experiencing feelings of autonomy has been consistently associated with increased feelings of wellbeing (Ryan & Deci, 2008). Indeed, White et al. (2018) found that participation in active travel for autonomous reasons was beneficial for mental wellbeing in adolescents. Thus, although the presence of an autonomously-oriented PDP may not be sufficient to implement behaviour change, the presence of such signs could benefit wellbeing by increasing feelings of autonomy. However, no study has yet investigated the effects of motivational PDPs on wellbeing. It is recommended that future studies investigate this relationship specifically for autonomously-oriented PDPs.

Another key finding of the current study was that individuals motivated by autonomous reasons specific for walking were significantly more likely to choose the active transportation option compared to participants motivated by controlled reasons. This finding supports and extends previous research that has established the importance of autonomous forms of motivation for exercise engagement and maintenance (Teixeira et al., 2012), and adds to the growing body of evidence that has found associations between autonomous motivation and incidental physical activities (Oliver & Kemps, 2018; Hagger et al., 2014). The current study suggests that autonomous motivation is similarly beneficial specifically for walking for transport. Taken together, the findings that levels of autonomous motivation were higher in the presence of an autonomously-oriented PDP, and that autonomous motivation significantly predicted active travel engagement, suggest that an autonomously-oriented PDP may benefit active travel engagement by means of increasing autonomous motivation. Therefore, the current results point to a benefit for autonomously-oriented PDPs, which warrants further investigation.

Notably, the control-oriented PDP did not influence individuals' motivation for transportation or engagement in active travel. Although this finding is not in line with the limited previous research that has found that PDPs which endorse controlled motivation are effective at increasing stair use, it provides support for self-determination theory which posits that controlled incentives have limited motivational sway and are usually ineffective for behaviour change (Suri et al., 2014; Ryan & Deci, 2008). To our knowledge, the current study was the first to directly investigate the influence of PDP messages on individuals' motivation for active transportation. Previous research utilising PDPs to increase physical activity has used a combination of autonomous and control-oriented PDPs, and has yielded inconsistent results (e.g. Badland & Schofield, 2005; Eves & Masters, 2006). Our findings suggest that the aforementioned findings may be due to previous PDPs targeting ineffective psychological mechanisms, such as controlled motives (e.g., highlighting potential weight loss and health benefits) involved in activity engagement. Thus, the current finding that a control-oriented PDP is ineffective at promoting motivation and engagement in active travel provides important insight into the underlying psychological mechanisms involved in PDP strategies. In doing so, it addresses an important gap in the literature and lends understanding into which type of PDP messages are the most (in)effective in promoting active travel (Marchiori et al., 2017)

The current study also found differences between the effect of an autonomously-oriented and a control-oriented PDP on individuals' motivation for incidental physical activity more generally. Specifically, when an autonomously-oriented PDP was present, individuals reported higher levels of controlled motivation for incidental physical activity, and a similar trend for autonomous motivation. This finding is in line with previous research which has demonstrated that individuals can experience more than one form of motivation at the same time (Oliver & Kemps, 2018; Lindwall et al., 2017; O'Dougherty, Kurzer & Schmitz; 2010; Stephan, Boiche & LeScanff, 2010). Findings also lend support to the generality of PDPs, as it appears that the presence of an autonomously-oriented PDP can influence motivation specific to the context (i.e., motivation for active travel), as well as motivation for more wide-ranging incidental physical activities. However, research investigating the behavioural and psychological spill-over effect of PDPs is scarce, and is an important avenue for future research (Marchiori et al., 2017).

There are a few methodological limitations of the study that should be mentioned. First, although the signs were placed for maximum visibility, there was no guarantee that all participants saw or read the content of the PDPs. Therefore, it is possible that the current study found no effect of PDPs on walking engagement as participants did not engage with the PDPs. Future research would benefit from including a debriefing question at the end of the study to measure how many participants saw the signs. However, as the current study proposed that PDPs would influence behavior on an automatic level, no measure of sign engagement was included. Previous research has found that the level of engagement with PDPs can influence decisions to take the stairs or escalator (Suri et al., 2014). Future research could investigate whether motivational content on PDPs influences active travel differently depending on the amount of time participants have to engage with PDP message content. Second, participants were asked a number of questions regarding their motivation for a variety of behaviours, including physical activity behaviours, prior to making the decision to walk or take the bus. It is possible that these questions raised suspicions about the aim of the study and primed participants to be more active. Suspicion probes should be utilized in future research to check whether participants are aware of the study aim. Third, a relatively small number of participants were recruited from a student population, and therefore caution is warranted interpreting these results. For future studies, it is important to include a larger and more representative group of participants to examine whether the findings of this study also apply to the general population. Finally, although the current study included a number of previously identified confounders of physical activity, measuring additional confounders (e.g., type of shoes worn, physical health, energy level and past typical campus-commuting behavior) could be of value in future research.

Findings from the current study have a number of theoretical implications. Results provide support for self-determination theory, as autonomous motivation for transportation was found to predict walking behaviour (Ryan & Deci, 2008). Self-determination theory suggests that individuals who act for autonomous reasons are more likely to initiate and persist with the behaviour (Deci & Ryan, 2000). Our findings suggest that this notion extends to active transportation. Our findings similarly suggest that messages (i.e., PDPs) that emphasize autonomy are more effective at promoting behaviour engagement, compared to messages that do not emphasize autonomy, as the presence of a control-oriented PDP did not influence individuals' motivation for transportation or engagement in active travel (Deci & Ryan, 2008). Therefore, findings also support traditional self-determination theory which suggests that optimal results occur due to autonomous forms of motivation, rather than controlled forms of motivation (Ryan & Connell, 1989). Findings of the current study also lend limited support to dual process models, as an implicit environmental cue (i.e., the presence of an autonomously-oriented PDP) influenced individuals' conscious motivation, and motivational quality predicted behaviour engagement. Findings suggest that PDP prompts may not directly increase active transportation engagement; however, implicit autonomously oriented PDPs may be beneficial for individuals' motivation, which in turn guides behaviour. Additionally, although the current study did not find an effect of a subtle alteration in the environment (i.e., introduction of a PDP) on walking engagement, engagement in the active travel option was considerably high across conditions, indicating that people are likely to opt for an active transport option if it is available, known and feasible. Socio-ecological models propose that facilitative environments are beneficial for physical activity engagement (Sallis, Owen & Fisher, 2015). Therefore, the current study provides some support for socio-ecological models, as most individuals were active in what would be considered a facilitative environment.

In terms of practical implications, our findings suggest that it would be beneficial to tailor motivational intervention techniques to target autonomous motivation and focus on specific types of physical activity. Programs should aim to increase autonomous motivation, rather than controlled motivation, as only autonomous motivation appears to benefit active transportation. Furthermore, programs looking to increase levels of incidental physical activity should focus on motivation for a specific target activity (e.g., walking for active travel), rather than motivation for incidental physical activity more generally, as only motivation specific for active travel was related to activity engagement. Furthermore, the current study found that the presence of an autonomously-oriented PDP increased autonomous motivation for active transportation, but this did not immediately translate into a behavioural change. It is therefore likely that other factors play a role in facilitating behaviour engagement. Previous research has found that individuals need to feel competent and accepted by others to adopt walking behaviour, and that autonomy is particularly pertinent in facilitating adherence (Kinnafeck et al., 2014). Future researchers should keep this in mind when designing PDPs. It may be that to increase immediate behaviour, PDP messages should emphasize competence and social connections, and that autonomous PDPs may be of more value in assisting individuals to persist with a behaviour. Finally, our findings encourage the development of communities that offer walking routes, as individuals appear to opt for these routes, even without prompts.

In conclusion, the current study investigated the effectiveness of two PDPs on individuals' motivation and walking engagement in a university setting. Our findings suggest that contextual autonomous motivation can predict active travel engagement, and that an autonomously-oriented PDP benefits autonomous motivation for active transport. Findings therefore provide support for self-determination theory and contributes to the limited research investigating the underlying psychological mechanisms involved in the efficacy of PDP messages.

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CHAPTER 6: STUDY 5

The contributions of motivation, neighbourhood satisfaction and incidental physical activity to well-being

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Abstract

Background: A growing knowledge base suggests that well-being is independently associated with motivation, incidental physical activity and satisfaction with one's neighbourhood; however, the inter-relationships between these factors remain to be determined. Understanding the inter-relationships between well-being, physical activity and the modern urban environment is important to develop effective sustainable strategies to enhance health and well-being. Informed by self-determination theory and socio-ecological models, this study investigated how motivation (autonomous and controlled), incidental physical activity and neighbourhood satisfaction contribute to well-being.

Method: Using an online cross-sectional design we investigated how motivation-type and incidental physical activity interact to predict well-being, and the role of neighbourhood satisfaction in this relationship.

Results: The relationship between autonomous motivation and well-being was moderated by incidental physical activity levels, and neighbourhood satisfaction mediated this relationship. Specifically, the positive contribution of autonomous motivation to well-being was dependent on whether individuals were satisfied with their neighbourhoods, and whether they engaged in high levels of incidental physical activity.

Conclusion: Findings provide support for self-determination theory as autonomous motivation was a key contributing factor to incidental physical activity engagement and well-being. Furthermore, findings indicate that neighbourhood satisfaction, motivation and incidental physical activity together play an important role in increasing overall well-being. The present study adds to the limited research investigating the combined roles of incidental physical activity and environmental factors for well-being.

Key words: *incidental physical activity, neighbourhood satisfaction, motivation, well-being, self-determination theory*

6.1 Introduction

The importance of enhancing well-being, as opposed to merely treating a mental disorder, is now widely considered fundamental for mental health (Slade, 2010). Well-being encompasses a range of domains including emotions, relationships, productivity and physical health, and refers to a state in which individuals thrive in these areas (Kinderman et al., 2011). It has now been established that engaging in intentional physical activity (i.e., exercise) has many psychological benefits (e.g., decreased levels of anxiety, depression, tension and anger, increased vigour) and promotes well-being (De Moor et al., 2006; Strawbridge et al., 2002; Pendo & Dahn, 2005). However, social and economic advancements have made it harder to engage in physical activity due to easy access to motorized transportation, sitting-based jobs, and availability of labour-saving devices, resulting in a sedentary lifestyle becoming the norm (Prentice & Jebb, 1995). Understanding the relationships between well-being, physical activity and the modern urban environment is therefore imperative for developing effective sustainable strategies to enhance well-being; yet the nature of these relationships remains unclear.

Despite the widely known health benefits of exercise, sedentary lifestyles continue to threaten the mental well-being of mass populations. Incorporating short bouts of physical activity is a sustainable strategy to overcome common barriers to exercise engagement (e.g., not having enough time or finding exercise inconvenient) (Kremers, Eves & Anderson, 2012). While exercise is typically conceptualized as structured, planned and purposeful, non-exercise related physical activity, or incidental physical activity, does not require special planning or preparation. Incidental physical activities are unstructured, such as walking for transport, housework and the performance of activities of daily living (e.g., walking to the printer, standing on the train instead of sitting). Despite an accumulating amount of evidence providing support for the physiological benefits of increased incidental physical activity (Villablanca et al., 2015), there has been limited research investigating incidental physical activity and its association with well-being. The limited body of research that has examined the relationship between incidental physical activity and mental health has yielded promising findings. Lathia et al. (2017) found that individuals were happier in moments when they were more active, including when engaging in incidental physical activity, and physical inactivity was associated with poorer psychological health. Thus, the frequency with which people are active, even if the movement is not rigorous exercise, has been associated with happiness. However, research in this domain is limited and the mechanisms or processes underlying the relationship between incidental physical activity and well-being are not well understood (Maas et al. 2009; Sugiyama et al. 2008). Thus, important questions remain as to how and why such beneficial effects occur.

Although positive associations between intentional physical activities (i.e., exercise) and well-being have been demonstrated, it is recognised that this relationship is complex, as not all individuals who participate in physical activity experience greater well-being (Biddle & Ekkekakis, 2005; O'Connor & Puetz, 2005; Scully et al., 1998). Previous research has highlighted that merely engaging in intentional physical activity (i.e., amount) is insufficient to benefit psychological well-being. The motivational quality driving a behaviour has been identified as a key contributing factor to well-being outcomes and physical activity engagement (Teixeira et al., 2012). Self-determination theory proposes that there are two overarching types of motivated behaviour: autonomous and controlled behaviour (Deci & Ryan, 2008). Behaviour performed out of choice or to experience pleasure and satisfaction inherent in the activity is considered 'autonomous'. By contrast, behaviour performed to achieve some separable goal, such as achieving rewards (e.g., weight loss) or avoiding punishment is considered 'controlled'. It is further proposed that these motivational aspects of behaviour contribute to differences in well-being. It is argued that while autonomous behaviours (e.g., seeking affiliation or challenge) benefit well-being, controlling behaviours (e.g., seeking social recognition or appearance improvement) are the cause of distress and behavioural pathology (Ryan & Deci, 2000).

Autonomous motivation has consistently been found to be beneficial for exercise engagement persistence, and well-being (Chatzisarantis et al., 2003; Deci & Ryan, 2008). Autonomous exercise motives have been associated with increased exercise engagement (Sebire et al., 2009) as well as multiple psychological benefits including increased enjoyment and positive affect in relation to exercise (Sebire et al., 2009; Fortier et al., 2012; Raedeke, 2007; Guérin & Puente & Anshel, 2010), and lower stress in long-term exercisers (Maltby & Day, 2001). On the contrary, controlled exercise motives have been associated with lower well-being (Ryan & Deci, 2006; Markland & Ingledew, 2007). Specifically, controlled forms of motivation have been linked to body image concerns, eating disorder symptomology and excessive exercise (Gonzalez-Cutre & Sicilia, 2012; Thorgersen-Ntoumani, & Ntoumanis, 2007). The implication of these and other findings (e.g., Brown et al., 2004) is that merely engaging in exercise, in terms of amount and/or intensity, may be insufficient to accrue benefits in well-being. Indeed, the process by which exercise may or may not benefit well-being is much more sophisticated and depends on the circumstances under which exercise engagement occurs (Berger & Motl, 2000; Biddle & Ekkekakis, 2005; Ekkekakis, Parfitt, & Petruzzello, 2011). Specifically, the motivational quality underlying exercise engagement is an important factor that assists in explaining the conditions under which exercise benefits well-being (Guérin & Fortier, 2013). However, there is currently little understanding of the circumstances under which incidental physical activity may benefit well-being.

Similar to exercise, there is some evidence to suggest that autonomous motivation influences incidental physical activity engagement and feelings of well-being (White et al., 2018; Keatley, Clarke & Hagger., 2013; Hagger et al., 2014). Autonomous motivation has been found to directly predict posture correction behaviour, a form of incidental physical activity (Dickin et al., 2017; Keatley et al., 2013; Lerma et al., 2016; Levine, 2007; Levine, 2003; Levine, Scheusner & Jensen, 2000), and recent qualitative research has found that autonomously motivated incidental physical activity (i.e., active travel) was associated with positive affect (White et al., 2018). However, recent research has also found positive associations between both autonomous and controlled motivation and incidental physical activity engagement; however, the relationship with well-being was not investigated (Oliver & Kemps, 2018). Thus, research regarding motivation and incidental physical activity is limited and further investigation is required to develop interventions with lasting effects on both incidental physical activity engagement and well-being (Teixeira et al., 2012b). Moderation frameworks with self-determined motivation have proven useful in explaining well-being outcomes (Lemyre, Roberts, & Stray-Gundersen, 2007). Specifically, the quality of motivation guiding behaviour engagement is proposed to be an important condition for understanding the behaviour-well-being relationship (Deci & Ryan, 1985; 2000). According to self-determination theory, motivation quality can be distinguished along a continuum from controlled motivation (i.e., behaviour resulting from demands and/or pressure) to more autonomous or self-determined motivation (i.e., behaviour arising from elements of volition, choice, and interest; Deci & Ryan, 1985). It is proposed that the more autonomous one's motivational quality is, the more likely one will engage in physical activity and experience feelings of well-being as the behaviour is more inherently satisfying and rewarding.

Therefore, applying principles from self-determination theory, the first aim of the current study was to investigate the moderating effect of motivational quality (i.e., autonomous or controlled) on the relationship between incidental physical activity and well-being. Considering the established physical health benefits and limited costs of incidental physical activity, it is important to understand how the motivational quality of this form of activity contributes to overall well-being. According to self-determination theory, intervention strategies that aim to increase incidental physical activity levels using controlled forms of motivation (e.g., use of commands or appearance improvement messages) may have detrimental effects on well-being (Ryan & Deci, 2008). Therefore, it is important to investigate this relationship for interventions to effectively increase incidental physical activity levels and benefit well-being.

In addition to motivation, there is increased recognition of the role of neighbourhood environments for well-being. Socio-ecological models propose that physical and mental health are supported or hindered by built environments (any human-modified or man-made environmental feature such as houses, workplaces and roads) (Sallis, Owen & Fisher, 2015). Indeed, well-being has been independently associated with satisfaction of the local neighbourhood environment. A negative perception of one's own neighborhood has been found to increase the risk of poor health (Wen et al., 2006; Wilson et al., 2004), and satisfaction with specific neighbourhood characteristics such as access to amenities, crime, traffic and safety have all been related to psychological well-being (Leslie & Cerin, 2008; Araya et al., 2006). In particular, Wilson et al. (2004) found that people who dislike aspects of their neighbourhood's physical environment are more likely to report poor mental health than those who like it. Living in a neighbourhood considered dangerous has also been found to be emotionally distressing (Sampson & Raudenbush, 1999), and general health and depression have been associated with perceived traffic stress (Gee & Takeuchi, 2004). In addition, Leslie and Cerin (2008) found that neighbourhood satisfaction (i.e., safety and walkability, access to destinations, social network, travel network, and traffic and noise) mediated the association between perceived environmental characteristics and self-rated mental health. Thus, satisfaction with the local neighbourhood is an important contributing factor to well-being.

Neighbourhood satisfaction has also been associated with incidental physical activity engagement (Merom et al., 2009; Hall & McAuley, 2010; Gay et al., 2011). Although findings are still equivocal, neighbourhood design (i.e., street connectivity, sidewalks, mixed land use), proximity and accessibility to destinations or walking facilities (i.e., parks, trails), neighbourhood attractiveness, traffic, safety, street-lights, and hilliness (i.e., neighbourhood satisfaction characteristics) have all been shown to correlate with walking regardless of whether objective or perceived measures of the environment are used (Cerin et al., 2007; Leslie et al., 2005; Saelens & Handy, 2008). Furthermore, preliminary evidence exists for a relationship between satisfaction with one's neighbourhood and motivation for physical activity. Perceived neighbourhood quality has previously been associated with autonomous motivation for walking, moderate-intensity, and vigorous-intensity physical activity (McNeil et al., 2006), and motivational aids (e.g., teaching self-regulation strategies, such as goal setting, self-monitoring, and recording of steps in a self-help walking program) have been found to be beneficial for walking engagement in unsupportive environments (Merom et al., 2009). Indeed, Zhang and Solmon (2013) proposed integrating neighbourhood environmental factors with self-determination theory based variables to better explain physical activity behaviours. However, to date, only one study has directly investigated the inter-relationships between perceived neighbourhood variables, motivation and physical activity engagement. Park et al., (2018) investigated the relationship between motivational and perceived neighbourhood environment factors to predict objective levels of physical activity in older adults. They found that perceptions of the neighbourhood environment were more positive (i.e., higher satisfaction), and engagement in light physical activities was higher, in older adults who were more autonomously motivated. Thus, limited evidence suggests that perceptions of the local neighbourhood (i.e., neighbourhood satisfaction), motivation and physical activity levels are inter-related. However, further research is required to clarify these relationships and determine how these factors together contribute to well-being. It is important to understand how the local environment is associated with motivational quality (i.e., autonomous or controlled motivation) to develop effective public health strategies that increase incidental physical activity levels and benefit well-being. Therefore, the second aim of the current study was to address this gap by investigating the contribution of motivation and neighbourhood satisfaction to incidental physical activity and well-being.

In summary, a growing knowledge base suggests that well-being is independently associated with motivation, incidental physical activity and satisfaction with one's neighbourhood; however, the inter-relationships between these factors have not been examined. Thus, the aim of the present study was to investigate how motivation and neighbourhood satisfaction together contribute to incidental physical activity and well-being. Based on the limited previous research investigating motivation and incidental physical activity (Oliver & Kemps, 2018; Niven & Markland, 2016), it was predicted that both autonomous and controlled motivation would be associated with incidental physical activity levels. However, drawing on traditional self-determination theory (Ryan & Deci, 2000), and the well-being literature (e.g., Ryan, Rigby, & King, 1993; Sheldon et al., 2004), we expected that only autonomous motivation would benefit well-being. Additionally, in light of previous research investigating motivation and exercise (Guérin & Fortier, 2013), we expected that motivation and incidental physical activity would interact to predict well-being. We hypothesized that high levels of incidental physical activity in individuals with high autonomous motivation, as compared to those with low autonomous motivation, would be associated with higher well-being due to greater enjoyment ans satisfaction incidental physical activity engagment. In contrast, we hypothesized that high levels of incidental physical activity in individuals with high controlled motivation, as compared to those with low controlled motivation, would be associated with poorer well-being due to feelings of pressure to engage in incidental physical activity.

Based on previous research investigating perceived neighbourhood environments and well-being (e.g., Wilson et al., 2004; Leslie & Cerin 2008), we further expected that neighbourhood satisfaction would be positively associated with well-being and incidental physical activity engagement. Furthermore, as neighbourhood satisfaction has previously been found to be an important contributor to happiness (Van Herzele & de Vries, 2011) and quality of life (Wilson et al., 2004), we anticipated that neighbourhood satisfaction would be an important contributor to well-being. Following the socio-ecological framework of human behaviour, and in view of the previously observed mediating role of neighbourhood satisfaction between various environmental (Leslie & Cerin, 2008; Van Herzele & de Vries, 2011; Phillips et al., 2005) and social factors (De Jong et al., 2012) and self-rated mental health, we anticipated that neighbourhood satisfaction may mediate the relationship between beneficial psychological mechanisms (i.e., autonomous motivation) and well-being (Leslie & Cerin, 2008). We explored a similar mediating role of neighbourhood satisfaction on controlled motivation for well-being.

6.2 Method

Participants and Design.

The data presented here are a subset extracted from a larger study that measured a broad range of environmental, psychological and health-related factors. The study used a cross-sectional design and consisted of 212 English speaking adults (163 females, 47 males, 2 preferred not to disclose). Participants were recruited from the student population at Flinders University, and the wider Adelaide community and were aged 17-73 years (M = 22.44, SD = 7.91). Student participants were reimbursed with course credit; community participants were entered into a lottery to win one of three $50 gift cards. The study was registered on the Flinders University online SONA System, allowing students to select the project voluntarily. Community participants were recruited through online classified, and community and social media websites.

Procedure.

The survey was administered using Qualtrics online computer software; median administration time was 30 minutes. Qualtrics is a web-based survey creation and distribution platform that allowed participants to access the survey using their personal computers or smartphones. Students accessed the survey via an anonymous link on the SONA System. Community participants were emailed an anonymous link following expression of interest in the study. All participants provided written informed consent prior to receiving the link to the questionnaire.

Materials.

Individual characteristics.

A range of potential covariates were measured, including age, years at current address, country of birth (categorized as “Australia” or “other”), highest education level (low—did not complete secondary education; medium—completed secondary education or equivalent; or high—tertiary qualification), marital status (married/de facto union, previously married or never married), number of dependent children (none, one, two, three or more), employment status (working full time, working part-time or not working), personal income (categorized as low—$0–299 per week; medium—$300–699 per week; or high—$700+ per week) and household income (categorized as low—$0–699 per week; medium—$700–1499per week; or high—$1500+ per week).

Well-Being.

Kinderman et al.'s (2011) BBC Well-being scale was used to measure subjective well-being. This is a highly reliable and valid measure of life satisfaction, personal growth and relationships (see Kinderman et al., 2011 for psychometric properties). Participants responded to 24 questions regarding life satisfaction (e.g., are you satisfied with your abilities to perform your daily living activities), personal growth (e.g., do you feel you have purpose in your life?), and relationships (e.g., are you satisfied with your friendships and personal relationships?) on four-point Likert scales anchored by the points "a little" to "extremely". An average score is calculated with higher scores indicating higher levels of well-being.

Incidental Physical Activity.

Incidental physical activity was assessed by the long version of the self-administered International Physical Activity Questionnaire (IPAQ-L), a well-established instrument for cross-nationally monitoring population levels of physical activity and inactivity. The IPAQ questionnaire has excellent test-retest reliability ($r = .80$) and validity ($r = .30$), and has been found to be suitable for use in adults (see Craig et al., 2003 for a summary of psychometric properties). Levels of incidental physical activity were measured by asking participants to report the amount of time (minutes per week) spent on being active in the workplace, for transportation and during household activities over the past 7 days. Specifically, participants were asked to indicate on how many days, and for how long (hours and minutes/day), they engaged in vigorous activities (e.g., lifting, climbing stairs, digging), moderate activities (e.g., carrying light loads, washing windows, sweeping), and walking (e.g., in bouts of at least 10 minutes) as part of their work, transport and household activities. To calculate total incidental physical activity per day, vigorous intensity, moderate intensity and walking were multiplied by their estimated intensity in metabolic equivalent (MET) energy expenditure, and summed into a single variable to indicate overall level of incidental physical activity (Craig et al., 2003). One MET represents the energy expended while sitting quietly at rest. The MET intensities used to score the IPAQ were vigorous (8 METs), moderate (4 METs) and walking (3.3 METs) (Craig et al., 2003).

Motivation.

An adapted version of Ryan and Connell's (1989) measure of Perceived Locus of Causality was used to measure motivation for incidental physical activity. Participants were presented with common word stems that related to incidental physical activity (e.g., "I use the stairs instead of an elevator or escalator because …") followed by eight motives for participating in that physical activity. In accordance with self-determination theory, the motives reflected forms of autonomous or controlled motivation (Deci & Ryan, 2008). Responses were recorded on 5-point scales ranging from "not true at all" to "very true". To ensure that we only captured behaviours that participants actually engaged in, participants only responded to word stems for activities that they selected to be relevant to them. Following the procedure of Hagger et al. (2014), an autonomous motivational regulation index was computed as the sum of the intrinsic motivation scale weighted by a factor of two, plus the identified regulation item. To account for the number of activities participants actually engaged in, this score was divided by the number of activities participants selected to be relevant to them. Similarly, the controlled motivational regulation index was computed as the sum of the external regulation scale weighted by two, plus the introjected regulation scale, and divided by the number of relevant activities.

Neighbourhood Satisfaction.

Neighbourhood satisfaction was assessed by measuring level of satisfaction with the presence or absence of environmental features. This measure has previously been found to have good test–retest reliability (ICC=0.80) (Lee et al., 2017). Specifically, following the procedure of Leslie and Cerin (2008), neighbourhood satisfaction was measured by asking participants to respond to the stem "How satisfied are you with…", followed by 17 items regarding certain physical (e.g., access to destinations, traffic and travel facilities) and social (e.g., friends, safety, walkability) environmental items in their neighbourhood. Responses were measured on a 5-point Likert-like scale ranging from strongly dissatisfied (1) to strongly satisfied (5). The mean of all items was computed to create an overall score of Neighbourhood Satisfaction.

Analytic strategy.

Data were analysed using SPSS Statistics 25.0 (IBM Corporation, Armonk, NY, USA). Durbin-Watson statistics indicated independence between the dependent and independent variables, as well as the NEWS subscales. Visual inspection of the regression residual plot for wellbeing, incidental physical activity, and neighbourhood satisfaction indicated that the data were normally distributed and homoscedastic (Field, 2013).

A series of hierarchical regression analyses were conducted to examine whether motivation and incidental physical activity predicted well-being (Ryan & Deci, 2000). These analyses were performed separately for autonomous and controlled motivation. Importantly, possible socio-economic confounders (i.e., employment, income and education) were included in step 1 of all analyses (Lesie & Cerin, 2008; Cerin et al., 2007; Meyer et al., 2014). To isolate the effect of the motivation of interest, for each regression, centred motivation (autonomous or controlled) was entered in step 2. Centred motivation type of interest (autonomous or controlled) and centred incidental physical activity scores were then entered in step 3. Finally, the two-way product term (motivation x incidental physical activity) was entered in step 4.

It was anticipated that neighbourhood satisfaction may mediate the relationship between motivation and well-being (Leslie & Cerin, 2008). Therefore, to investigate whether autonomous motivation indirectly contributed to well-being via neighbourhood satisfaction PROCESS (model 4) with 5000 bootstrap samples was used. To isolate the effect of autonomous motivation, we controlled for the effect of controlled motivation. Additionally, possible socio-economic confounders (i.e., employment, income and education) were controlled for in the analyses (Lesie & Cerin, 2008; Cerin et al., 2007; Meyer et al., 2014). Similarly, to investigate whether controlled motivation indirectly contributed to well-being via neighbourhood satisfaction (while controlling for autonomous motivation and socio-economic confounders) PROCESS (model 4) with 5000 bootstrap samples was again used.

6.3 Results

Sample characteristics.

A power analysis using GPower computer software (Erdfelder, Faul & Bucher, 1996) indicated that a total sample of 148 participants would be needed to detect large effects (f =.40) with 90% power using regression analyses with 4 predictors (α = .05). Thus, the current sample (N = 212) had adequate power to detect large effects. The majority of respondents were women (76.9%) who had completed secondary education (53%), were low income earners (63%), single (75%), and working part time (45%) and/or studying full time (39%). Compared with national data for Australia, respondents had slightly lower earnings and were less educated than the general population (Australian Bureau of Statistics, 2018). Demographic data for the full sample are presented in Table 1. Respondents reported an average of 839.96 MET-minutes of incidental physical activity per week (*SD = 741.51*). One participant was removed from the final analyses due to incomplete data.

Correlations between the physical activity, motivation, neighbourhood satisfaction and well-being.

Table 2 shows the correlations between neighbourhood satisfaction, physical activity, motivation and well-being. Autonomous motivation, but not controlled motivation, was positively correlated with incidental physical activity. Additionally, autonomous motivation was positively associated with neighbourhood satisfaction. We found no associations between well-being and incidental physical activity, autonomous motivation or controlled motivation.

Interaction between incidental physical activity, motivation and well-being.

i. Autonomous motivation

As can be seen in Table 3, we found a significant main effect of autonomous motivation, but no significant main effect of incidental physical activity when predicting well-being. Step 4 of the analysis showed a significant interaction between autonomous motivation and incidental physical activity. Simple slopes analysis showed that for individuals who engaged in high levels of incidental physical activity, autonomous motivation was a significant predictor of well-being, (+ 1SD) B = .363, $t(204)$ = 3.208, p = .002, whereby high levels of autonomous motivation and high levels of incidental physical activity engagement were beneficial for well-being (see Figure 1a). By contrast, for individuals who engaged in low levels of incidental physical activity, autonomous motivation was not a significant predictor of well-being (-1SD) *B* = .076, *t*(204) = .721, *p* = .472.

Table 1.

Percentages of sample characteristics

Characteristics	%
Gender	
Male	22.5
Female	76.9
Prefer not disclose	0.9
Educational attainment	
Yr 10 or equivalent	1.4
Yr 12 or equivalent	53.9
Trade/ apprenticeship	0.5
Certificate/ diploma	13.1
University degree	29.1
Higher university degree	2.3
Employment	
Working full-time	9.9
Working part-time	44.6
Unemployed	5.2
Keeping house/or raising children full time	0.9
Studying full-time	39
Retired	0.5
Personal Income	
$0-$299	63.4
$300- $699	25.8
$700 +	10.8
Marital Status	
Married	7
Single	74.6
Divorced	1.4
Domestic partnership	16.9

Table 2.

Correlations between study variables

	1.	2.	3.	4.	5.
1. Well-being		-.019	.070	-.122	.408**
2. Incidental physical activity	-.019		.198**	.084	-.106
3. Autonomous motivation	.070	.198**		.544**	.151*
4. Controlled motivation	-.122	.084	.544**		.030
5. Neighbourhood satisfaction	.408**	-.106	.151*	.030	

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

Table 3.

Interactions between incidental physical activity and motivation in predicting wellbeing

Step	Predictors	Model			Wellbeing		
		R^2	R^2 Change	F Change	B	SE	b
1	Socio-economic characteristics	.006		(3,208)			
2	Controlled motivation	.020	.015	(1,207) 3.124	-.2.84	.008	-.022
3	Autonomous motivation	.049	.029	(2,205) 3.121*	.208	.007	.017
	Incidental physical activity				-.042	.000	-3.46
	Incidental physical activity x autonomous motivation	.068	.018	(1,204) 4.041*	.140	.000	1.603
1	Socio-economic characteristics	.006		(3,208)			
2	Autonomous motivation	.011	.005	(1,207) 1.021	.208	.007	.017
3	Controlled motivation	.049	.039	(2,205) 4.189*	-.238	-.008	-.022
	Incidental physical activity				-.042	.000	-3.46
	Incidental physical activity x controlled motivation	.073	.023	(1,204) 5.117*	.158	.000	1.976

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

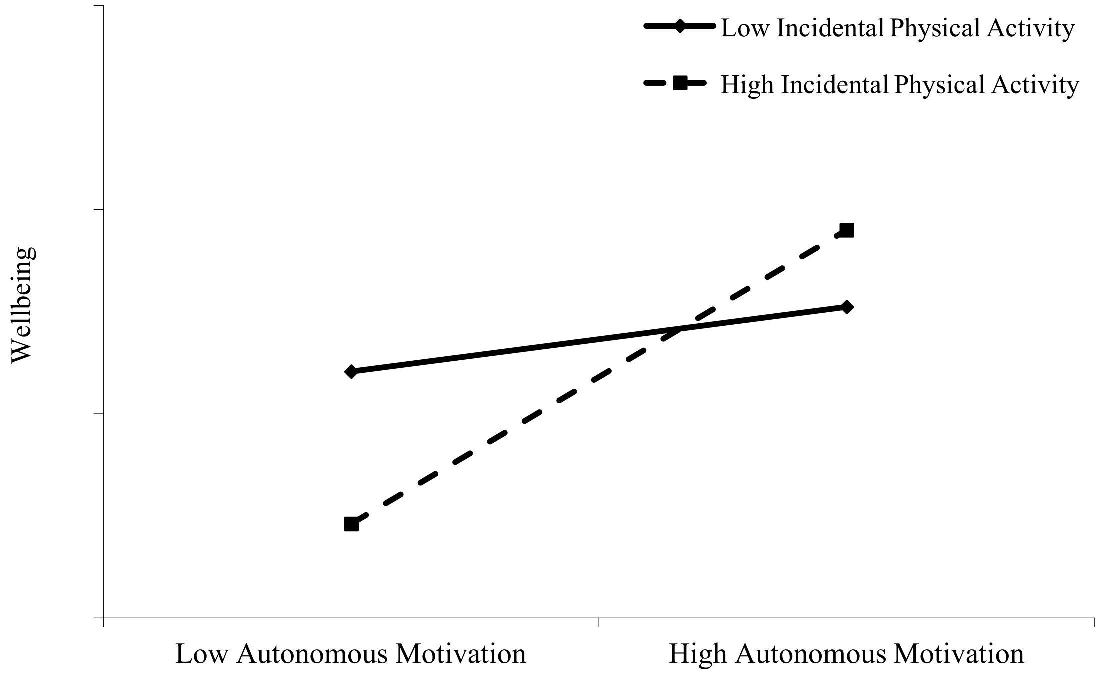

Figure 1a. Interaction between autonomous motivation and incidental physical activity while controlling for controlled motivation.

ii. Controlled motivation

Similar to autonomous motivation, we found a significant main effect of controlled motivation, but again no significant main effect of incidental physical activity when predicting well-being (table 2). Step 4 of the analysis showed a significant interaction between controlled motivation and incidental physical activity. Simple slopes analysis showed that for individuals who engaged in high levels of incidental physical activity, controlled motivation was not a significant predictor of well-being (+1SD) $B = -.083$, $t(204) = -.770$, $p = .442$. However, for participants who engaged in low levels of incidental physical activity, it was, (-1SD) $B = -.393$, $t(204) = -3.653$, $p = .000$ (see Figure 1b). These results indicate that high levels of controlled motivation together with low levels of incidental physical activity is unfavourable for well-being.

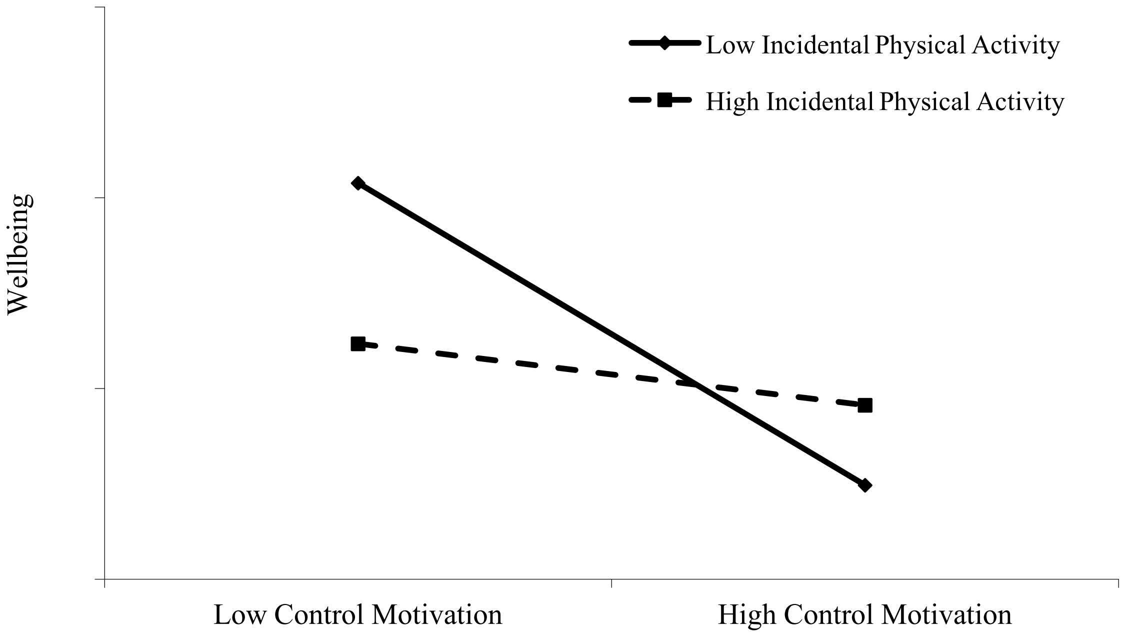

Figure 1b. Interaction between controlled motivation and incidental physical activity while controlling for autonomous motivation

Relationship between motivation, incidental physical activity, neighbourhood satisfaction and well-being.

i. Autonomous motivation

Autonomous motivation was significantly positively associated with well-being (pathway *c'*, Figure 2), *b* = .0165, *SE*= .006, *t(*206) = 2.43, *p* = .016, and neighbourhood satisfaction (pathway a Figure 2), *b* = .0169, *SE*= .007, *t(*206) = 2.41, *p* = .018, when controlling for controlled motivation. However, with the mediator, neighbourhood satisfaction, in the model, autonomous motivation no longer predicted well-being, *b* = .010, *SE = .006*, *t*(205) = 1.57, *p* = .117 (95% CI: 0.0077 to 0.1643). Thus, we found a significant indirect effect of autonomous motivation on well-being via neighbourhood satisfaction.

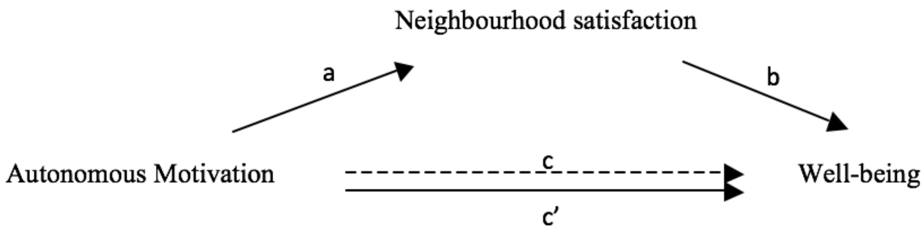

Figure 2. Model of conditional effect of autonomous motivation on well-being. *Note.* Bold arrows denote significant relationships; bold dashed arrows denote mediation of adjoining relationship by neighbourhood walkability.

ii. Controlled motivation

When controlling for autonomous motivation, controlled motivation was significantly negatively associated with well-being b = -.0223, SE = .0079, t(206) = -2.83, p = .005. However, we found no relationship between controlled motivation and neighbourhood satisfaction b = -.0084, SE = .0081, t(206) = -1.039, p =.299, and no indirect effect of controlled motivation on well-being with the mediator, neighbourhood satisfaction, in the model, b = -.0191, *SE = .0073,* t(205) =-2.63, p = .009, (95% CI: -0.1076 to 0.0397).

6.4 Discussion

This study contributes to the literature by exploring the associations between incidental physical activity, neighbourhood satisfaction and well-being from the motivational perspective of self-determination theory. Although we found no direct association between well-being and incidental physical activity, both autonomous and controlled motivation were found to interact with incidental physical activity to contribute to well-being. These findings suggest that the quality of one's motivation plays an important role in determining whether incidental physical activity benefits well-being. Findings further suggest that well-being is subject to whether individuals are satisfied with their neighbourhoods. To our knowledge, the current study is the first to directly investigate the combined contributions of motivation, neighbourhood satisfaction and incidental physical activity engagement to well-being. Findings highlight the importance of considering motivational, behavioural and environmental factors to promote well-being.

The main focus of the current study was to investigate the inter-relationships between motivation, incidental physical activity, neighbourhood satisfaction and their contributions to well-being. Results showed different patterns between how autonomous and controlled motivation interact with incidental physical activity to contribute to well-being. As expected, high levels of incidental physical activity were found to be beneficial for well-being for individuals with high levels of autonomous motivation, but not for individuals with low levels of autonomous motivation. This is in line with previous research in the exercise domain (Teixeira et al., 2012b), and the limited research that has found a positive association between autonomously motivated incidental physical activity (i.e., active travel) and well-being in adolescents (White et al., 2018). Our research strengthens this pattern of results by indicating a positive relationship between autonomous motivation, incidental physical activity and well-being. Moreover, our findings extend upon this research as they suggest that incidental physical activity engagement only benefits well-being when autonomous motivation is high, as incidental physical activity did not independently contribute to well-being. Therefore, an important and novel finding of the current study is the combined contribution of autonomous motivation and incidental physical activity to well-being.

In contrast to autonomous motivation, we found negative relationships between controlled motivation, incidental physical activity and well-being. Our findings suggest that high levels of controlled motivation are unfavourable for well-being, particularly when incidental physical activity levels are low. Despite the inconsistent findings regarding controlled motivation and behaviour engagement (see Teixeira et al., 2012a for a review), it has been established that controlled motivation is not beneficial for mental health or well-being (Sheldon et al., 2004; Ryan et al., 1999; Deci & Ryan, 2008). Our findings further support this notion, as they indicate that having controlled motives for incidental physical activity, in combination with low incidental physical activity engagement, is associated with poorer well-being.

The current study uniquely investigated the combined contribution of motivation and neighbourhood satisfaction to well-being. We found that neighbourhood satisfaction fully accounted for the contribution of autonomous motivation to well-being, indicating that neighbourhood satisfaction is necessary for autonomous motivation to benefit well-being. This finding is in line with previous research that has found satisfaction with the local neighbourhood to be a key contributing factor to happiness (Van Herzele & de Vries, 2011), quality of life (Wen et al., 2006) and self-reported physical and mental health

(Wilson et al., 2004; Leslie & Cerin, 2008; Araya et al., 2006). Neighbourhood satisfaction refers to an individual's appraisal of their residential environment in relation to their needs and expectations (Gentile, 1991). Therefore, a possible explanation for the mediating role of neighbourhood satisfaction on autonomous motivation and well-being found here may be that neighbourhoods perceived as satisfying meet individuals' needs and/or expectations required for activity engagement. For example, satisfying neighbourhoods may offer ample opportunities (e.g., walkable streets, access to parks) and support (e.g., safer neighbourhoods) for incidental physical activities. Therefore, individuals feel they have the option to engage in incidental physical activity (e.g., feelings of choice/ autonomous motivation), but do not feel required to engage in such activity (e.g., feelings of pressure/controlled motivation) due to neighbourhood restraints (e.g., traffic congestion, limited parking spaces). Positive perceptions of neighbourhood environments have previously been associated with increased autonomous motivation and engagement in light physical activities in older adults (Park et al., 2018), and previous research in the exercise domain has demonstrated that certain environments (e.g., green spaces and convenient exercise locations) are associated with motivation and enjoyment of physical activity (Gay et al., 2011; Calogiuri & Elliot, 2017). However, previous studies have not considered whether neighbourhood perceptions, motivation and incidental physical activity contribute to well-being. Thus, an important finding of the current study is the combined contributions of autonomous motivation, neighbourhood satisfaction and incidental physical activity to well-being.

In contrast to our findings for autonomous motivation, the negative relationship between controlled motivation and well-being was no longer present when neighbourhood satisfaction was included in the model. Previous researchers have suggested that supportive neighbourhoods are associated with better mental health and higher quality of life (Mohan & Twigg 2007; Sirgy & Cornwell, 2002). Our findings support this proposition, and suggest in particular that supportive neighbourhoods may benefit well-being by negating the unfavourable effect of controlled motivation.

It is important to note that the current cross-sectional design does not allow for inferences of a causal relationship between the investigated factors. This design can demonstrate associations between variables; however, it cannot serve to draw inferences of causal relationships. Additionally, the current study utilised moderation and mediation analyses on data collected at a single time-point. Cross-sectional examination of mediation and moderation has been argued to generate biased results when compared to data collected across multiple time-points (Maxwell & Cole, 2007). Thus, although the current research is an important starting point for understanding the combined contributions of motivational, behavioural and environmental factors to well-being, future research should use longitudinal or experimental designs to ascertain the direction of environment-behavior relationships.

Despite the limitations inherent in a cross-sectional design, our findings do yield some important theoretical implications. In particular, our findings support self-determination theory which suggests that optimal results occur when autonomous forms of motivation are present but controlled forms are not (Ryan & Connell, 1989). Specifically, autonomous motivation was directly associated with incidental physical activity levels. Our findings further support the self-determination theory notion that motivational quality is a driving contributing factor to well-being outcomes, as incidental physical activity engagement appears only to benefit well-being if it is driven by autonomous motives (Ryan & Deci, 2008). According to self-determination theory the more autonomous one's motivational quality is, the more likely one will engage in a behaviour and experience feelings of well-being, as the behaviour is more inherently satisfying and rewarding. This can be applied to incidental physical activity using the example of taking the dog for a walk. Consider two people engaging in the same activity or walking the dog as a result of different motivations: One person walks the dog due to an autonomous motive to see their dog happy, and thus has an inherent enjoyment of walking the dog, which in turn contributes to feelings of wellbeing. Another person walks the dog due a controlled motive, as they have been told to do so to prevent their dog chewing on their belongings. Although the activity is still engaged in, the motivation is external, and consequently feelings of wellbeing are likely to not be experienced. Therefore, despite the same type and amount of incidental physical activity engagement, feelings of wellbeing will differ due to the motivational quality underlying the behaviour. Additionally, findings lend support to the self-determination theory proposition that certain environments can facilitate or undermine autonomous or controlled motivation (Deci & Ryan, 2008). In particular, findings suggest that autonomous motivation benefits well-being for those who live in supportive neighbourhoods, and that supportive neighbourhoods may negate the negative effect that controlled motivation can have on well-being.

The present set of findings also have practical relevance, in particular with regard to programs designed to increase levels of incidental physical activity and enhance well-being. Specifically, our findings suggest that it is important to target motivational, behavioural as well as environmental factors to enhance well-being. While acknowledging the need for additional confirmation of causal influences from prospective studies, findings from the current study suggest that perceptions of the local neighbourhood may be an important contributor to mental health. When residents perceive their environment to be more aesthetic, safer and more socially integrated, well-being may be enhanced. Additionally, our findings suggest that intervention programs that seek to increase levels of incidental physical activity and enhance well-being should target autonomous motivation, as only autonomous motivation was directly related to incidental physical activity engagement, and together these factors contributed to well-being. For example, public health campaign messages could emphasise choice and enjoyment of incidental physical activities to actively encourage autonomous motivation and engagement in incidental physical activities. Programs could also highlight opportunities available in the neighbourhood to assist in creating a supportive, and satisfying, urban environment (Deci & Ryan, 2008; Giles-Corti & Donovon, 2002). Furthermore, our findings raise caution for programs that promote controlled motivation, such as health promotion strategies that focus on weight-loss and calorie-burning. They suggest that targeting controlled motives is likely not to increase incidental physical activity engagement and will not benefit well-being. However, as an important next step, longitudinal, experimental or quasi-experimental studies that are motivationally focused and community-oriented are required to clarify the casual nature of the relationships between motivational, environmental and behavioural factors and their contributions to well-being in order to further assist the development of effective interventions.

In conclusion, the current study addressed an important gap in the literature by considering how motivational and environmental factors, together with incidental physical activity, contribute to psychological well-being. Our findings provide support for self-determination theory in that autonomous motivation contributed directly to both incidental physical activity levels and well-being. Findings further suggest that the contribution of autonomous motivation to well-being depends on whether individuals are satisfied with their neighbourhoods, as well as whether they engage in incidental physical activity. The current study highlights the importance of considering motivational, behavioural and environmental factors together in order to enhance well-being.

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CHAPTER 7: GENERAL DISCUSSION

7.1 Chapter Overview

Environmental and psychological factors have previously been shown to contribute to intentional physical activity behaviour. However, relatively little research has examined these factors as potential underlying mechanisms of incidental physical activity, despite the well-known health benefits of engagement in this behaviour. The overarching aim of this thesis was to explore the interplay between environmental and psychological (motivation and implicit processes) factors specifically within the context of incidental physical activity. Chapter 1 introduced the theoretical perspectives of self-determination theory and socio-ecological models to inform an understanding of the motivational tenants and possible environmental and automatic precursors for incidental physical activity, with a view to providing a backdrop for the subsequent empirical chapters.

The current research had two primary aims. The first was to investigate whether environmental and psychological factors contribute to incidental physical activity, as they do for leisure time physical activity. Specifically, the research sought to develop an understanding of some of the underlying mechanisms to incidental physical activity, and how these may differ from those of leisure time physical activity. The second aim was to investigate the inter-relationships between these factors in order to inform future interventions to increase incidental physical activity and enhance well-being. Five empirical studies were conducted, each with their own specific aims, but situated within the two overarching aims of the thesis. The purpose of this final chapter is to provide an integrated discussion of the main findings. First, a brief summary of the findings is provided. Next, theoretical and practical implications are discussed. Finally, methodological issues and directions for future research are considered.

7.2 Summary of Findings

Studies 1, 2 and 3 addressed the first aim of the thesis, namely, to develop an understanding of some of the underlying mechanisms to incidental physical activity, and how these may differ from those of leisure time physical activity. Studies 4 and 5 addressed the second aim, which was to examine the inter-relationships between motivation and environmental factors, with a view to inform strategies to increase incidental physical activity and enhance well-being.

Study 1 aimed to explore the contribution of motivational factors to incidental physical activity engagement, in combination with intentions and environmental factors. The study demonstrated that walkable neighbourhoods, motivation and intentions together play an important role in guiding incidental physical activity levels, as well as leisure time physical activity. However, the specific nature of these relationships differed for incidental versus leisure time physical activity. For incidental physical activity, motivation mediated the relationship between intentions and activity engagement, and this relationship was moderated by neighbourhood walkability. For leisure time physical activity, neighbourhood walkability moderated the relationship between motivation and intentions, and intentions contributed to activity engagement when motivation was present. Study 2 addressed the contribution of different motivational components to incidental physical activity, compared to leisure time physical activity. Similar to Study 1, the findings showed a different pattern of results for incidental and leisure time physical activity. Specifically, the findings showed that leisure time physical activity was positively associated with both contextual and dispositional motivation, whereas incidental physical activity was positively associated only with contextual motivation. Findings from Study 2 indicated that incidental and leisure time physical activity are determined by different motivational properties, and highlighted the importance of contextual motivation for incidental physical activity. Study 3 then investigated the combined contributions of implicit processes and motivation to incidental physical activity. It was found that autonomous motivation and certain implicit processes (i.e., implicit attitudes and approach-avoid biases) together contributed to incidental physical activity engagement. Collectively, findings from Studies 1-3 indicate that incidental physical activity engagement is associated with different underlying mechanisms to those underlying leisure time physical activity.

Studies 4 and 5 addressed the second aim the thesis, which was to examine the inter-relationships between motivation and environmental factors, with a view to inform strategies to increase incidental physical activity and enhance well-being. Following the findings of Studies 1-3, Study 4 was conducted to investigate the idea that individuals' natural tendencies to be active can be facilitated by contexts that support autonomy (Shuler, Sheldon & Frohlich, 2010). Study 4 examined how a subtle change in the environment affects contextual motivation and subsequent engagement in walking for active travel, a form of incidental physical activity. The findings showed that although the presence of a Point-of-

Decision Prompt did not increase walking engagement, autonomous motivation for active travel predicted walking engagement. In addition, the presence of an autonomously-oriented Point-of-Decision Prompt was associated with higher levels of autonomous motivation for active transportation. Thus findings suggest that an autonomously-oriented Point-of-Decision Prompt is beneficial for individuals' motivation.

Findings from Studies 1-4 indicated that both motivational and environmental factors contribute to incidental physical activity levels. Extending upon these findings, Study 5 investigated the combined contributions of incidental physical activity, motivation and neighbourhood satisfaction to subjective well-being, with the aim to assist in the development of strategies that benefit both physical and mental health. Findings showed a moderating role of incidental physical activity on the relationship between autonomous motivation and well-being, and a mediating role of neighbourhood satisfaction on this relationship. Specifically, the positive contribution of autonomous motivation to well-being was dependent on whether individuals engaged in higher levels of incidental physical activity and whether they were satisfied with their neighbourhoods. Findings indicate that autonomous motivation, incidental physical activity and neighbourhood satisfaction together play an important role in increasing overall well-being.

These studies as a set contribute to the emerging research investigating the interactions between psychological and environmental contributors to incidental physical activity. The research presented in this thesis draws from self-determination theory and socio-ecological models, and identifies contextual autonomous motivation and perceived neighbourhood factors as important contributors to incidental physical activity and well-being. The results also contribute to the theoretical understanding of how motivation contributes to incidental physical activity and will assist in the development of interventions designed to increase such behaviour, and thus benefit well-being.

7.3 Theoretical Implications

The research presented in this thesis has a number of implications for the theoretical understanding of incidental physical activity behaviour. As highlighted in Chapter 1, the research was informed by several theoretical perspectives. Self-determination theory provided a framework for motivational contributors to incidental physical activity and well-being outcomes, while dual process models identified potential automatic precursors for incidental physical activity engagement, and socio-ecological models recognized built environments as correlates of physical activity. Drawing on these theoretical perspectives, the current studies provide insight into the associations between several motivational, environmental and implicit factors for incidental physical activity. Specifically, Studies 1 and 2 are informative in identifying motivations that contribute to incidental and leisure time physical activity within the context of Self-determination yheory. Studies 3 and 4 extend upon these findings in that they examined more specific motivational regulations (i.e., the perceived locus of causality), as well as their contribution to incidental physical activity engagement together with implicit processes (i.e., implicit attitudes, approach-avoid biases and attentional biases), as proposed by dual process models. Drawing on socio-ecological models, Studies 1, 4 and 5 investigated how certain environmental characteristics (i.e., perceived neighbourhood walkability, an autonomy-promoting environment and neighbourhood satisfaction,) contribute to incidental physical activity engagement. Furthermore, Study 5 identified environmental circumstances under which motivation and incidental physical activity engagement benefit well-being. The theoretical implications of these findings for self-determination theory, dual process models and socio-ecological models are discussed in the following sections.

7.3.1 Self-Determination Theory

As highlighted in Chapter 1, self-determination theory is comprised of several sub-theories. The studies presented in this dissertation pertained specifically to two sub-theories, causality orientations theory which describes motivation as an enduring, trait-like characteristic, and organismic integration theory which describes more contextual motivational regulations and the internalization process by which behaviours such as physical activity become increasingly more autonomous, or self-determined (Deci & Ryan, 1985). Although dispositional motivation (as posited by causality orientations theory) was not associated with incidental physical activity engagement, findings from the current thesis shed light on the importance of contextual motivational regulations (as posited by the organismic integration theory), in relation to incidental physical activity engagement. The findings from Study 2 suggest that dispositional (i.e., global) motivation is beneficial for leisure time physical activity, but not for incidental physical activity. Similarly, previous research has found that the prediction of behaviour by dispositional motivations is confined to intentional physical activity behaviours (Keatley et al., 2011). Furthermore, previous research has linked engagement in leisure-time physical activity to enduring personality traits such as openness and conscientiousness, and it has been proposed that certain personality traits influence self-regulatory behaviour, which in turn drive leisure-time physical activity engagement (Ingledew & Markland, 2008; Rhodes & Smith, 2006). This implies that general, global motivations suggested by causality orientations theory may apply to health behaviours that are performed largely due to choice, such as leisure time physical activity. However, by nature, some incidental phsyical activities are performed out of neccesity (e.g., housework). Therefore, it is possible that incidental physical activities are not strongly influenced by generalised, dispositional motivational orientations. Instead, as elaborated below, incidental physical activities may be predominately determined by contextual, proximal influences.

The importance of contextual motivations, as posited by organismic integration theory, in relation to incidental physical activity engagement is highlighted throughout the research in the thesis. Findings from Study 1 suggest that contextual motivation is an important contributor to both incidental and leisure time physical activity and that without contextual motivation, intentions are unlikely to translate into incidental physical activity engagement. Furthermore, results pertaining to motivational regulations in Studies 2-5, attest to the merit of contextual motivation in relation to incidental physical activity engagement (Blanchard, Mask, Vallerand, de la Sablonnière, Provencher, 2007; Guay, Vallerand, & Blanchard, 2000). Specifically, Studies 2 and 3 found that both autonomous and controlled motives contributed to incidental physical activity engagement, while Studies 4 and 5 found that autonomous motives, but not controlled motives, contributed to incidental physical activity engagement. Taken together, these findings suggest that contextual motivation that is specific to certain behaviours (e.g., motivation to walk for active travel) benefits incidental physical activity engagement, rather than trait-like feelings of autonomy (i.e., a dispositional motivation).

Although findings between studies differed slightly regarding the benefit of specific contextual motivational regulations to incidental physical activity engagement, as a whole the thesis found support for the self-determination theory principle that more self-determined, autonomous motivations are associated with higher levels of behaviour engagement and well-being (Deci & Ryan 2012; Teixeira et al., 2012). In particular, findings from Studies 4 and 5 provide support for traditional self-determination theory tenets that optimal results occur when autonomous forms of motivation are present but controlled forms are not (Ryan & Connell, 1989). Specifically, Study 4 found that autonomous motivation predicted walking as a means of active travel, and that messages (i.e., Point-of-Decision Prompts) that emphasise autonomy are more effective at promoting motivation, compared to messages that do not emphasise autonomy (Ryan & Deci, 2008). Additionally, in Study 5, autonomous motivation was directly positively associated with incidental physical activity levels; conversely, there was no direct relationship between controlled motivation and incidental physical activity. However, conflicting results were found in Studies 2 and 3. Findings regarding contextual motivation for incidental physical activity in these studies suggest that individuals can experience more than one form of motivational regulation simultaneously, and that both autonomous and controlled forms of motivation are valuable for engagement in incidental physical activity. Specifically, while Study 2 found direct associations between autonomous and controlled motivational regulations and incidental physical activity engagement, Study 3 found a combined contibution of both autonomous and controlled motivation, along with certian automatic processes (i.e., implicit attidues and approach-avoid biases) to incidental phsyical activity levels.

There is ongoing discourse in the self-determination theory literature as to which types of motivation are more critical in explaining and promoting physical activity. Some researchers propose that although controlled forms of motivation might facilitate initial participation in physical activity engagement, activity engagement may decline over time (Pelletier, et al., 2001), become rigid (e.g., exercise dependency) and be accompanied by repercussions to mental and physical health (e.g., lower well-being, injury) (Ackard, Brehm, & Steffen, 2002). Conversely, as proposed by Teixiera et al. (2012) holding controlled motivations is not necessarily problematic, motivationally speaking, as long as self-determined regulations are also held. While findings from Study 2 and 3 support and extend this assertion by suggesting that both autonomous and controlled motivation have value for incidental physical activity engagement, findings from Study 5 indicate that only autonomous motivation is associated with beneficial psychological outcomes. Indeed, self-determination theory suggests that motivational quality is not only associated with behaviour engagement, but also with well-being outcomes, with more autonomous regulations hypothesized to contribute to more positive affect. Findings from Study 5 support this premise. Furthermore, Study 5 showed that controlled motivation for incidental physical activity was negatively associated with well-being when autonomous motivation was controlled for. Therefore, although findings from Studies 2 and 3 indicate that both autonomous and controlled motivation may contribute to incidental physical activity engagement, findings from Study 5 suggest that only autonomous motivation for incidental physical activity is beneficial for well-being. Thus, despite the differing results regarding controlled motivation and behaviour engagement, several findings from the current thesis support the self-determination theory tenet that autonomous motivation is beneficial for behaviour engagement and well-being. Studies 2-5 all found positive associations between autonomous motivation and incidental physical activity levels and Study 5 showed a positive association between autonomous motivation and well-being.

7.3.2 Dual Process Models and Self-Determination Theory

Studies 3 and 4 were informed by dual process models, which posit that behaviour is determined by interactions between the impulsive and reflective system (Strack & Deutsch, 2004). While the impulsive system guides behaviour in an automatic manner derived from learned responses to situational and environmental cues, the reflective system is responsible for regulating these impulses through conscious deliberation based on long-term standards and goals (Strack & Deutsch, 2004). Aspects of the impulsive system, together with motivation, were found to play a role in guiding incidental physical activity. Specifically, Study 3 found that along with motivation, positive implicit attitudes contributed to increased incidental physical activity levels. Furthermore, motivation and approach-avoid biases interacted to predict incidental physical levels, suggesting that certain motivational profiles may result in optimal incidental physical activity levels depending on one's approach-avoid bias. In particular, a high autonomous-low controlled motivational profile appears to benefit individuals with a high approach bias, supporting traditional self-determination theory, which posits that autonomous forms of motivation should be present, and controlled forms absent, for the best outcome to occur (Ryan & Connell, 1989). By contrast, a high autonomous-high controlled motivational profile appears to benefit those with a high avoidance bias, supporting contemporary notions that autonomous and controlled motivation can co-exist and benefit behaviour engagement (Niven & Markland, 2016; Chatzisarantis et al., 2003; Webber et al., 2010). From this perspective, it appears that controlled motivation can benefit incidental physical activity engagement when individuals have a tendency to avoid incidental physical activity stimuli. Nevertheless, despite the contrasting results regarding controlled motivation and incidental physical activity engagement, in line with traditional self-determination theory and previous research in the exercise domain, autonomous motivation was consistently associated with increased incidental physical activity engagement across studies (Deci & Ryan 2000; Teixeira et al., 2012).

Following the findings of Study 3, Study 4 was conducted to investigate the idea that individuals' natural tendencies to be active can be facilitated by contexts that support autonomy (Shuler, Sheldon & Frohlich, 2010). To this end, a nudging technique, which taps into both motivational and implicit processes, was employed in Study 4. The behavioural decision-making process evident in nudging techniques is predominately explained by dual process models (Marchiori et al., 2017). Nudging techniques take advantage of the unconscious interaction between a person and the environment by applying subtle environmental modifications to implicitly guide people towards certain options (Marchiori et al., 2017; Thaler, Sunstein & Balz, 2014). Specifically, nudges make use of the flaws in automatic decision making and assume that people do not give full attention to their options (Sunstein & Thaler, 2003; Thaler & Sunstein, 2008). Thus, nudging principles assume that choices will inevitably be influenced by default rules, frames, and starting points (Sunstein & Thaler, 2003; Thaler & Sunstein, 2008). Point-of-decision prompts are a type of nudge that are thought to operate as 'cues to action' which motivate and guide people towards healthy alternatives (Rosenstock, 1990). Study 4 investigated the effectiveness of two motivational Point-of-Decision Prompts to promote walking as active travel, a form of incidental physical activity, on a university campus. Although neither an autonomously-oriented nor a control-oriented Point-of-Decision prompt determined choice of active transportation, individuals displayed higher levels of autonomous motivation when an autonomously-oriented Point-of-Decision prompts was present. Furthermore, motivation for transportation predicted transport choice, such that individuals who chose to walk were motivated by autonomous reasons. Findings suggest that Point-of-Decision prompts may not directly increase active transportation engagement; however, autonomously oriented Point-of-Decision prompts may be beneficial for individuals' motivation, which in turn guides behaviour. Findings of Study 4 lend limited support to dual process models in that an implicit environmental cue influenced individuals' conscious motivation, and motivational quality predicted behaviour engagement. Therefore, studies 3 and 4 provide support for the basic premise of dual process models that implicit and reflective processes interact to guide behaviour (Strack & Deutsch, 2004).

7.3.3 Socio-Ecological Models and Self-Determination Theory

An important point highlighted by the findings from Study 4 is that contextual motivation for incidental physical activity can be influenced by environmental factors. Study 4 showed that feelings of autonomy for active transportation increased in an environment that emphasised autonomy. These results offer support for the self-determination theory proposition that certain environments can facilitate or undermine autonomous or controlled motivation (Deci & Ryan, 2008). The findings of Studies 1, 4 and 5 are also informative for understanding the contribution of environmental factors, as posited by socio-ecological models, to incidental physical activity engagement. In addition to assessing the contribution of motivation to incidental physical activity, these studies also assessed various environmental factors such as perceived walkability and satisfaction with the local neighbourhood.

Although socio-ecological models propose that health behaviours, such as physical activity, are simultaneously influenced by aspects of the physical environment and individual attributes, only a limited number of studies have previously investigated how both environmental and psychological factors contribute to physical activity levels (Deforche et al., 2010; Ball et al., 2001; Cerin et al., 2008; Giles-Corti & Donovan, 2003). Findings from studies 1, 4, and 5 uniquely highlight the importance of considering psychological characteristics, such as motivation and intentions, in combination with supportive environments to facilitate incidental physical activity. Specifically, findings from Study 1 showed that living in a neighbourhood perceived as walkable can be a protective factor for incidental physical activity levels when intentions to engage in incidental physical activity are low. This is a novel finding and points to the need for future research to continue the investigation of how built environments interact with psychological mechanisms like intentions to contribute to incidental physical activity. Study 4 utilised ecological principles by implementing a simple change in the environment to guide individuals towards being more incidentally active (Thaler & Sunstein, 2008). Findings from Study 4 also lend support to socio-ecological models as most individuals were active in what would be considered a facilitative environment (Sallis, Owen & Fisher, 2015). Importantly, findings from Study 5 indicate that being satisfied with the local neighbourhood is a key factor for overall well-being. In addition, Study 5 showed that autonomous motivation benefits well-being for those who live in supportive neighbourhoods and that a supportive neighbourhood may counter the negative effects of controlled motivation on well-being. Thus, findings from studies 1, 4 and 5 collectively provide support for socio-ecological models and suggest the need for further investigations into the interactions between psychological and environmental factors to explain health-related behaviours and health outcomes (Sallis, Owen & Fisher, 2015).

What is unique about this thesis is that it investigated the inter-relationships between motivational, automatic and environmental factors that contribute to incidental physical activity. Therefore, findings have implications for multiple theories, and encourage the adoption of multiple theories in order to understand incidental physical activity behaviour (Hagger & Chatzisarantis, 2008; Vallerand, 2007; Sallis, Owen & Fisher, 2015). Self-determination theory and dual process models identify important individual factors, whereas socio-ecological models recognize correlates of physical activity that occur at a broader, community level (Ryan & Deci, 2007; Sallis & Owen, 1998). Although these frameworks have distinctive theoretical underpinnings, this research suggests that integrating self-determination theory with dual process and socio-ecological models may offer unique insight into understanding physical activity behaviour. Although the scope of the studies presented in this thesis was limited to investigating particular components of self-determination theory, dual process models and socio-ecological models, the research presented found inter-relationships between the investigated motivational, automatic and environmental factors. Specifically, the results of studies 1 and 2 highlight the unique motivations that contribute to incidental physical activity engagement, compared to leisure time physical activity engagement. Studies 2-5 demonstrate important associations between context specific motivations, automatic processes and incidental physical activity. In addition, studies 1, 4 and 5 highlight the value of supportive environments for incidental physical activity engagement and feelings of well-being. It should be noted that incorporating key constructs from different theories to advance the understanding of health behaviour has previously been encouraged (Noar & Zimmerman, 2005; Biddle, Hagger, Chatzisarantis, & Lippke, 2007). The findings from this thesis therefore further encourage the adoption of key theoretical components to inform effective interventions to increase incidental physical activity engagement and enhance well-being (Hagger & Chatzisarantis, 2008).

7.4. Practical Implications

Given the prevalence of sedentary lifestyles and the health benefits of lifestyle approaches to increase incidental physical activity, the findings of the current thesis have several important practical implications (Ng et al., 2014). In particular, they have the potential to inform practical approaches to promote incidental physical activity engagement, and to benefit psychological well-being. Two consistent themes arose from the research presented in this thesis. First, context specific motivation (Studies 2-5) and perceived environmental factors (Studies 1, 3, 4 and 5) are important contributors to incidental physical engagement. This highlights the importance of addressing motivations specific to certain incidental physical activities in interventions that aim to increase physical activity levels. Second, findings highlight the importance of considering the interplay between environmental characteristics and certain psychological mechanisms when developing incidental physical activity interventions. The following sections discuss potential avenues for addressing both motivational and environmental characteristics derived from the findings presented in the thesis.

7.4.1 Increasing Contextual Motivation

One potential avenue for increasing physical activity and well-being would be to adapt interventions based on self-determination theory. According to self-determination theory, optimal outcomes occur when people support others' autonomy, rather than control others' behaviour (Ryan & Deci, 2000). Autonomy support refers to what one person says and does to enhance another's perceived choice and internal perceived locus of causality, which has positive implication for their quality of motivation and behaviour engagement (Reeve et al. 2003). Autonomy supportive interventions involve teaching people to provide meaningful rationales (e.g., verbal explanations of why the activity would have personal value), acknowledge negative feelings (e.g.,' acknowledgment that the task may conflict with personal inclinations), use non-controlling language (conveying a sense of choice and flexibility by minimising the use of "should" and "have to's" (Deci et al., 1994), offer choices (e.g., providing information about options and encourage choice-making) (Williams et al, 1999) and nurture inner motivational resources (e.g., utilising interests, enjoyment, and psychological need satisfaction during the activity) (Reeve et al., 2004). Previous research in the education (Chatzisarantis & Hagger 2009; Tessier et al. 2008; Reeve et al. 2004), exercise (Reeve et al. 2004), sport (Sullivan 2005) and company management (Hardré and Reeve 2009) domains has demonstrated that people can learn to be significantly more autonomy-supportive toward others. In relation to physical activity, autonomy supportive interventions have previously been effective at increasing autonomous motivation and participation in the field of exercise promotion (Edmunds, Ntoumanus & Duda, 2008; Moustake et al., 2012) and physical education (Cheon et al., 2012; Cheon & Reeve, 2013; Chatzisarantis & Hagger, 2009). Importantly, intervention programs designed to support autonomy have previously been found to increase autonomous motivation and exercise participation in group-based exercise settings (Su & Reeve, 2011). Findings from Studies 2-5 indicate that similar interventions could also increase levels of incidental physical activity by supporting contextual autonomous motivation for specific activities. For example, autonomy supportive strategies could be utilised by workplaces to enhance autonomous motivation for certain incidental physical activities (e.g., the use of standing desks, utilising active travel to work and regular walking breaks from the desk). Results from the current thesis indicate that targeting autonomous motivation that is specific to certain incidental physical activities would be particularly valuable. Findings from Studies 2 and 4 in particular indicate that enhancing contextual autonomous motivation would be beneficial for incidental physical activity engagement. Programs looking to increase levels of incidental physical activity should therefore focus on supporting autonomy for a specific target activity (e.g., using standing desks), rather than motivation for incidental physical activity more generally, as only motivation specific to incidental physical activities was related to activity engagement.

Additionally, the results of Study 4 demonstrated that a subtle environmental manipulation can influence contextual motivation for an incidental physical activity. Specifically, individuals displayed higher levels of contextual autonomous motivation for an active travel option when a motivational sign endorsing autonomy was present. The findings of this study support the utility of a brief environmental intervention to increase contextual autonomous motivation specific to an incidental physical activity behaviour. Furthermore, findings from Study 5 indicate that targeting autonomous contextual motivation and increasing incidental physical activity engagement may contribute to feelings of overall well-being. Thus, programs should aim to increase autonomous motivation (e.g., choice and enjoyment), rather than controlled motivation (e.g., calorie burning) for specific incidental physical activities as contextual autonomous motivation was consistently associated with incidental physical activity engagement, and was also associated with well-being.

7.4.2 Supportive Environments to Facilitate Motivation

Findings from the current thesis also highlight the importance of considering environmental characteristics when developing interventions targeted at increasing incidental physical activity engagement. Environmental interventions have previously been shown to be effective at increasing physical activity by encouraging stair-use in workplaces (Blake et al., 2008; Eves, Webb & Mutrie, 2006), shopping centres (Webb, Eves & Kerr, 2011), train stations (Boen et al, 2010; Eves et al., 2009), health-care facilities (Marshall et al., 2002) and universities (Grimstvedt et al., 2010; Ford & Torok, 2008). However, a number of studies have found that environmental interventions do not effect immediate or sustained physical activity behaviour (Engelen et al., 2017; Nocon et al., 2010; Coleman & Gonzalez, 2007; Adams & White, 2002).

The findings presented in Studies 1, 4 and 5 may explain the variable success achieved in previous environmental interventions. As indicated by Study 1, the variable success of environmental interventions could be explained by motivational differences. Findings from Study 1 suggest that living in an activity-friendly neighbourhood appears to serve as a buffer when psychological resources are low, while findings from Study 5 indicate that satisfying neighbourhoods may facilitate autonomy for incidental physical activity and enhance well-being. Indeed, the results of Study 4 showed that autonomous motivation for transportation predicted walking behaviour, and that an environmental manipulation that emphasised autonomy was more motivating compared to a message that did not emphasise autonomy. Therefore, environmental interventions aimed at increasing incidental physical activity levels might best be targeted at encouraging autonomous motivation. Future infrastructure should be developed with this in mind, as creating satisfying and walkable neighbourhoods that promote autonomy will assist individuals to engage in physical activity when psychological resources are low, and may have benefits for psychological well-being. Potential interventions include restructuring the layout of buildings (e.g., shopping malls, offices) to encourage movement, promoting standing on public transport over sitting, or incorporating standing desks into the workplace.

Although environmental modifications have the potential to promote autonomy, as demonstrated in Study 1, a supportive environment does not guarantee autonomous motivation. Collectively, Studies 1, 4 and 5 demonstrate the complex relationship between the environment and motivation. Thus, the findings from Studies 1 and 2 which highlight the importance of tailoring intervention techniques to a specific type of physical activity, should also be considered. Study 1 indicates that programs looking to increase levels of incidental physical activity would benefit from infrastructural interventions that aim to increase the perceived walkability and perceived safety of neighbourhoods. For example, improving street lighting can offer a clear field of vision and limit places where potential risks may be concealed, which in turn increases the perceived safety and walkability of the neighbourhood (Gatersleben & Andrews, 2013). Study 1 further showed that by contrast, programs that target leisure time physical activity would benefit from focusing on psychological factors, such as motivation and intentions, and use the built environment as a complementary feature. For example, public health campaign messages could emphasise the convenience of exercising in the neighbourhood to increase individuals' intentions (Powell et al., 2003), and hint at the fact that neighbourhood environments provide opportunities to meet people and engage in social activities to increase motivation (Deci & Ryan, 2008; Giles-Corti & Donovon, 2002).

7.5 Methodological Issues and Future Directions

The current thesis utilised a mix of cross-sectional, field and lab-based studies. While these provide valuable insight into the psychological, environmental and automatic processes that contribute to incidental physical activity engagement, limitations of this research also need to be acknowledged. This section will discuss the methodological contributions and limitations of the work presented in this thesis.

7.5.1. Theoretical Components

While the key focus of this thesis was to address the relative scarcity of research investigating motivational and environmental contributors to incidental physical activity, the scope of the studies presented in the current thesis was limited to investigating particular components of self-determination theory, dual process models and socio-ecological models. Another potential aspect of self-determination theory that may contribute to engagement in incidental physical activity engagement and well-being is the satisfaction of basic psychological needs. The three basic psychological needs proposed by self-determination theory are feelings of personal initiative (autonomy), effective functioning (competence), and a connection to others (relatedness) (Deci & Ryan, 2008; Vallerand, 2007). It is posited that autonomously motivated behaviour will most likely be sustained as it meets an individual's basic psychological needs (Deci & Ryan, 2008), and that when these psychological needs are not achieved the individual experiences negative psychological outcomes (Vallerand, 2007; White et al., 2018). There is emerging evidence to suggest that the satisfaction of basic psychological needs may be relevant to incidental physical activity behaviour (White et al., 2018). Specifically, White et al. (2018) found that adolescents' participation in incidental physical activities (i.e., active travel) was associated with positive affect if participants engaged in the activity out of choice (autonomy) or for social reasons (connectedness).

Furthermore, in regards to motivational regulations, the studies presented in the current thesis only examined active motivational regulations, rather than amotivation. In addition to autonomous and controlled motives, self-determination theory proposes that individuals can also be amotivated by an activity (Deci & Ryan, 2008). Amotivation occurs when individuals experience a lack of contingency between their behaviour and outcomes, and represents a complete absence of self-determination and volition with respect to the targeted behaviour. This is evident when individuals do not value an activity at all, or when they experience feelings of incompetence and uncontrollability. Therefore, while the current thesis focused on active motivational regulations (i.e., external regulation, introjected regulation, identified regulation and integrated regulation) as a starting point for the investigation into the psychological mechanisms that contribute to incidental physical activity engagement, future studies could usefully consider the role of basic needs satisfaction and amotivation for incidental physical activity behaviour engagement.

The research presented in this thesis contributes to the limited investigations into the interactions between individual characteristics and built environmental factors, and their contributions to incidental physical activity levels, as posited by socio-ecological models. However, it should be acknowledged that socio-ecological models provide a complex framework for explaining health behaviour. Accordingly, environmental settings are described as having multiple physical, social and cultural dimensions that can affect health behaviors such as physical activity (Sallis, Owen & Fisher, 2008). Previous research has found that leisure time physical activity engagement can be influenced by social and cultural factors such as support from teachers, partners or friends (Trost et al., 2002), and ethnic background (Wilcox et al., 2000). Although this was beyond the scope of the research presented in the present thesis, future studies could usefully investigate the contribution of social and cultural dimensions to incidental physical activity engagement, and how these interact with individual characteristics (e.g., motivation) to provide a greater understanding of incidental physical activity engagement.

Dual-process models propose that individuals' behaviour is guided by either rational, reflective processes which involve conscious decision-making or implicit, impulsive processes which represent well-learned, spontaneous, and non-conscious responses (Hagger, 2017; Strack & Deutsch, 2004). Conscious, cognitive resources are thought to be limited, as people do not have the time or ability to carefully consider all decisions they make throughout the day. Therefore, behaviour can be unknowingly guided by implicit, automatic processes when conscious cognitive resources are low (Strack & Deutsch, 2004). Based on previous research which has found associations between implicit attitudes, cognitive biases (i.e., attentional and approach) and exercise (Conroy et al., 2010; Berry, Spence & Stolp, 2011; Cheval et al., 2014), this thesis investigated the potential relationship between these implicit processes and incidental physical activity levels. Implicit motivations (i.e., automatic autonomous or controlled motives individuals are unaware of or unwilling to report) represent another implicit process which may contribute to individuals' incidental physical activity engagement (Keatley, Clarke & Hagger, 2014). Indeed, a recent theoretical development in self-determination theory incorporates implicit, non-conscious motivations (Hagger & Chatzisarantis, 2014). Incorporating both explicit and implicit motivation measures may therefore contribute to a deeper understanding of incidental physical activity engagement by examining the extent to which individuals engage in such activities due to impulsive, automatic motivation or reflective, conscious motivation. The research presented in this thesis provides accumulating evidence of associations between conscious contextual motivations (i.e., perceived locus of causality variables) and incidental physical activity engagement. Considering these findings, together with the small body of research that has found that implicit motivations can predict sport and intentional physical activity engagement (Caudwell & Keatley, 2016; Keatley, Clarke & Hagger, 2014; Vallerand, 2007), it is possible that implicit motives for incidental physical activity are valuable contributors to incidental physical activity engagement. Future research could investigate how implicit motivations for incidental physical activity influence behaviour to further the understanding of what guides incidental physical activity engagement.

7.5.2 Measurement Issues

An important methodological issue to consider regarding the studies presented in this thesis is accurately capturing incidental physical activity. Studies 1 and 5 used the International Physical Activity Questionaire to measure incidental phsyical activity. Although this measure has previously been found to be a highly valid and reliable measure of physical activity (Craig et al., 2003), it is not exempt from issues that can arise from self-report data. The construct of incidental physical activity may be particularly prone to self-report issues that can arise when measuring physical activity levels (e.g., over-reporting of activity engagement), as individuals do not typically moniter their engagment in incidental physical activity (Sallis & Saelens, 2000; Lee et al., 2011). Thus, although Studies 1 and 5 utilised a widely reccomended measure of phsyical activity, concerns of self-report measures should be considered when interpreting these findings.

A clear strength of Studies 2 and 3 was the use of a seven-day step count obtained from pedometers as an objective measure of incidental physical acitivity. Pedometers have previously been found to be a valid and reliable mesaure of physical activity (Dowd et al., 2018;Tudor-Locke et al., 2002; McNamara et al., 2010). In general, objective measures of physical activity demonstrate less variability than self-report measures. Upon reviewing the literature on techniques for physical activity measurement in adults, Dowd et al. (2018) concluded that objective measures of physical activity, such as pedometers, should be utilised when measuring physical activity in adults in free-living environments. However, it is also recognised that no perfect measure of physical activity exists (Dowd et al., 2018). Indeed in Studies 2 and 3, to obtain a “pure” measure of incidental physical activity, particants were requested to remove the pedometers when engaging in intentional exercise. However, as researchers were unable to directly moniter whether participants followed these instructions, this measure relied on participants being truthful. Until recently, differentiating between light and vigorous physical activity has created difficulties in interpreting objective data obtained from pedometers. However, accelerometers can now quantify time spent in different intensities of activity by summing time above and below specified count thresholds. Future studies should therefore use accelometers that can objectively differentiate between high intensity physical activity (i.e., exercise) and incidental physical activity.

Another important issue that applies across the studies in this thesis is the assessment of motivation that is hypothesised to be contextual. By nature, contextual motivations are difficult to capture as such motivations have previously been found to shift and change (Niven & Markland., 2016; Guay et al., 2015). This may be particularly relevant for incidental physical activity as it involves a variety of sub-behaviours, some that people choose to do versus those that they have to do. For example, some people may choose the active transport option (e.g., walking or cycling) whereas others take it out of necessity as the passive transport option (e.g., driving) is not available or feasible. Therefore, our measure of motivation may have been confounded by including a variety of sub-behaviours. Future research should investigate motivational correlates of specific incidental physical activity sub-behaviours. For example, motivational factors associated with active modes of travel to work, standing desks, walking for transport, taking the stairs and domestic chores are likely to all have varying motives. Understanding the driving motivations for specific sub-behaviours of incidental physical activity would assist in the design of more effective intervention strategies.

7.5.3 Research Design

Although identifying the correlates of physical activity is an important line of research regarding physical activity engagement (Sallis et al., 2000; Bauman, Sallis, Dzewaltowski, & Owen, 2002), the limitations that are inherent in a cross-sectional design do not allow for inferences of any causal relationships between the investigated factors in Studies 1, 2, 3 and 5. This design can demonstrate associations between variables; however, it cannot serve to draw inferences of causal relationships. The proposed flow of effects in Studies 1 and 5 is thus implied by theory alone, not by the data. Additionally, the current research utilised a retrospective designs which can be subject to bias. Specifically, Studies 2 and 3 are susceptible to reporting bias as the self-report motivation measures were adminsitered after having monitored participants' incidental physical activity for a week. Additional confirmation of causal influences from prospective longitudinal, experimental or quasi-experimental studies is required to clarify the casual nature of the relationships between motivational, environmental and behavioural factors, and their contributions to well-being, is required to further assist the development of effective interventions. How motivational regulations contribute to incidental physical activity persistence and subsequent well-being is another important avenue for future research. Longitudinal or experimental designs could clarify whether autonomous forms of motivation result in sustained incidental physical activity engagement, and controlled forms of motivation result in an eventual decline of activity engagement, as has previously been found for exercise (Pelletier et al., 2001).

Additionally, the use of self-report questionnaire measures means that the results can be subject to a number of cognitive and/or response biases. Given the length of some of the questionnaires it is possible that participants may have felt burdened, leading to erroneous responding (Reis & Gable, 2000). In an attempt to reduce the participant burden, Study 2 utilized the perceived choice subscale of the Self-Determination Scale to assess the construct of trait autonomy. Although the selected subscale has previously been found to be a valid and reliable measure of enduring behavioral autonomy (Sheldon, Ryan & Reis, 1996), future research would benefit from replicating the findings presented in Study 2 utilizing a more comprehensive measure of trait motivation. It is also possible that participants were aware of the nature of the hypotheses being investigated in this research, and therefore responded in ways that the researcher would expect (e.g., "I walk to get from A to B because I enjoy it'). Social desirability may also have swayed participants to under- or over-report certain motivations or physical activity levels in order to appear a certain way to the researchers (Grimm, 2010). Indeed, high levels of motivation and physical activity engagement were reported across the studies. Notwithstanding possible biases, it is conceivable that most participants were genuinely motivated and physically active, which is possibly a reflection of the population that was studied (i.e., active, healthy individuals). It will be important in future studies to consider controlling for response factors.

7.5.4 Sample

The samples of the studies in the current thesis represent a homogenous demographic profile. Specifically, the samples in the current research consisted of predominantly young, female, educated, active and motivated individuals. This limits the external validity and generalizability of the findings

(Henrich et al., 2010a). While the studies have provided a better understanding of the processes that contribute to incidental physical activity behaviour in mostly healthy, normal weight adults, this limits the ability to generalise the findings to clinical samples, including individuals who suffer from a health problem that prevents them from engaging in, or being motivated for, any form of physical activity. Future research could usefully explore specific motivating factors for incidental physical activity for sub-populations. Additionally, from a public health perspective, it is important to determine whether findings from the current thesis generalise to a more representative sample of the population. It has been suggested that people from Western, educated, industrialized and democratic societies represent a unique sub-sample of the world's population (Heinrich al at., 2010b). Future research could usefully investigate whether findings apply across varying age and socio-economic groups, including older, inactive and unmotivated individuals. Furthermore, evidence suggests that motivational processes vary across populations (Henrich et al., 2010b). Therefore, an important avenue to investigate is whether findings apply to non-Western societies. For example, Asian cultures tend to reason holistically by considering people's behaviour in terms of their situation, and may therefore utilise different motivational processes (Henrich et al., 2010a).

7.6 Conclusion

Despite the above limitations this thesis makes a unique contribution to the literature in that it has identified important inter-relationships between psychological and environmental factors, as well as their contributions to incidental physical activity engagement, and the circumstances in which incidental physical activity is beneficial for psychological well-being. Findings from Studies 1 and 2 highlight the unique contributing factors to incidental physical activity, compared to leisure time physical activity. Findings from Studies 3 and 4 highlight how the interplay between motivational and automatic processes can contribute to incidental physical activity engagement. Findings from Studies 1, 4 and 5 shed light on the contribution of certain environmental factors to the relationship between motivation and incidental physical activity engagement. Finally, Study 5 provides important information regarding the circumstances under which incidental physical activity engagement is associated with higher well-being. Thus, the findings presented in the current thesis suggest that incidental physical activity is determined by a myriad of factors. Findings highlight the complexity of the relationship between individual and environmental factors, and how they contribute to incidental physical activity.

In conclusion, the current thesis addressed an important, but often overlooked, contributor to a healthy lifestyle, namely incidental physical activity. The five empirical studies addressed specific questions about the relationships between motivational and environmental factors constructs, under the umbrella of several complementary theoretical perspectives. The findings support specific constructs from self-determination theory, socio-ecological and dual process models, and encourage the adoption of multiple theories in order to understand incidental physical activity behaviour. In a practical sense, the findings suggest that interventions aimed at increasing incidental physical activity would be best targeted towards increasing autonomous motives for specific incidental physical activities, while also considering the role of the neighbourhood environment. Further exploration and application of the ideas surrounding motivational, environmental and automatic contributors to incidental physical activity may foster a greater understanding of the underlying mechanisms that facilitate incidental physical activity engagement, and lead to successful and sustainable strategies that promote active lifestyles.

7.7 References

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