Understanding school travel behaviour: An application of the theory of planned behaviour and the construct of habit

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Declaration of authenticity and author's rights

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Date: 12/09/2012

ABSTRACT

The purpose of this thesis was to develop an understanding of active school travel and to investigate the effects of a school-based intervention within the context of an extension of the theory of planned behaviour (Ajzen, 1985, 1991). Specifically, the focus was on understanding the role of habit and cognition in guiding intention and behaviour. This focus was addressed in four studies. The first two studies addressed measurement issues in this area: Study 1 examining the validity and reliability of the Self Report Habit Index (SRHI; Verplanken & Orbell, 2003) as a measure of habit and study 2 examining the validity of a measure of active travel cognition. The third study examined the theory of planned behaviour and the role of habit in predicting active school travel intention and behaviour. Finally, the fourth study examined the effect of a school-based active travel intervention, the Travelling Green resource, at changing these constructs. The findings from the research in this thesis emphasised the importance of both cognition and habit in the prediction of behaviour. However, the ability to change these constructs through the Travelling Green resource was not demonstrated. The implications of these findings in terms of direction for future research and practice are discussed in the final chapter of this thesis.

SUMMARY OF PUBLICATIONS, SUBMITTED MANUSCRIPTS AND PRESENTATIONS

Publications and manuscripts from this thesis

Study 1 **Murtagh, S**., Rowe, D.A., McMinn, D., & Nelson, N.M. (In preparation). Validity of the Self Report Habit Index for measuring active commuting habit in children. *British Journal of Social Psychology*.

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Other Publications

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Other Manuscripts

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McMinn, D., Rowe, D.A., **Murtagh, S**. & Nelson, N.M. (In review). Medium and long-term effects of a school-based intervention on children's commuting and daily physical activity: A quasi-experiment. *International Journal of Behavioral Nutrition and Physical Activity.*

Presentations

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Rowe, D.A., McMinn, D., **Murtagh, S**., & Nelson, N.M. (2011, May). Daily variability in active commuting behaviours in primary school children. *Presented at the International Congress of Ambulatory Monitoring of Physical Activity and Movement, Glasgow, Scotland.*

Murtagh, S., Rowe, D.A. McMinn, D., & Nelson, N.M. (2011, May). Effectiveness of a school-based intervention at improving the psychological antecedents of children's active travel. *Presented at the British Psychological Society Annual Conference, Glasgow, Scotland.*

Rowe, D.A., McMinn, D., **Murtagh**, S., & Nelson, N.M. (2011, May). Daily variability in active commuting behaviours in primary school children. *Presented at the International Congress of Ambulatory Monitoring of Physical Activity and Movement, Glasgow, Scotland.*

McMinn, D., Rowe, D.A., **Murtagh, S.,** & Nelson, N.M. (2011, May). The Travelling Green Study: Treatment of missing and outlying data. *Presented at the International Congress of Ambulatory Monitoring of Physical Activity and Movement, Glasgow, Scotland.*

2010

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CHAPTER ONE

Introduction

Background of the Studies

Participation in physical activity in childhood is essential for healthy development and the reduction in risk of chronic disease in later life (World Health Organization, 2008). Researchers have shown that the risk factors for cardiovascular disease and obesity begin in childhood and track into adulthood (Biddle, Gorely & Stensel, 2004). Childhood has been acknowledged as a key time to develop the skills, knowledge and attitudes that lead to active and healthy lifestyles (Rampmeyer & Clements, 2000).

Much research has focused on how best to increase children's physical activity levels. It has been suggested that this is best performed through the promotion of sustainable forms of activity such as active travel (i.e. walking and cycling) which can be easily incorporated into everyday routines and carried forward into adulthood (Pont et al., 2009; Duncan et al., 2008). Recent reviews have demonstrated that children who actively travel to school achieve higher overall levels of physical activity (Faulkner et al., 2009) and achieve greater health benefits such as cardiovascular fitness and body composition (Lubans et al., 2011). Despite the associated benefits, levels of active travel are declining. For example, in Scotland just under half of children currently walk to school (Scottish Government, 2009).

The declining trend in children's active travel needs to be addressed. Identifying effective solutions to encourage children to adopt active and sustainable forms of travel is necessary. A systematic review by Ogilvie et al. (2007) examining the effectiveness of walking interventions in children and adults found clear evidence to support the use of targeted interventions to increase walking by up to 30-60 minutes a week on average. However, of the 48 studies included, only three of the studies were aimed at promoting change in school children's travel behaviour. Interventions focused specifically on increasing active travel to and from school have increased in the last few years since the first peer-reviewed study was published by Rowland et al. (2003). As a result, a more recent systematic review has been performed to evaluate the effectiveness of interventions aimed at increasing active travel to and from school (Chillon et al., 2011). Fourteen studies were identified. These interventions were heterogeneous and varied in terms of their focus, size and scope. It was concluded that interventions appeared to evidence a small but promising effectiveness in increasing active transportation to school (p. 15). However, although the findings stemming from this review were positive, a number of limitations were apparent. Particularly evident was the need for a theoretical approach to understanding active travel behaviour. Application of a theoretical framework to this area of research, both in design and evaluation of interventions, can provide a conceptual understanding of the factors that are guiding behaviour (Noar, Chabot & Zimmerman, 2007). This can provide structure for future intervention and direction for practitioners, in terms of the provision of potentially modifiable targets (Glanz et al., 1997a).

The theory of planned behaviour (TPB; Ajzen, 1985, 1991) has emerged as one of the most influential social-cognitive models in understanding the cognitive process that determine an individual's planned intentions and lead to the best prediction of health-related behaviour (Glanz et al., 1997b; Noar, 2006; Noar et al., 2007). The TPB states that a person's individual motivational factors are used to predict the performance of a specific behaviour. Behaviour is predicted by intention and perceived behavioural control (PBC) when the behaviour is not completely volitional. In turn, intention is predicted by an individual's attitude, subjective norm and PBC. Attitude represents an individual's overall evaluations of performing the behaviour. Subjective norm is representative of the individual's assessment of the social pressures placed on the individual to perform or not to perform a behaviour. Finally, PBC represents the degree to which the individual perceives the behaviour is easy or difficult to perform.

The application of the TPB to travel related behaviour offers a reasoned account of behaviour assuming that an individual forms a decision through deliberation over the advantages and disadvantages of available travel modes. Such an application has been successfully demonstrated in research (Bamberg & Schmidt, 2003; de Bruijin et al., 2009; Forward, 2004; Kaiser & Gutscher, 2003). To date, no studies have applied the TPB in understanding the cognitive process of children's active travel. However, application of the theory has been performed to understand physical activity in children. These studies have generally demonstrated strong support for the use of the theory with children (Craig, Goldberg & Dietz, 1996; Martin et al., 2005; Martin, Oliver, & McCaughtry, 2007; Motl et al., 2002; Mummery, Spence & Hudec, 2000; Rhodes et al., 2006; Theodorakis, Doganis, Biagiatis, & Gouthas, 1991; Trost, Saunders & Ward, 2002). It is therefore logical to suggest that the application of the TPB to children's active travel behavior might provide a good account of behaviour. In addition to the TPB providing both a theoretical and pragmatic solution to understanding children's active travel, the theory also provides an outline for a number of potentially modifiable constructs that can be targeted in active travel interventions.

Although the utility of the TPB has been widely demonstrated, the application of the TPB alone has been criticised due to underlying assumption that behaviour is guided solely through reasoned decision-making. This assumption disregards the potential of behaviour being guided by automatic processes. For instance, it has been suggested that behaviours such as travel that have been frequently performed may become habitual (Garling, 1998; Kenyon & Lyons, 2003; Verplanken, Aarts & van Knippenburg, 1997). Here habits are viewed as automatic actions under certain conditions, especially within stable contextual frames (Verplanken et al. 1997). It is expected that when an individual is in a new or unfamiliar situation a behaviour will be determined through cognitive reasoning (Aarts, Verplanken & van Knippenberg, 1998). In contrast, when a behaviour has been performed frequently in the past and may therefore be governed by habits, an individual is likely to perform the behaviour in the absence of conscious reasoning (Aarts & Dijksterhuis, 2000a). Consequently, behaviours which have been frequently performed may become habitual to the extent that change is either inhibited or prevented (Garling, 1998; Kenyon & Lyons, 2003 Verplanken, Aarts & van Knippenburg, 1997). Additionally, habits are also associated with biased estimation of alternative travel models, for example, individuals with strong habits towards one mode of travel will increase their perception of the associated disadvantages of alternative forms of travel (Kenyon & Lyons, 2003).

Whilst a plethora of research dealing with repeated behaviour and habit has been conducted, few studies have been performed using a child population. Amongst adults, the importance of habit has been previously recognized in the literature addressing a range of behaviours including travel. For instance, research using experience-sampling diaries in both community and student samples have shown that approximately 45% of everyday behaviours tend to be repeated in the same location every day (Quinn & Wood, 2005; Wood, Quinn & Kashy, 2002). In terms of travel behaviour, it has been suggested that because mobility is a major part of modern everyday lives, choices relating to travel mode choice becomes an extremely repetitive behaviour (Verplanken, Walker, Davis & Jurasek, 2008). Additionally, the repetitive nature of a behaviour is also particularly significant given the cumulative impact on health, social and economic outcomes. This has been illustrated by Hill, Wyatt, Reed and Peters (2003) who estimated that weight gain and obesity in the majority of the population could be addressed by small changes in behaviour, such as 15 minutes per day of walking or a reduction in calorie consumption by approximately 100 kcal/day.

Finally, although the literature has pointed towards the addition of habit to models of behaviour, its inclusion within research in this area has been limited for a number of reasons. One reason for this is the historic lack of an effective methodological tool to measure the construct (Ouellette & Wood, 1998). However, more recently a measure has been developed to assess habit strength namely, the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003). The SRHI has overcome previous methodological and conceptual difficulties that have been associated with the measurement of habit.

In addition to the lack of inclusion of the construct of habit into theoretical models of behaviour which is evident in the psychological and social science literature, researchers have drawn attention to the issues concerning habit measurement through the use of the SRHI. According to a recent communication, the inclusion of a number of items in the SRHI are questionable given that they pertain to the antecedents and consequences of habit and not the construct *per se* (Sniehotta & Presseau, 2012). For example, according to these authors, a pre-condition to the formation of habit is previous enactment (i.e. behavioural frequency) and while this pre-condition determines habit it is not part of the construct itself. Additionally, self-identity does not appear to be a necessary feature of habit. Furthermore, the authors also question the extent to which an individual is able to accurately report levels of awareness through a self-report measure. Addressing these criticisms, further development concerning habit measurement can also be seen in a recent publication written by Gardner and colleagues who have attempted to refine the SRHI through the creation of a more parsimonious measure, namely the Self-Report Behavioural Automaticity Inventory (SRBAI; Gardner, Abraham, Lally & de Bruijn, 2012). . The SRBAI contains four items taken from the SRHI all of which relate to the feature of automaticity which is considered the ‘active ingredient’ of habit. To date this development has only been examined by Gardner et al (2012) and these authors examined the reliability, convergent validity and predictive utility of the measure in a secondary analysis of all SRHI applications. Concerning the predictive utility of this study found that although the SRBAI represented a measure which was more parsimonious, the SRHI predicted more variance in behaviour than did the SRBAI.   Given these findings, the authors highlight that although the SRBAI can distinguish detect the effects of habit on behaviour, it is unlikely to distinguish between habit-forms of automaticity and other forms of automaticity. Consequently, the authors concluded that, compared to the use of the SRHI, the SRBAI only provides a useful alternative in studies of habit formation.

To date, no research has examined the role of habits in the determination of children’s travel behaviour. However, previous findings in physical activity suggest that activities such as biking or running seem to be performed automatically without the formation of intentions or planning (Aarts, Verplanken, & van Knippenberg, 1997). Furthermore, research examining habit in adult travel behaviour has demonstrated the importance of this construct (de Bruijin et al., 2009; Gardner, 2009). Based upon these findings, the investigation of habit in children’s travel behaviour may constitute an important determinant of behaviour.

Significance of the Thesis

Researchers have indicated that active travel provides both a feasible solution for addressing the decline evident in chidlren's phsycial activity (Davison, Werder & Lawson, 2008); however more needs to be known in terms of the most effective methods by which active travel interventions can address declining trend in physical activity. The application of the reasoned (i.e. TPB constructs) and automatic (i.e. habit) processes offers an important and valuable addition to current investigations of travel behaviour. The thesis may be significant for four main reasons: The examination of the validity and reliability evidence of a measure that can be used to assess school travel habits (walking and car/bus use) may therefore be a useful tool in the assessment of children's school travel behaviour. This examination of validity of the SRHI as a habit measure is particularly pertinent given the recent debate and interest concerning the measurement of habit (see Garder et al., 2012; Sniehotta & Presseau, 2012). Secondly, the examination of the validity and reliability evidence of a measure of that can be used to assess TPB constructs in relation to school travel behaviour may also be a valuable tool to enable the examination of cognitions of active school travel in children. Thirdly, incorporating the construct of habit a theoretical understanding of behaviour can potentially increase understanding of active travel behaviour. This understanding can then be subsequently used to inform potential behaviour change strategies. Additionally, such a perspective also represents an important contribution to the wider literature addressing the interplay between behaviour which is led by conscious decision making (i.e. constructs outlined in the TPB) and that of the automatic processing demonstrated through habitual performance. Finally, the thesis demonstrates an evaluation of the 'Travelling Green' intervention which is a school-based resource that is currently available to all schools in Scotland. Findings from this thesis can therefore provide potentially important information that can be used to assist educators, practitioners and policy makers to enhance future initiatives.

Objectives of the Thesis

The thesis has four main purposes:

1. To provide validity and reliability evidence for the questionnaire methods to assess levels of habit in primary school children (Study 1, presented in Chapter 2).
2. To provide validity and reliability evidence for the questionnaire methods to assess the TPB constructs to measure cognitions towards walking to school in primary school children (Study 2, presented in Chapter 3).
3. To understand how these constructs predict both intention and behaviour (Study 3, presented in Chapter 4).
4. To examine the effects of the Travelling Green intervention on habit and the TPB constructs (Study 4, presented in Chapter 5).

It is expected that the findings from this thesis will contribute to improvements in the efficacy of subsequent interventions aimed at increasing active travel through the identification of constructs that determine behaviour.

Dissemination of the Thesis

The present thesis comprises four studies. The initial study explores the validity and reliability of the Self-Report Habit Index (SRHI) for measuring walking habit and car/bus use habit in children. This study addressed important issues concerning the current conceptualization of the construct of habit. The findings of this study were presented at the

British Association of Sport and Exercise Science Annual Conference in September 2010. The second study examined the validity and reliability of a self-report questionnaire used to assess each of the TPB constructs in relations to walking to school. Findings from this study were presented at the e-conference *International e-Conference Kinesiology and Integrated Physiology* in October 2011. The third study examined the utility of the theory of planned behaviour and the construct of habit to explore active travel intentions and behaviour. Specifically, in regards to habit, the study explored whether habit moderated the intention-behaviour relationship and provided additional understanding above and beyond that offered by the TPB. The addition of habit therefore addressed the current issues regarding what has been named as the "intention-behaviour" gap, a term used to describe the difference between an individual's intention and their actual behaviour (Ogden, 2000). This is seen as an important conceptual issue, particularly so within the domain of physical activity promotion. For example, most intentions are reliant on behaviour change through changes in cognitions (i.e. intention). However, existing theories (including TPB) leave a substantial proportion of the variance in behaviour, beyond the effect of intentions to be explained (Sheeran, 2002; Webb & Sheeran, 2006). There has been recent accumulation of evidence in social and cognitive psychology, that habituation is an important component of human behaviour. Traditional models of behaviour change have not fully integrated this evidence yet. However, such integration can potentially improve the effectiveness of interventions. This study therefore demonstrates the importance of such integration. This research was presented at the *American College of Sports Medicine's Annual Meeting* in May 2011. Finally the fourth paper investigates the effects of the Travelling Green intervention on the TPB constructs and habit. This study made an important contribution to current research investigating the promotion of active school travel. For example, the evaluation of the TPB constructs and habit addressed several of the main limitations of previous studies by providing a more comprehensive examination of psychological determinants that were demonstrated in study 3 to underpin children's travel behavior. Additionally, the identification of the constructs in this study provides both a pragmatic evaluation of a complex school-based intervention and a number of modifiable targets that can be identified in future research and practice. The findings from this paper were presented at the *British Psychological Society Annual Conference* in March 2011.

CHAPTER TWO

Review of the Literature

This chapter will examine current and recommended levels of physical activity participation in children. This will be followed by an examination of the benefits of active travel and the effectiveness of active travel interventions as a means of increasing physical activity in children. The chapter will discuss the application of theory to understand behaviour and, more specifically, examine the use of the theory of planned behaviour to predict active school travel in children. The chapter will then examine the role of habit in the context of the theory of planned behaviour and in doing so, examine the conceptual and methodological issues surrounding habit. A brief overview of the current understanding of reliability and validity will be provided. Finally, the aims and objectives of the thesis will be discussed at the end of this chapter.

Physical Activity Participation in Children

Over the last decade, a number of reviews have been performed to investigate the relationship between physical activity and health in children. These have included both physiological and psychosocial aspects of health. Overall, these reviews have provided overwhelming evidence demonstrating the importance of physical activity as part of a healthy lifestyle in childhood. These include meta analyses (e.g. Ahn & Fedewa, 2011; Rowlands, Ingledew & Eston, 2000), systematic reviews (e.g. Janssen & LeBlanc, 2010; Strong et al., 2005; United States Department of Health and Human Services, 2008) and narrative reviews (e.g. Etnier et al., 2006; Janssen, 2007; Kelley & Kelley, 2003; Reilly & McDowell, 2003; Tolfrey et al., 2000; Twisk, 2001).

The benefits of physical activity are wide ranging and include the promotion of healthy weight, development of peak bone mass, improved cognitive function, increased self-esteem, and the facilitation of motor and social skill development (Alpert et al., 1990; Anderson et al, 2004; Fisher et al., 2005; Haywood, & Getchell, 2005; Saakslahti et al., 1999). Physical activity has also been positively associated with measures of classroom-related performance such as mental cognition, concentration levels, academic performance (Dwyer, Blizzard & Dean, 1996; Jarrett, Maxwell, Dickerson, Hoge, Davies, & Yetley, 1998; Biddle, 1995; Sallis, McKenzie, Kolody, Lewis, Marshall, & Rosengard, 1999; Shephard, 1996), and classroom-related behaviour such as a reduction in fidgeting and school-related stress and anxiety (Field, Diego & Sanders, 2001; Jarrett, 1998; Mahar, Murphy, Rowe et al., 2006). Moreover, there is research to suggest that physical activity plays an important role in improving social and moral development (Burt, 1998; Miller et al., 1997).

Physical activity participation has been recognised as a key element in the prevention of obesity (Wareham et al., 2005). It has been suggested that a reduction in physical activity over time is likely to offset the energy balance equation (Rennie et al., 2005). This is suggested as a contributing factor in the increased prevalence of childhood obesity seen worldwide (Crespo et al., 2001; Dietz & Gortmaker, 1985; Gortmaker et al., 1996; Kesaniemi et al., 2001; Parsons et al., 1999; Tremblay &Willms, 2003; Wang & Lobstein, 2006). In Scotland, recent data recorded by the Scottish Health Survey has highlighted the extent of this problem. According to this survey, 29.9% of children (31.1% of boys and 28.5% of girls) are currently overweight or obese (Scottish Government, 2011). Although this survey found that the proportion of girls who are overweight or obese has not varied between 1998 and 2010, the prevalence of boys who are overweight or obese has increased by 3.3% (27.8%

to 31.1%). It is also expected that in the long-term, children and adolescents who are overweight have a 70% chance of becoming overweight or obese in adulthood and that this statistic increases to 80% if one or more parent is overweight or obese (Torgan, 2002).

Increasing levels of obesity represent a significant economic burden to society. It has been estimated that obesity causes at least as many health problems as poverty, smoking and alcohol consumption and has an estimated total annual cost to Scottish society of £457 million (Scottish Government, 2011). From a public health perspective it is therefore important to address the factors associated with obesity, such as physical inactivity. Since these behaviours are often established in early age (Reilly, 2006), there is a heightened global awareness of the importance of physical activity promotion in children in the context of obesity prevention (Goran, Reynolds & Lindquist, 1999).

Physical Activity Recommendations

In recognition of the wide ranging benefits of physical activity, the Scottish government developed a national physical activity strategy, “Let's make Scotland more active” (Physical Activity Taskforce, 2003). This strategy aimed to increase the percentage of individuals who are currently physically active and recommended that children should achieve at least one hour of moderate activity on most days of the week. The strategy also specified a national target to increase the proportion of children meeting the physical activity recommendations to 80% by the year 2022.

More recently, these physical activity guidelines were superseded by the release of the UK-wide physical activity guidelines announced in 2011 in the report, “Start active, stay active”

(Department of Health, 2011) . The report, which was written by the four Chief Medical Officers (CMOs) of England, Scotland, Wales and Northern Ireland, provided a summation of all current evidence. This was the first time UK-wide physical activity guidelines had been produced and therefore provided a consistent message across the four home countries. Based on the evidence reviewed, the report recommended that children should achieve a daily minimum of 60 minutes of moderate-intensity activity. This thereby increased previous recommendations from “most days of the week” to “daily”.

Current Physical Activity Levels

Despite the known health benefits, current trends demonstrate that a large proportion of children do not achieve the recommended minimum levels of physical activity. Data collected in Scotland found that only 19% of boys and 11% of girls meet the current recommended minimum target of at least 60 minutes of physical activity per day (Currie, Levin, Kirby et al., 2011). Additionally, older children were found to take part in less physical activity than younger children. For example, only 8% of girls and 13% boys aged 15 years were meeting the recommendations compared with 16% of girls and 24% boys aged 11 years (see Figure 1).

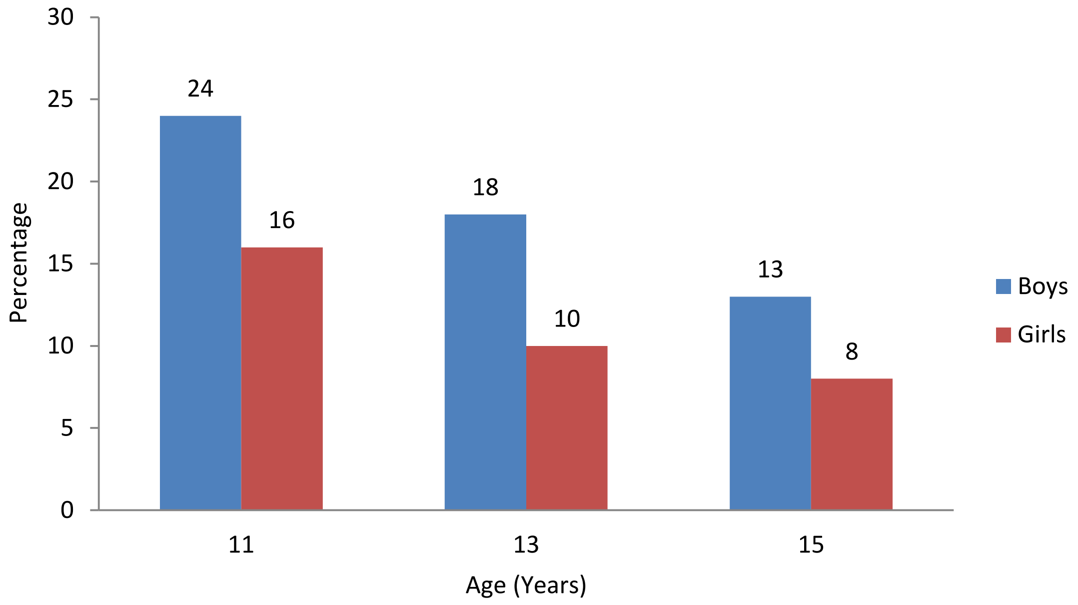


Figure 1. Percentage of children meeting the physical activity recommendations (Currie et al., 2011).

Data presented in this survey suggest that there is an age-related decline in physical activity from childhood to adolescence. Despite, these data being cross-sectional and therefore not conclusive, this finding *is* supported by a recent systematic review examining change in physical activity during adolescence. The review conducted by Dumith et al. (2011) included 26 studies that were carried out in ten different countries, including one in Scotland (Knowles, Niven, Fawkner et al., 2009) and one in England (Broderson, Steptoe, Boniface et al., 2007). Findings from the review demonstrated that, on average, physical activity levels decrease by 7% per year during adolescence (Dumith et al., 2011).

Physical Activity Promotion

As presented in the previous section, recent trends have found that 81% of girls and 89% of boys of Scottish children do not participate in sufficient physical activity to gain health benefits (Currie, Levin, Kirby et al., 2011). Additionally, an age-related decline in physical activity has been demonstrated (i.e. Dumith, et al., 2011). The promotion of physical activity in children therefore represents an important public health objective.

The promotion of physical activity in children is underpinned by the assumption that physical activity can provide both immediate and long-term health benefits (Malina, 1997). The benefits of physical activity in childhood have been outlined by Blair et al. (1989). Benefits include: a) the improvement of childhood health status, b) the improvement of adult health status (i.e. through the delayed onset of chronic diseases in adulthood), and c) the indirect enhancing of adult health status which may be achieved through the increased likelihood of maintaining adequate health status (see Figure 1).

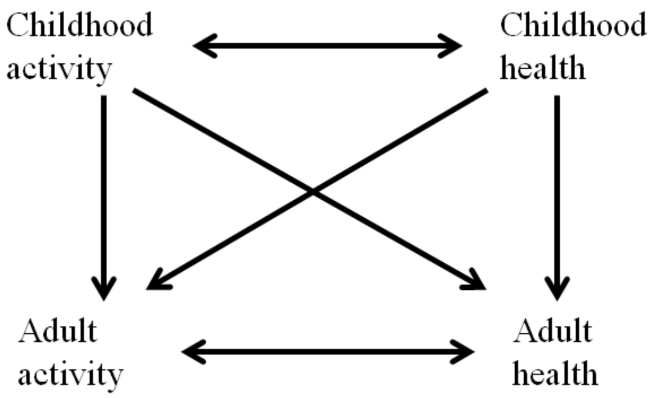


Figure 2. Physical activity in children and adults (Blair et al., 1989).

Consequently, strategies are needed that: a) effectively increase current physical activity levels in children, thus enhancing current health status and, b) can be maintained over the life course, and thus increase the likelihood of participation in activity in adulthood (Corder, Ogilvie & van Slujis, 2009). To date, there have been many longitudinal studies examining physical activity patterns over the lifespan. Much of this research has examined the extent to which physical activity will be maintained over time in relation to one's peers, a concept referred to as “tracking” (Boreham & Riddoch, 2001). These studies assume that physical activity behaviours and healthy lifestyles developed in childhood will track across the lifespan (Boreham & Riddoch, 2001). This assumption has been used to justify the promotion of physical activity in children and adolescence.

However, researchers investigating the tracking of physical activity behaviours between childhood, adolescence and young adulthood have found the magnitude of this association to be low (Evans, Sheila, & Crombie, 2009). According to authors in this area, these findings could be due to a number of different reasons. One reason suggested for the low level of tracking is the type of involvement in various sports and activities observed in childhood (Kjonniksen, Torsheim & Wold, 2008). For example, physical activity encompasses a wide variety of activities that may include competitive and recreational sports, household chores, and travel. These activities vary in terms of the frequencies, durations, and intensities that they can be performed at, the contexts which they can be performed in and the level of organisation required (WHO, 2011). A vast array of opportunities therefore exist for individuals to accumulate the recommended levels of physical activity. The degree of maintenance is likely to differ across activity types and activity domains (Kjonniksen, Torsheim & Wold, 2008). In addition, cross-sectional studies have shown that the rate of decline in participation levels varies between different activities (Craig, Cameron, Russell, & Beaulieu, 2001), repeat cross-sectional studies (Ifed, 2008), and longitudinal studies (Dovey, Reeder & Chalmers, 1998; Kjonniksen, Torsheim, & Worl, 2008; Telama & Yang, 2000; van Mechelen, Twist, Post, Snel, & Kemper, 2000). Consequently, Sallis et al. (2000) suggested that physical activities that can be performed with little organisation, without the reliance on others and at little expense may be more easily carried over from adolescence into adulthood. Furthermore, the incorporation of activities into everyday routines is significantly more likely to facilitate the permanent adoption of such behaviour (Laitakari, Vouri & Oja, 1996). This approach is also congruent with perspectives on habitual behaviour. According to Verplanken and Melkevik (2008), frequent involvement in physical activity in consistent and stable environments (e.g. a brisk walk every morning before breakfast) can lead to the development of the behaviour as habit and therefore offer a good opportunity for prolonged involvement.

Individual level activities such as walking, hiking and cycling may provide opportunities for prolonged involvement (Sallis et al., 2004). A recent study by Belanger et al. (2009) tracked physical activity participation through adolescence, and demonstrated that of 29 activities measured (including a range of individual and team activities), the continuation rates (e.g. continued participation in the behaviour across adolescence) were highest for walking, when compared with any other activity. This study also found walking to be the only activity in which the prevalence of participation did not decrease over time among girls. Increasing physical activity through active forms of travel such as walking, may therefore offer a valuable, feasible, and most importantly, long-term solution to increasing physical activity. Accordingly, the promotion of active forms of travel has been suggested to be a better public health strategy than traditional structured and organised programs (Handy, 2004; Litman, 2003; Saelensminde, 2002).

Active Travel Promotion

The term “active travel” (also referred to as active transportation) is used to describe any mode that requires using human physical power, but is predominantly used to describe walking and cycling as transport (Saelens, Sallis, & Frank, 2003). Active travel can be easily practised by a large number of individuals without the need for large investment (i.e. facilities and resources). It is therefore advocated as the most practical and sustainable way to increase physical activity on a daily basis (The Toronto Charter for Physical Activity, 2011). The promotion of active travel has been widely recognised as a valuable approach to increasing physical activity (Cooper et al., 2003; Cooper et al., 2005; Sirard et al., 2005).

Researchers have shown that children walking at a moderate speed (5 km/hour) can expend sufficient energy to meet the threshold for moderate intensity physical activity (Ridley & Olds, 2008), the intensity at which health benefits are achieved. Many exercise programs are limited by factors such as cost, access, adherence, and ability. Walking, however, affords a readily available, inexpensive, and convenient means of being physically active. It is thought that promoting purposive forms of walking, such as shopping and travelling to work or school, is more effective as these forms of walking are associated with higher adherence rates than walking for fitness or pleasure (Coogan & Coogan, 2004).

Experts in the area of transportation have recognised the long-term importance of early childhood intervention when it comes to achieving long-term sustainable transport practices (Faulkner et al., 2009). For example, in emphasising the importance of early adoption of healthy and sustainable travel behaviour, Roberts (1996) has suggested that "it may be unrealistic to expect the chauffeured children of today to become the ambulant adults of tomorrow" (p. 1229). Interventions may therefore be more effective in developing sustainable behaviour change when aimed at children and adolescents rather than adults (Frank et al., 2003).

One way of helping children to accumulate activity is to encourage active travel to and from school. In this context, walking and cycling can provide convenient and effective opportunities for incorporating at least two bouts of physical activity into children's daily routines. In addition, this form of active travel promotion has been considered an important policy in terms of reducing congestion and accidents that are associated with the journey to and from school (Scottish Executive, 2006).

Despite the proposed benefits of active school travel, population based data in the UK have reported that between 1985/86 and 2006, the percentage of UK primary school children who regularly walked to school decreased from 67% to 52% and that car use in this time has increased from 22% to 41% (Department for Transport, 2007). The survey showed that only 1% of primary school children cycled to school. These findings are consistent with trends in the US (McDonald, 2007) and Australia (Salmon et al., 2005; van der Ploef et al., 2008).

As a result of recent trends in children's school travel there is a need to find effective ways by which to increase active travel to and from school. To achieve this, there is a need to examine the research investigating active school travel in terms of the implied association with physical activity and health. Additionally, there is a need to examine how effective current interventions are at influencing this behaviour. The following sections provide an overview of the current research pertaining to these areas of research.

Benefits of Active Travel

The benefits associated with active travel have been widely researched, and the hypothesised benefits are wide ranging. For example, there is much research investigating the environmental impact of active travel such as improvements in air quality, and reductions in car usage, urban congestion and carbon emissions (Woodcock, Banister, Edwards, Prentice & Roberts, 2007; Litman, 2009). Active travel is also considered beneficial over motorised forms of transport for reasons of convenience and safety. For example, these benefits include the reduction in congestion and parking costs, and the improvement in mobility options, traffic safety and efficiency of land use (Fishman et al., 2011). Although these benefits are acknowledged, the rationale for this thesis is focused on the promotion of active travel primarily in terms of the associated health benefits. For this reason, the following section includes research investigating the health outcomes associated with active travel.

The association between children's active travel and health outcomes has been examined in two recent reviews (Davison et al., 2008; Faulkner et al., 2009). These reviews differ in terms of their inclusion criteria and the number of studies included. Faulkner et al. (2009) conducted a systematic review of 13 studies. Details of the sampling and participant characteristics, physical activity measures and active school travel classification (e.g. to or to and from school) were provided in detail for each study. Only studies using objective measures to assess physical activity (i.e. the main outcome measure) were included. In comparison, the review by Davison et al. (2008) included studies using both objective and subjective measures. The use of subjective measures, particularly in children's physical activity research, has been considered unfavourable due to various measurement limitations such as cognitive, affective, and self-presentation biases (Baranowski, 1988; Cale, 1994). Additionally, the review by Davison et al. (2008) did not quantify the evidence or report the sample characteristics or study details associated with each of the studies. Therefore, although findings from both the reviews are considered in this literature review, the more recent and more rigorous review by Faulkner et al. (2009) may be regarded as a potentially more useful insight into this area of research.

Davison et al. (2008) included all health outcomes associated with children's active travel which had previously been examined in the literature. This resulted in three key health indicators being identified: physical activity, cardiovascular fitness, and body mass index (BMI). The majority of studies included were cross-sectional in design. According to the evidence in this review, children who actively travel to school have higher daily levels of physical activity. These effects are noted when both subjective and objective measures of physical activity were used. One study demonstrated that children who cycled to school were nearly five times more likely to be in the top quartile for fitness than were youth who walked or used motorised forms of transport (Cooper, WedderKopp, Wang et al., 2006). However, no evidence was found to support the link between cardiovascular fitness and walking. With regard to BMI, the review found no evidence to support the association of active travel and this outcome.

Faulkner et al. (2009) substantiated the earlier findings of Davison et al. (2008) through the use of a systematic and more robust methodology. The review examined evidence linking active travel to overall physical activity levels and body weight among children and adolescents aged between 5 and 18. The majority of studies (11 of 13) demonstrated that active school commuters tend to be more physically active overall than passive commuters. Congruent with Davison et al. (2008), the authors concluded that current evidence relating active travel to a healthy body weight is less convincing.

Specific findings related to physical activity duration and intensity were explored by Faulkner et al. (2009). The evidence reviewed suggested that in comparison to children who used motorised transport, children who actively commuted to school accumulated a significantly greater volume of physical activity, accumulated higher levels of moderate to vigorous physical activity levels, expended significantly more kilocalories, and had an overall greater step count. Based on the evidence available, the authors concluded that since active travel incorporates both health and transport benefits "a focus on active school transport is suitable given that adequate participation in physical activity during childhood and adolescence could be critical to the prevention of chronic disease later in life." (p. 7). Consequently, Faulkner et al. (2009) concluded that interventions that are able to modify attitudes and cognitions towards active travel appear particularly attractive as they would provide a feasible and potentially cost effective solution to targeting changes in children's physical activity.

The findings of the review by Faulkner et al. (2009) therefore provided justification for policy makers towards funding of initiatives promoting active travel. Despite the supportive evidence for the promotion of active travel in children, there are limitations within the current literature. A particularly notable gap in the literature concerns the underlying mechanisms of interventions in terms of *how* "initiatives promote active school travel and facilitate an increase in daily physical activity" (p. 7). As a result, an understanding of the determinants of active travel and the underlying mechanisms responsible for guiding behaviour is needed in order to develop interventions that can modify behaviour.

Active Travel Interventions

To date, active school travel interventions have used a variety of different approaches to change behaviour. These include educational strategies, infra-structure changes and events. The Walking School Bus (WSB) is one example of an active travel initiative. The WSB initiative was originally designed in Denmark over a decade ago with the main objective being to improve road safety on the school journey (Anderson, 1997). The WSB involves a group of children walking to school along a designated route. The bus is escorted by several adult volunteers; one of whom is at the front ("the driver") and another is at the back ("the conductor") and collects children along the way at "bus stops". Each walking bus has a designated coordinator who ensures that there are sufficient volunteers, and is responsible for registering the children who wish to use the walking school bus. A recent evaluation of this intervention found that children using the WSB successfully increased both active school travel and daily physical activity (Heelan et al., 2009).

Another widely implemented program is the "Walk Once a Week" (WoW) scheme. This scheme was first implemented in the UK in 2005 and is managed by the charity Living Streets (see www.walktoschool.org.uk). The scheme encourages children to dedicate at least one day to walking to school (usually a Wednesday or the same day every week). Progress is then recorded weekly by either the teacher or a pupil monitor, using a monthly class wall chart. Pupils are rewarded on their progress with a collectable badge. To date, only an independent (non-peer reviewed) report has evaluated the scheme (Wavehill Consulting, 2009). Data collection for this survey involved 341 schools (n = 23,450). The evaluation involved a "hands up" survey in which a series of questions were asked to categorise each child's travel into one of the standard response categories (Transport for London, 2008). This is a class-room based measure in which children show their hands in response to the questions and the teacher records the number of responses to each question. Firstly, the survey found that of the schools taking part in WoW, 59% of girls and 60% of boys reported walking to school. These levels were higher than that of the national average (i.e. 51%, National Travel Survey, 2007). The results also suggested that 19% of boys and 18% of girls stated that they had started walking to school because of WoW. Although the study appeared to demonstrate some positive findings, the research methodology was limited by the measurement of behaviour (i.e. hands up survey) and the non-randomisation of schools invited to participate in the survey.

Some active travel interventions have also included strategies to change local infra-structure. Safe Routes to School (SRTS), a program widely implemented in the US, aims to create safe, convenient and fun opportunities for children to actively travel to school. These aims are achieved through changes to local infra-structure such as sidewalks, crosswalks and bicycle lanes, and educational programmes which are provided to communities on the benefits and safety aspects of active transport. In addition to these strategies, the program receives support through increased enforcement of traffic laws around schools (see http://www.saferoutesinfo.org). The program has been evaluated by Boarnet et al. (2005a; 2005b) and has shown promising results. For example, of the ten projects measured, half produced evidence of increases in active travel ranging from 10% to 850% across the five sites (Boarnet et al., 2005b).

Travelling Green is another program that has been developed to increase active school travel. This resource was developed by West Dunbartonshire Council and NHS Greater Glasgow between 2001 and 2005. The Scottish Executive has provided funding to make the project available to all Primary Schools throughout Scotland. The program is a curricular-based resource that aims to increase walking and cycling to school through class lessons and goal setting activities. The resource comprises of a teacher pack and a pupil pack. The teacher pack contains a total of 13 lesson plans that are aligned to the Scottish curriculum, the "Curriculum for Excellence" (Scottish Executive, 2004). These lessons encompass a number of areas including: a) health and wellbeing science, b) social studies, c) expressive arts, d) technologies, and e) languages. Included in the pupil pack are materials that can be used both in the school and taken home. These include a guide for children and a guide for parents, goal setting activities such as wall charts and challenges, and fluorescent/reflective stickers.

An initial evaluation of the Travelling Green resource was performed by McKee et al. (2007). A quasi-experimental trial was employed to examine the effect of the intervention on active and inactive modes of travel and “stage of behaviour change” (Prochaska & Marcus, 1994) relating to active school travel. Distance travelled to school was measured using a computerised mapping programme in which children were asked to provide information on their usual mode of travel to school. Questionnaires were used to measure children’s “stage of behaviour change” (Prochaska & Marcus, 1994) of active school travel. Findings from this study demonstrated that children in the intervention school increased daily walking distance from 198 meters to 772 meters (389% increase) and decreased daily distance driven by 2,018 meters to 933 meters (57.5% decrease). In contrast, the control school increased their walking from 242 meters to 285 meters (17%) and increased their distance travelled by car from 933 meters to 947 meters (1.5%). The differences between the schools in walking and car use were both significant ($p < .01$). In terms of “stage of behaviour change” of active travel, findings demonstrated that 71% of children in the intervention school progressed to a higher “stage of change” or remained in the “action” or “maintenance” stage of change relating to active school travel compared to 52% of the control school. According to Prochaska and Marcus (2004), a movement towards the ‘‘action’’ and ‘‘maintenance’’ stages of change is reflective of progression with regards to an individuals’ readiness to adopt a healthy behaviour. In line with this theoretical definition, the results of McKee et al (2007) suggested that a greater proportion of intervention school children had progressed in relation to their readiness to adopt an active journey to school. Despite the positive findings of this study, the study had limitations. The sample was relatively small; only two schools took part;

one intervention school, *n* = 31, and one control school, *n* = 29. Additionally, although both schools were similar in demographic profiles, randomisation of the schools to either the intervention or control was not possible due to preferences of the school as to when the intervention could be implemented. Finally, physical activity was not measured objectively.

As demonstrated, a variety of interventions exist that aim to promote children's active travel. Evaluation of active travel interventions can identify the effectiveness of promoting active travel and can identify the mechanism of behaviour change.

Evaluating the Effectiveness of Active Travel Interventions

In comparison to the literature regarding physical activity promotion in children, the investigation of children's active travel is relatively new, with the first study being published in 2003 (i.e. Rowland et al., 2003). Examination of the wider domain of active travel interventions (i.e. in an adult population and/or walking or cycling interventions) may therefore also provide additional understanding of the effectiveness of interventions. For these reasons, three reviews are considered in the context of this thesis. These reviews have investigated the effectiveness of walking interventions in the general population (Ogilvie et al., 2007) and active school travel in the child population (NICE, 2007; Chillon et al., 2011).

The first systematic review to examine the effectiveness of interventions aimed at increasing walking at both an individual and population level was performed by Ogilvie et al. (2007). Interventions aimed at both adults and children were included. The review identified a total of 19 randomised controlled trials and 29 non-randomised controlled studies. Overall, results of this review were positive and demonstrated that the most successful interventions could (at least in the short term) increase walking among a target population by up to 30 to 60 minutes a week on average.

Interventions in this review included several different approaches to encourage behaviour change. Interventions that were most effective were those with tailored interventions (i.e. the use of strategies that are specific for an individual or a group) and those targeted at individuals most motivated to change. This finding confirmed the notion that a one size fits all approach is not appropriate and that individuals are likely to differ in response to different approaches.

Overall, the review was important in providing much needed empirical evidence in support of the use of active travel interventions. However, although children and young people were included in the review, the majority of studies were primarily focused on the outcome measured through households or adults and only three studies measured outcomes for children (with only one study demonstrating a significant positive effect; i.e. McKee et al., 2007).

Children's Active Travel Interventions

The first review to examine the effectiveness of interventions to increase children's active travel was carried out in 2007 by the National Institute for Health and Clinical Excellence (NICE, 2007). The review identified a total of 17 studies. Of the studies included in the review, only one study used a randomised controlled trial (Rowland et al., 2003) and two studies used experimental designs with controls (McKee et al., 2007; Tapestry, 2003). The remaining fourteen studies used experimental designs with no controls.

All of the interventions included in the review had been delivered in a school setting, with most being delivered in a primary school setting. This was due to the fact that primary schools typically have a shorter average commute and therefore are often considered by many practitioners to be a more feasible setting in which to deliver interventions compared to secondary schools. The review identified four types of approaches used to increase active travel. The effectiveness of these four approaches was considered separately. These approaches included: a) the promotion of cycling, b) the development of school travel plans, c) the implementation of walking buses, and d) the promotion of walking. Fourteen of the studies demonstrated an increase in active travel and these studies evidenced support in all of the four types of approaches used to promote active travel. However, the quality and strength of the evidence was somewhat mixed. This was particularly notable in the implementation of school travel plans. For example, although there was some weaker evidence to suggest this approach may be successful, stronger evidence, in the form of a randomised control trial (Rowland et al., 2003), demonstrated that although having a school travel coordinator increased the production of school travel plans, the approach was not significant in increasing active travel. Despite this conclusion, the evidence of this study was unclear and warranted further investigation. For example, two of 11 intervention schools and one of 10 control schools in this study reported having travel plans prior to the study. It was also noted that, at the follow up measure (one year later), nine of 11 intervention schools and none of 10 control schools had a written travel plan. In addition, the authors of this study commented that many of the actions listed in the school travel plans that had been written had not been implemented and that none of the intervention schools had taken action in all four of the recommended areas stated in the "Best Practice" guidelines developed for school travel plans. Consequently, the authors of this study highlighted the need for a further randomised controlled trial to examine the effectiveness of this approach.

Overall, the most successful initiatives included strategies that incorporate the school, parents and local community. These recommendations were consistent with previous findings from a recent review regarding school-based physical activity promotion (i.e. van Sluijis et al., 2007). In summary, the reviewed evidence performed by NICE (2007) demonstrated some evidence that school-based interventions increased active travel to school. However, the review was inconclusive in terms of identifying the most effective active travel interventions and understanding how interventions may change behaviour. A number of limitations were highlighted. One of the most significant was the lack of comparison or control groups in most of the studies. Further limitations were also apparent in the measurement techniques employed, particularly the use of "hands up" surveys, which can often result in inaccuracies through either self-presentation bias (i.e. the manner in which children respond in order to make impressions on others) or unreliable estimates (i.e. inaccurate in the counting by the teacher). Finally, studies were excluded from the review if a detailed report published in English was not available. One such intervention, identified in the initial stages but not included in the review, was the "traffic snake game" (www.schoolway.net/index.phtml?id=1109). At the time of the review, the "traffic snake game" had been implemented in France and had demonstrated a 29% increase in active travel on the school journey (www.eltis.org/index.php?id=13&study_id=784). Since the report was published, the "traffic snake game" has been implemented in schools in nine other countries including Austria, Belgium, Bulgaria, Greece, Hungary, Italy, the Netherlands, Slovenia and England. An evaluation of this intervention has not yet been published in a peer-reviewed journal. However, an independent review of the intervention, including data collections in each of the nine countries, has been published in an online report (http://www.schoolway.net). This review demonstrated an average increase in active travel of 8.29% in the nine countries (England = 5%). The exclusion of this study from the review may therefore be highlighted as a limitation given these data. The inclusion of such schemes could have also broadened the current insight and provided useful illustrations in terms of more varied approaches to the promotion of active school travel.

More recently, a systematic review of interventions aimed at increasing active school travel was performed by Chillon et al. (2011). The review included studies published in the literature encouraging active travel in children and adolescents between 6 and 18 years of age and containing at least one outcome or indicator of active travel or physical activity. The review identified 14 interventions. These mainly focused on primary school children within the UK, USA and Australia. Interventions were heterogeneous in terms of both the strategies incorporated (i.e. educational, infra-structural, and events such as Smart Commute Day and Safe Routes programs etc.) and the groups at which they were targeted (i.e. children, parents and community). A common element in nearly all of the interventions was the presence of school involvement (except for Boarnet et al. (2005a; 2005b) which focused on infrastructure projects in the community). The methodologies employed were varied. For example, some studies adopted the use of focus groups and interviews (e.g. Kong et al.,2009; Mendoza et al, 2009;Rowland et al, 2003; Sirard et al. 2008; and Zaccari & Dirkis, 2003) and other questionnaire-based methods (e.g. McKee et al., 2007; Boarnet et al., 2005; Jordan et al., 2008).

In addition to the main outcome of active travel in the review by Chillon et al. (2011), a number of studies investigated other outcome measures to facilitate an understanding of the way in which strategies may have changed behaviour. These investigations were varied both in the methodology used to investigate the outcome and the focus of the investigation. This focus included the investigation of change in child and parent cognition. A variety of cognitive changes in the child were investigated. These included self-efficacy (Jordan et al, 2008), “stage of behaviour change”, benefits, motivations and barriers towards active travel (McKee et al., 2007), and satisfaction (Jordan et al., 2008). Changes in parent cognitions included investigation of attitudes and barriers to walking (Merom et al., 2005), and safety concerns (Rowland et al, 2003).

Overall, the majority of studies identified within the review reported an increase in the percentage of active travel to school. The effect sizes between baseline and follow-up in active travel for each of the studies within the review varied: three reported a trivial effect size, six reported small effects, two reported a large effect, and one reported a very large effect size. The degree of change varied from 3% to 64%. Of the remaining studies, two studies reported improvements, but in other outcomes such as increased physical activity levels (Sirard et al., 2008) and longer average distances walked to school (McKee et al., 2007), and two did not report significant improvements in active school travel or other outcomes (Jordan, Erickson, Cox et al., 2008; Rowland, DiGuiseppi, Gross et al., 2003).

Although these results of the Chillon et al. (2011) review were considered promising in terms of the effectiveness of active travel interventions, the ability to draw substantive conclusions from the review were limited for a number of reasons. In particular, the authors noted that many interventions included methodological weaknesses such as a lack of reliability and validity evidence for the measures used, a lack of experimental design (i.e. no control group), variations in terms of timing, a weak study protocol, a lack of appropriate statistical analyses, and a lack of information regarding intervention implementation and evaluation. Additionally, there were no studies identified that had examined potential meditating variables of interventions. In terms of the comparison between studies, this may have been confounded due to the different calculations used to determine the effect size within each of the studies. For example, although Cohen's *d* was used as the indices for all studies, the calculation for each study varied depending on the values available in each of the studies. As a result three different ways of calculating the effect size were used: four studies (e.g. McKee et al.,2007; Rowland et al., 2003; Sirard et al., 2003; Wen et al. 2008) used the standard formula (mean/proportion differences divided by the pooled standard deviation; Cohen, 1988); five studies (e.g. Boarnet et al.2005a; Boarnet et al.2005b , Merom et al., 2005; Staunton et al., 2003; Tenbrink et al.,2009; Zaccari & Dirkis, 2003) calculated the effect size using proportions at baseline ($\sqrt{pq}$; $q = 1-p$) and the standard formula (proportion differences divided the standard deviation; Cohen, 1988); and three studies (e.g. Boarnet et al.; Heelan et al. and Mendoza et al.) used an intermediate calculation of *r* using the formulae of Cohen (1988) and Abramowithz and Stegun (1964). Consequently, the comparison of effect size between studies was somewhat limited.

In summary, over the past decade there has been a considerable increase in the evaluation of active travel interventions in children. In general, findings from these studies have proved promising (Chillon et al., 2011). While recent developments in the literature have advanced our understanding of the promotion of active school travel, limitations are evident in the literature base. Particularly notable is the lack of a theoretical basis upon which interventions are evaluated.

Comprehensive evaluations of interventions of theoretically derived predictors of active travel are therefore required. It is suggested that the application of a theoretical framework can provide a clear understanding of the hypothesised mechanisms or causal processes that explain behaviour and behaviour change (Noar & Zimmerman, 2005). The use of a theory can also provide explanations as to why interventions work and help clarify the underlying causal processes (Rothman, 2004). According to Michie and Abraham (2004), this is particularly notable given the consensus within the literature as to the need for understanding how interventions work.

The identification and understanding of the causal mechanisms and predictors of active travel can be subsequently used to both steer and improve the implementation of active travel promotion in schools. The next section of this chapter will examine the literature regarding relevant theories of behaviour.

Theories of Behaviour

A theory has been defined as "a set of interrelated concepts, definitions and propositions that presents a systematic view of events or situations by specifying relations among variables in order to explain and predict events or situations" (Glanz, Lewis, & Rimer 1997, p. 21). According to this definition, a theory should firstly describe the variables that are most important in the prediction of behaviour and secondly, describe how the variables relate or interact to one another. Theories provide an account of why individuals do or do not engage in particular behaviours and how individuals go about changing their behaviours (Noar, Chabot & Zimmerman, 2007). The use of theory as a foundation for intervention development and evaluation is consistent with the current guidance provided by the National Institute for Health and Clinical Excellence (NICE, 2007).

According to Michie & Abraham (2004), the use of theory in the evaluative process allows a number of key issues to be addressed. First, *does it work?* The identification of measurable targets within a theory allows for the intervention to be tested as to whether an improvement (relative to a control group or prior research) has taken place (Abraham, Norman, & Conner, 2000). Second, *how well does it work?* The measurement of the effect size of the intervention that is generated through a trial can be used to indicate the level of impact the intervention is likely to have. Third, *how does it work?* Simply identifying that an intervention has worked is important but does not necessarily imply that the intervention will work in different circumstance or in different populations (Michie & Abraham , 2004). Instead the application of a theory can identify the active ingredients of effective interventions and the causal mechanisms that account for change (Abraham & Michie, 2005). These ingredients can then be targeted in subsequent interventions (Abraham & Michie, 2005).

In health related research, it is suggested that the application of theory is necessary to guide the evaluative process in terms of "knowing what variables to measure, how to measure them, and how to combine them" (Noar & Zimmerman, 2005, p. 275). Application of a theoretical model to the area of active school travel may offer a number of advantages. First, this allows for a reduction in the number of possible variables and mechanisms related to active school travel that are under consideration (Campbell el al., 2000). This is particularly significant given the broad range of factors that influence how a child travels to and from school (Davison et al., 2008; Pont et al., 2009). Second, the application of theory provides a generalisable framework for predicting and interpreting behaviour and identifying the potential causal mechanisms (Rothman, 2004). Finally, the development of subsequent interventions can modify strategies based upon the identified variables and mechanisms which are considered significant in changing behaviour (Campbell el al., 2000). The effectiveness of targeting such mechanisms can then be tested through randomised controlled trials (Francis, Grimshaw, Zwarenstein, Eccles, Garfinkel, Godin, et al., 2005).

Theoretical Models of Motivation

A variety of theoretical models have been constructed to provide a structured conceptual approach to understanding and predicting physical activity and health-related behaviours (Biddle & Nigg, 2000). Current theories that have been used to explain behaviours are classified by the level at which they are directed (Glanz & Rimer, 1995). The classifications of levels include: a) intrapersonal, b) interpersonal, and c) community. Glanz and Rimer (1995) have provided a description of each of the classifications. At the intrapersonal level, the focus of influence is on the individual's knowledge, attitude, and beliefs of his or her behaviour. These influences are specified in theories of cognition, perception, and motivation. At the interpersonal level, the focus of influence is on the social influences and the social norm surrounding the individual's behaviour. The influences at this level include that of significant others to the individual such as family members, friends, and co-workers on an individual's behaviour. Together, the first two classifications (i.e. the intrapersonal level and the interpersonal level) are referred to as individual level approaches. Finally, the factors of influences included at the community level include that of the organisational settings and their influences. For example, these are likely to include the influences of workplaces, schools, churches as well as the influences of social and health policies and other society influences such as wealth.

Interventions can be directed at a number of levels (i.e. individual or community). The strategies and methods that are used differ depending on the level at which the overall intervention is directed (Bartholemew, Parcel, & Kik, 2001; Bensley, Brookings & Fisher, 2003; Orleans, Gruman, Ulmer et al., 1999). For example, on the community level, typical intervention strategies include the use of mass media, media advocacy and social marketing, policy changes, urban planning, social planning and community development (Bracht, Kingsbury, Rissel, 1999; Minkler & Wallerstein, 1997). Comparison intervention strategies that target change on the individual level typically include a variety of educational, skill development, behavioural, and training strategies (Kreuter, Jacobsen & McDonald, 2003). The focus of this thesis is on an intervention that incorporates strategies addressing the influences held at an individual level. Selection of an individual level theory is therefore warranted.

In general, individual level theoretical models focus on the motivational factors underlying individuals' decisions to perform or not perform health behaviours, and are therefore often referred to as motivational theories (Armitage & Conner, 2000). Many early theoretical models in this domain focused on the attitude-behaviour relationship (Wicker, 1969); however in recent years these theoretical models have become more integrated and include additional predictors of behaviour such as social norms or intentions (Olson & Zanna, 1993). These models include the transtheoretical model (Prochaska & DiClemente, 1983), protection motivation theory (Maddux & Rogers, 1983), health belief model (Janz & Becker, 1984), the theory of planned behaviour (Ajzen, 1985, 1991) and social cognitive theory (Bandura, 1977). These models differ in terms of the variables they include and how the variables are thought to combine in order to predict behaviour or behavioural intentions (Biddle & Nigg, 2000). Despite this, a degree of overlap exists between models, for example, most theoretical models include measures of perceived control (i.e. self-efficacy, perceived barriers, perceived behavioural control) and intention (i.e. social cognitive theory, protection motivation theory, theory of planned behaviour) and they are all a form of expectancy-value theories (Biddle &

Nigg, 2000). Expectancy-value theories suggest that an individual's choice, persistence, and performance can be explained by their beliefs about how well they will perform the activity and the extent to which they value the activity (Atkinson, 1957; Eccles et al., 1983; Wigfield, 1994; Wigfield & Eccles, 1992). For example, behaviour is posited to be dependent on two variables: a) the "value" an individual places on a particular outcome, and b) the likelihood that an individual will be successful in achieving their goal (i.e. "expectancy"; Lewin, Dembo, Festinger & Sears, 1944).

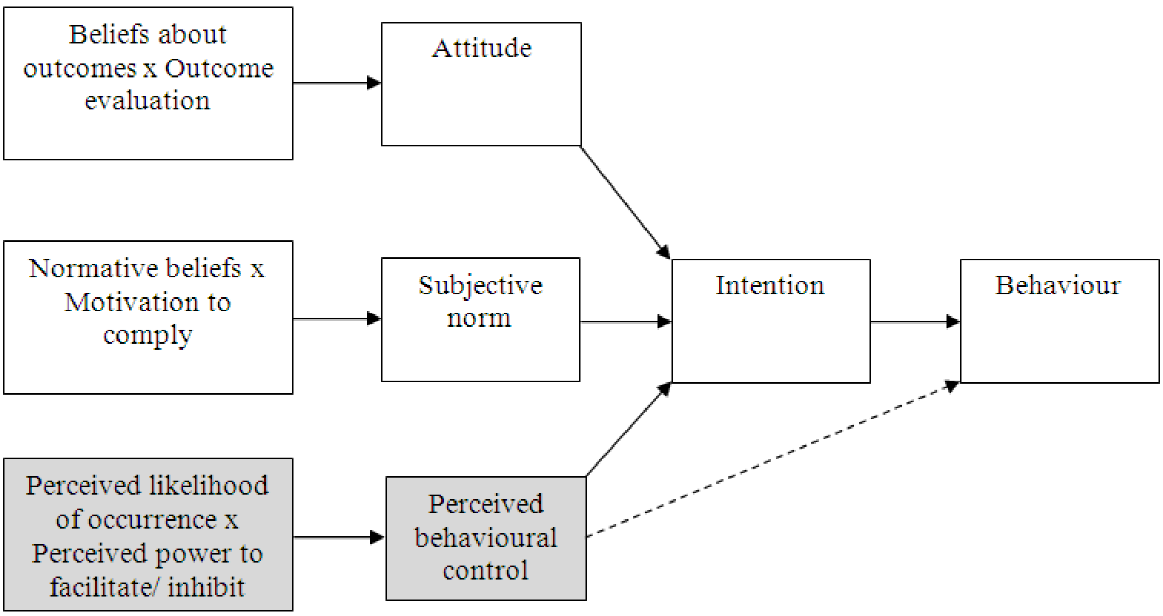
Arguably, it is the theory of planned behaviour (Ajzen, 1985, 1991) that has emerged as the most influential social-cognitive model in understanding the cognitive process that determines an individual's planned intentions and behaviour (Armitage & Conner, 2001). Comparing the efficacy between models, research has shown that the theory of planned behaviour to be more effective in explaining intentions and behaviour than the health belief model, the protection motivation theory and the social cognitive theory. For example, a meta-analysis has shown that when directly comparing the models in terms of effect sizes, the variance explained by the theory of planned behaviour in intention and behaviour resembles large effect sizes (Ajzen 1991; Armitage & Conner, 2001; Godin & Kok, 1996). In comparison, the effect sizes of the health belief model, protection motivation theory and the social cognitive theory typically reveal small to medium effects sizes when predicting behaviour (Armitage & Connor, 2000).

There are several factors that may explain the greater efficacy of the theory of planned behaviour over competing theoretical models. For example, the theory of planned behaviour has been suggested to provide stronger definitions of the specified constructs, a better description of combinatory rules and greater evidence for the discriminant validity of the components (Armitage & Conner, 2000). The theory of planned behaviour also acknowledges the importance of measurement correspondence (Fishbein & Ajzen, 1975). This principle, that is not included in other theoretical models, states that the predictor and the criterion should be measured at the same level of specificity and should be matched with respect to the four components: action, target, time and context (Ajzen, 1988). The inclusion of these components has been consideration important as it allows for maximal power in obtaining the prediction of behaviour (Armitage & Conner, 2000; Sutton, 1998).

The Theory of Planned Behaviour

This section will provide an overview of the theory of planned behaviour and examine the literature regarding its efficacy in explaining behaviour. The theory of planned behaviour (Ajzen, 1985, 1991) states that an individual's intention represents the most immediate predictor of behaviour. The construct of intention reflects an individual's relative strength of motivation to engage in a given behaviour (Ajzen, 1985). The theory posits that an individual's intention to perform a particular action or behaviour is a function of three belief based components: attitude, subjective norm and perceived behavioural control.

The theory of planned behaviour is essentially an extension of the theory of reasoned action (Figure 1; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) that incorporates measures of control belief and perceived behavioural control (Armitage & Conner, 2001). The inclusion of perceived behavioural control reflects the extent to which actual barriers to the behaviour influence the enactment of intentions and therefore its inclusion serves as an important proxy measure of actual control of behaviour (Ajzen & Madden, 1986). With regard to the influence of perceived behavioural control on intention, Ajzen (1991, p.188) stated that, "the relative importance of attitude, subjective norm, and perceived behavioural control in the prediction of intention is expected to vary across behaviours and situations". In terms of the prediction of behaviour, the measure of perceived behavioural control is a reflection of resources and opportunities alongside actual barriers, and will therefore also contribute to an individual's level of intention towards a given behaviour (Ajzen & Madden, 1986). The addition of the construct of perceived behavioural control was therefore reflective of the ability of the theory of reasoned action to: a) explain and predict an individual's behaviour for actions which are performed under volitional control, and b) its failure to predict the behaviour of actions which are potentially being constrained by other factors. The inclusion of perceived behavioural control to the theory therefore provided information as to the potential effect of the constraints an individual may have on a behaviour and provides an additional understanding as to why intentions do not always predict behaviour (Ajzen, 1985).



Notes: Additional theory of planned behaviour components shown in grey.

Figure 3. The theory of reasoned action (Ajzen & Fishbein, 1980) and the theory of planned behaviour (Ajzen, 1985, 1991).

According to the theory of planned behaviour, an individual's attitude is regarded as the personal evaluation of the target behaviour (Ajzen & Fishbein, 1980). Subjective norm has been described as an individual's perception of the expectation significant others have for them to engage in or avoid the target behaviour (Ajzen & Fishbein, 1980). Perceived behavioural control is an individual's perception of how attainable the target behaviour is and their perception of whether they have the required resources to successfully engage in the target behaviour (Ajzen & Madden, 1986).

It is theorised that the effects of the three factors (attitude, subjective norm and perceived behavioural control) on the target behaviour is mediated by intentions. It is also suggested that each of the constructs within the theory correlate more strongly with intention than with each other (Ajzen, 1991).

Beliefs

Underlying the three factors (attitude, subjective norm and perceived behavioural control) is a set of salient beliefs that are associated with each of the variables (see Figure 1). According to the theory, the predictors of intention are formed of two elements: a) the expected consequences of performing the behaviour, and b) the evaluation of those consequences (Ajzen, 1991).

In the explanation of behaviour, Ajzen (1991) stated that at a basic level, the theory postulates that behaviour is a function of information, or beliefs, about a given behaviour. It is expected that an individual may hold many or few beliefs about any given behaviour at any given moment (Miller, 1956). It is these salient beliefs that are thought to be the prevailing determinants of an individual's intention and subsequent behaviour (Ajzen, 1991). Ajzen

(1991) distinguishes between three kinds of beliefs: behavioural beliefs, normative beliefs and control beliefs. Behavioural beliefs are assumed to influence attitudes toward the behaviour, normative beliefs constitute the underlying determinants of subjective norms, and control beliefs that provide the basis for perceptions of behavioural control.

Behavioural belief

The theory suggests that an individual's attitude will be formed through an information processing model: the expectancy-value model of attitudes (Fishbein & Ajzen, 1975). According to this model of motivation, attitudes are formed through the development of beliefs that an individual holds about a given behaviour. These beliefs are generally formed through the association of the behaviour with certain attributes. The associated attributes will be either positively or negatively valenced. These attributes will also be evaluated in terms of the importance each attribute has to the individual. The individual's attitude toward a behaviour is determined by the sum of the beliefs about performing the behavior, weighted by the evaluations of the beliefs. For example, where one associates a behaviour with mostly desirable attributes it is likely that the individual will form positive attitudes. Conversely, where one associates negative attributes with a behaviour one is more likely to form a negative attitude. The magnitude of the attitude will therefore be in direct proportion to the strength of the subjective belief (Ajzen, 1991). The indirect measure of attitude is given in Equation 1.

$$A \propto \sum b_i \, e_i \qquad \text{Equation 1}$$

This equation shown suggests that the strength of each salient belief (b) is combined in a multiplicative fashion with the subjective evaluation (e) of the belief's attribute, and the resulting products are summed by the number of salient beliefs. A person's attitude (A) is then directly proportional to this summative belief index (Ajzen, 1991).

A number of studies have been performed to investigate the relationship between salient beliefs and a global measure of an individual's attitudes (i.e. testing Equation 1). In general, these compare a global measure of attitude to a belief-based measure (Notani, 1998). Global measures of attitude typically consist of a few items (usually between two and four) that are designed to directly measure a person's overall perception of a construct. In contrast, belief-based measures typically consist of a list of individual beliefs that the sample considers salient and are usually obtained through pilot testing (Notani, 1998). Findings from these studies have demonstrated positive correlations between global measures of attitude and measures of salient beliefs (e.g. Fishbein & Ajzen, 1974; Fishbein, 1963, Fishbein & Ajzen, 1981; Jaccard & Davidson, 1972; Insko, Blake, Cialdini, & Mulaik, 1970).

Normative beliefs

Ajzen (1991) refers to normative belief as the likelihood that important and significant individuals or groups with whom the individual is motivated to comply with will approve or disapprove of the behaviour. The theory posits that the strength of a subjective norm is proportionate to the sum of the resulting products across the salient referents (n). The strength of subjective norm (SN) is calculated by multiplying each of the normative beliefs (n) with an individual's motivation to comply (m) (see Equation 2).

$$SN \propto \sum n_i m_i \qquad \text{Equation 2}$$

Empirical studies have found correlations between belief based and global estimates of subjective norm to be generally in the range of .40 to .80 (Ajzen & Madden, 1986; Fishbein & Ajzen, 1981). These findings indicate that measures of subjective norm are reflective of an individual's underlying normative belief (Ajzen, 1991).

Control beliefs

The inclusion of control beliefs within the theory recognised the extent to which behaviour and intention are also determined through the presence or absence of resources and opportunities. According to Ajzen (1991), these beliefs are based on multiple factors that include past experience, second hand information about the behaviour through the experiences of friends and acquaintances, and the perceived difficultly an individual has of performing the behaviour. Individuals who perceive the likelihood of a greater number of resources and opportunities and anticipate the likelihood of fewer obstacles are likely to have greater perceptions of control over their behaviour (Ajzen, 1991). This expectation is illustrated in Equation 3 in that each control belief (c) is multiplied by the perceived power (p) of the particular control factor to facilitate or inhibit performance of the behaviour. Perceived behaviour control (*PBC*) is a result of the summation of the *n* salient control beliefs.

$$PBC \propto \sum p_i \, c_i \qquad \text{Equation 3}$$

Measurement of the Theory of Planned Behaviour Constructs

Although the theory is widely used and well established in a vast array of health behaviours (Armitage & Conner, 2001), there are unresolved issues that exist within the measurement domain of this theory (Francis et al., 2004; French et al., 2007). This thesis therefore examines the current methodological issues that surround the application of this theory. This is performed in the context of the overall application of the theory and the specific application of the theory in the context of active school travel.

Indirect verses direct measures of the constructs

The underlying beliefs of each of the constructs can be measured directly or indirectly (Ajzen, 2002; Figure 1). In practice, the direct measurement of the constructs involves asking the individual to judge the target behaviour and usually therefore take a generic form that is potentially applicable to a range of behaviours. For example, an individual may be presented with the following item as a direct measure of attitude towards walking to school: "Walking to school every day is fun". The individual then responds with their level of agreement with the statement on a scale. In comparison, an indirect measure requires the individual to rate their corresponding beliefs. Therefore compared to the direct measure of the construct, the indirect measure takes a more specific form. For example, in this form individuals are asked to rate their beliefs about the likelihood of a specific outcome, referred to as the expectancy belief, and then rate the desirability of that outcome, referred to as the evaluation. The two scores are then multiplied to produce a total score for each individual, which is known as the "expectancy-value" score. Through this scoring system an estimate can be made of the size of the contribution of a belief to global attitude, relative to the size of the contribution to other beliefs (Francis et al., 2004).

According to Ajzen (2002), both the direct and indirect measures are measures of the same construct. However, the indirect form is a measure of the latent construct whereas the direct measure is that of the manifested construct. The relationship between the two measures has been investigated in a meta-analysis by Armitage and Conner (2001). The review, which included a total of 185 studies, reported an average correlation of r = .50 between the direct and indirect measure for each construct (attitude, subjective norm, and perceived behavioural control). Although both techniques may appear to assess the same construct, each are reliant upon different assumptions about the underlying cognitive structure, therefore their use should be carefully considered (Francis et al., 2004).

The strengths and weaknesses associated with indirect and direct measures vary. Therefore, the choice between the two techniques is commonly dependent upon a number of factors such as the behaviour of interest and the time frame to complete the research (Francis et al., 2004). Explained further, the indirect measure of belief allows an insight into the underlying cognitive foundation of each of the constructs. This can be valuable, particularly in intervention research, as it allows the researcher to explore not only *what* people think about a given behaviour but *why* they think that. Although, this appears as advantageous over direct measures, a number of drawbacks are inherently associated. For example, according to Francis et al. (2004), one of the major drawback that is apparent with the this form of measurement is the assumption that individuals are able to accurately report their belief in a probabilistic way and can also accurately report the relative weightings of that belief. Further to this, this method also relies upon the assumption that attitudes are composed of a rational combination of the weightings of these probabilities. There is also an assumption that the development of question items includes all of the associated beliefs surrounding the behaviour. This also has a number of implications. First, in order to ensure content validity, sufficient pilot testing is required. Second, questionnaires must include sufficient items to cover the content area, which can result in lengthy questionnaires. Finally, it is recommended that the pilot testing is conducted through one-to-one interviews (Ajzen, 2002). As a consequence, the validity of the content will be dependent on the quality of information that is elicited by the interviewer (Francis et al., 2004). This latter issue is not only sometimes unfeasible to the design of some studies, but can limit the ability to compare findings between studies in terms of the potential differences that may exist between populations and behaviours.

There are also a number of unresolved issues with regard to the scoring of this approach that can result in practical drawbacks. This topic, referred to as the “expectancy-value muddle”, has received discussion in the literature (French & Hankins, 2003). This problem concerns the degree of association between the expectancy-value belief, which is determined through the multiplicative scoring system, and the generalised attitude towards the behaviour that is typically operationalised using a semantic differential scale (Osgood, Suc, & Tannenbaum, 1957). The issues surrounding the multiplicative scoring system have been examined by French and Hankins (2003). According to these authors, the approach is flawed for a number of reasons. First, constructs are typically measured on a bipolar scale (e.g. -3 to +3). However, given that the location of the “true zero” is unknown, the use of such is considered inappropriate (French & Hankin, 2003). The resulting double negatives within the bipolar scaling can also be considered problematic. For example, an individual who considers that a behaviour is both likely and desirable (i.e. +3 and +3) would generate the same score as an individual considering the same behaviour as unlikely and undesirable (i.e. -3 and -3). The use of this scoring system would assume that a negatively valued consequence with a low perceived probability of occurring (i.e. a negatively framed question) represents a reason of equal importance to a positively valued consequence with a high perceived probability of occurring (i.e. a positively framed question). However, researchers have shown that the correlation between a negatively framed question and a direct measure of the construct is lower than that of a positively framed question with a direct measure of the construct (Trafimow & Finlay, 2002).

Instead, some researchers have advocated the use of a unipolar scale. Scores on this type of scale would range from 0 (i.e. impossible) to 1 (i.e. certain) and therefore represent probabilities. This is consistent with the views of previous researchers in the broader psychology domain who have equated "expectancies" with the term "subjective probabilities" (Fishbein & Ajzen, 1975; Tolman, 1932). However, although the unipolar approach may overcome the problems evident with the bipolar approach, it is not ideal. For example, using a scale of -3 to +3 compared to +1 to +7 would result in a change in the rank ordering of individuals' expectancy-belief scores and therefore influence the size of the correlation coefficient. The standard statistical approach typically uses a hierarchical regression equation in which behavioural beliefs and outcome evaluations are entered into on the first step and the belief-evaluation interaction (the multiplicative composite) is entered at the second step. Variation in the correlation coefficient is therefore likely to effect the prediction of intention (Ajzen, 1991; Wankel, Mummery, Stephens, & Craig, 1994). This issue was first highlighted by Schmidt (1973) who used an artificial data sets with different zero points to demonstrate the potential problems associated with the scoring systems. Subsequent authors have further documented this issue (i.e. Ajzen, 1991; Ajzen, 2002; Gagne & Godin, 2000; Hankins, French, & Horne, 2000). More recently, French and Hankins (2003) commented that such variation potentially "invalidates all the analyses examining the association between beliefs and attitude reported in the many theory of reasoned action and theory of planned behaviour studies" (p. 40).

In contrast, the use of direct measures of the theory of planned behaviour constructs has a number of advantages. For example, items within the questionnaire are relatively easy to develop, as the same format can be used for a number of different behaviours. Additionally, since response and question formats can be formatted in a similar fashion, results between behaviours and studies are directly comparable. Despite, these advantages there are a number of inherent drawbacks. Primarily, the use of the direct approach is based on the assumption that individuals have direct access to the evaluations and can accurately give a "summary report" of an underlying constructs. However, the accuracy of the "summary reports" may be questioned particularly regarding components that may be considered "complex (e.g. consisting of subcategories), ambivalent (e.g. consisting of some positive and some negative beliefs) or irrelevant (e.g. unlikely to influence behaviour)" (Francis et al., 2008, p. 46).

Measurement correspondence

The literature regarding the theory of planned behaviour recommends a systematic approach to the measurement of the constructs following a set of pre-defined elements (Ajzen, 2002). The behaviour of interest is defined in terms of its Target, Action, Context, and Time (TACT) elements (Fishbein 1967). This approach is used for indirect and direct measures of the constructs. The definition of each of the TACT elements is arbitrary. However, it is crucial that the principle of compatibility is observed. According to Ajzen (2001), this principle requires all of the constructs to follow the exact same elements. An illustration of this principle in the context of active school travel would be the statement "Walking to school every day". In this statement, the target would be considered as the participant, the action would be "walking", the context would be "to school", and the time would be "every day". Compliance with the principle of compatibility would therefore ensure that all constructs outlined in the theory of planned behaviour are measured to the same degree of specificity.

For example, an item statement for attitude may include "walking to school every day would be fun" and an item statement for intention may include "I intent to walk to school every day".

Application of the Theory of Planned Behaviour

The ability of the theory of planned behaviour to predict intention has been tested in many fields within the health domain including participation in cancer screening (DeVellis, Blalock, & Sandler 1990), participation in leisure activities (Ajzen & Driver, 1991; Ajzen & Driver 1992), health-protective behaviours (McCaul, Sandgren, O'Neill, & Hinsz, 1993), weight control (Schifter & Ajzen, 1985) and exercise behaviour (Godin, Valois, & Lepage 1993; Kimiecik, 1992). Relevant to this thesis, the theory has successfully demonstrated the ability to predict physical activity behaviour and intention in adults (Hausenblas, Carron, & Mack, 1997) and children (Craig, Goldberg, & Dietz, 1996; Hagger, Cale, Almond, & Kruger, 1997; Rhodes et al., 2006). The theory has also demonstrated the ability to predict travel behaviour. These behaviours include both active modes of travel behaviour, such as walking (Eves, Hoppea, McLaren, 2003; Rhodes, Brown & McIntre, 2006; Rhodes, Courneya, Blanchard, Plotnikoff, 2007), cycling (de Bruijn et al., 2009; Gardner, 2009), and inactive modes of travel, such as car use and public transport use (Bamberg & Schmidt, 2003; Bamberg, Ajzen, & Schmidt, 2003; Forward, 2004; Gardner, 2009; Harland, Staats, & Wilke, 1999; Kaiser and Gutscher, 2003).

A meta-analytic review of the theory of planned behaviour has been conducted by Armitage and Conner (2001), to test the efficacy of the theory in the prediction of behaviour and intention. The analysis included any study that had been published utilising the theory of planned behaviour in any domain (thus was not limited to physical activity behaviour). The review demonstrated that, across all behaviours, the theory of planned behaviour constructs accounted for 27 percent of the variance in behaviour and 39 percent of the variance in intention. Attitude, subjective norm, and perceived behavioural control were all predictors of intention. However, the subjective norm construct was generally found to be a weaker predictor of intention than attitude and perceived behavioural control. Differences were demonstrated between the prediction of objective and subjective measures of behaviour. Where subjective measures were used, the theory of planned behaviour accounted for 31 percent of the variance in behaviour. In comparison, where objective measures were used, the theory of planned behaviour accounted for 21 percent of the variance in behaviour. A meta-analytic review of the theory of planned behaviour has also been conducted to test the efficacy of the theory in the prediction of physical activity intention and behaviour (Hagger et al., 2002). The investigation of physical activity in this study included a wide range of behaviours, such as leisure-time physical activity, organised sports and exercise. The studies identified in this review (n = 72) included a range of different age groups from children to older adults. Across all studies, the theory accounted for, on average, 45% of the explained variance in intentions and 27% of the explained variance in behaviour. Similar to the previous findings of Armitage and Conner (2001), the analysis found that attitude, subjective norm and perceived behavioural control significantly predicted intention. The review also found that subjective norm was (to a lesser extent than the review performed by Conner and Armitage) a weaker predictor of intention than attitude and perceived behavioural control. In terms of the prediction of behaviour, both intention and perceived behavioural control were found to significantly predict behaviour.

Overall, the theory of planned behaviour has been widely applied to the explanation of health and social behaviours. However, since it has been suggested that the independent contribution of individual components within the theory of planned behaviour are both context and population specific (Ajzen, 2002), research utilising the theory should therefore seek to establish and confirm the importance of each construct within each individual context and population. In the context of this thesis, it is therefore important to examine the extent to which attitude, subjective norm and perceived behavioural control predict children's intention to walk to school and the extent to which intention and perceived behavioural control predict a child's walking behaviour.

The theory of planned behaviour and travel behaviour

The application of the theory of planned behaviour to travel offers a reasoned account of behaviour assuming that an individual arises to a decision through deliberating over the advantages and disadvantages of available travel modes. Research has successfully demonstrated its predictive validity in travel behaviour in an adult population (Bamberg &Schmidt, 1998; Bamberg & Schmidt, 2003; Forward, 1994; Kaiser & Gutscher, 2003).

Regarding inactive travel modes, findings from a recent meta-analysis performed by Gardner and Abraham (2008) have demonstrated support for the theory. This review identified a total of 23 studies measuring car use behaviour and/or intentions. Their findings confirmed that the theory of planned behaviour successfully predicted associations between attitude, subjective norm, and perceived behavioural control and found typical intention-behaviour associations of around r = .50. The findings therefore supported the use of the theory of planned behaviour constructs in this context.

The theory of planned behaviour has also been used in a number of studies to investigate active travel. These studies include the investigation of walking (Eves, Hoppé & McLaren

2003; Scott, Eves, French & Hoppé, 2007; Rhodes et al., 2006; Rhodes et al., 2007) and bicycle use (de Bruijn et al., 2009; Gardner, 2009). Concerning the investigation of walking, the findings observed in these studies found the theory's prediction of behaviour to be consistent with those of other, more general, behaviour domains such as physical activity (Hagger et al., 2002) and exercise (Downs & Hausenblas, 2005) and therefore demonstrated the suitability of the theory as a valid conceptual model for understanding travel behaviour. The relative prediction of each of the constructs varied between studies. A review of the literature on TPB studies of walking has recently been published in a study by French, Darker, Eves and Sniehotta (*In press*). These authors conducted a search of the literature in 2007 and identified seven empirical studies that had examined the predictors of walking intentions and/or behaviour (Darker & French, 2009; Darker & French, 2010; Eves, Hoppe & McLaren, 2003; Galea & Bray, 2006; Rhodes, Brown, & McIntyre, 2006; Scott, Eves, French & Hoppe, 2007; Study 1; Scott, Eves, French & Hoppe, 2007; Study 2). The studies identified in this review and the findings of each study are provided in Table 1. On reviewing these studies, French et al. (*In press*) highlighted that although the prediction of walking intentions differed between studies, the most prominent feature of these studies was that the evidence pointed towards PBC as having the largest relationship with walking intentions. According to these authors, this was evidenced through the following results: a) PBC being a significant predictor of behaviour is all seven studies whereas in comparison subjective norm and attitude were only significant predictors in four studies each; b) the overall sample-weighted mean between PBC and walking intention was larger (r = .47) than subjective norm (r = .30) and attitude (r = .33), and c) PBC had the largest relationship with walking intentions in six of the seven studies. The differences observed between the studies may have been a result of a number of factors such as geographical variation, measurement differences (e.g. general walking versus leisure-time walking), or sampling fluctuations (Rhodes et al., 2007). However, regardless of the variation between studies in terms of samples employed and measurement context, the empirical application of the TPB to walking provides strong support for the theory. Additionally, French et al (*In press*) highlighted that the results of their empirical application of the TPB were impressive and provides support for developing interventions to increase intentions to walk in that PBC is the construct which interventions should aim to change.

Table 1.

Summary of raw correlations between walking intentions with attitude, subjective norm, and perceived behavioural control in TPB studies (French et al. in press).

Study	**N**	**Attitude**	**Subjective Norm**	**PBC**
Eves, Hoppe and McLaren (2003)	233	.06	-.01	.37**
Scott, Eves, French and Hoppe (2007; Study 1)	41	.31	.45**	.50**
Scott, Eves, French and Hoppe (2007; Study 2)	200	.06	.04	.69**
Darker and French (2010)	295	.37**	.49**	.49**
Darker and French (2009	46	.33**	.29	.50**
Rhodes, Brown and McIntyre (2006)	351	.55**	.41**	.33**
Galea and Bray (2006)	62	.72**	.59**	.74**
Overall means correlations (sample weighted)	**1228**	**.33****	**.30****	**.47****

The application of the theory of planned behaviour to predict bicycle use has been performed in two separate studies, both of which were conducted with adult samples in the Netherlands (de Bruijn et al., 2009; Gardner, 2009). The study performed by de Bruijn et al. (2009) found that bicycling was predicted by both intention and perceived behavioural control. Attitude, but not subjective norm, was also significant in the prediction of behaviour, after accounting for the effects of intention and perceived behavioural control. In the study performed by Gardner (2009), intention also predicted behaviour. However, since this study did not include measures of attitude, subjective norm or perceived behavioural control, no further comparisons can be made.

The predictive utility of the theory of planned behaviour has not yet been examined in relation to children's travel behaviour. The thesis therefore draws upon the application of the theory to a related context, children's physical activity behaviour. The application of the theory of planned behaviour to this context has typically demonstrated strong support (Craig, Goldberg & Diets, 1996; Martin, Oliver, & McCaughtry, 2007; Martin et al., 2005; Motl et al., 2002; Mummery, Spence & Hudec, 2000; Rhodes et al., 2006; Trost, Saunders & Ward, 2002; Theodorakis, Doganis, Biagiatis, & Gouthas, 1991). In these studies, the theory of planned behaviour variables have predicted from 6% (Trost, Saunders & Ward, 2002) to 8–9% of children's objectively measured physical activity (Martin et al., 2007). In comparison, when physical activity is measured subjectively, the theory of planned behaviour variables account for between 35-50% of the explained variance in behaviour (Rhodes et al., 2006). In terms of the predictions of children's intention to be physically active, the theory has explained a significant percentage of the explained variance ranging from 45% (Martins et al., 2007) to 76% (Rhodes et al., 2006).

Although it is generally agreed that the theory of planned behaviour provides a good account of behaviour, a significant amount of unexplained variance in behaviour remains (Sheeran, 2002; Conner & Armitage, 1998; Godin & Kok, 1996). As a result, altering intentions alone may not be sufficient to alter behaviour (Orbell & Sheeran, 1998). The unexplained variance between intention and behaviour may be attributed to differences in cognitions or other unknown factors (Amireault et al., 2008). Ajzen (1991) has stated that the theory is not exhaustive and is open to the inclusion of variables which can enhance the predictive utility of behaviour and/or intention. Given these findings, the identification of other factors is warranted.

TPB and the "Intention-Behaviour Gap"

Understanding the variance between intention and behaviour is a current challenge within behavioural research (Hamilton & White, 2008). Whether or not intention evolves into behaviour has become known as the "intention-behaviour gap". The phrase has been used to refer to the unknown psychological process that occurs between an individual's intention and their action (Armitage & Conner, 2001). The inconsistency between an independent variable and a dependent variable (in this context intention and behaviour) may be indicative of the presence of a third variable (Baron & Kenny, 1986). This variable may affect the direct link and/or the strength of this relationship and provide useful information about how or why intentions are not necessarily translated into behaviour. Therefore, in order to increase understanding of behaviour, the identification of potential "third variable" is necessary. Many factors such as emotion (Mohiyeddini, Pauli, & Bauer, 2009), anticipated regret (Richard, van der Pligt, & de Vries, 1995), affect (Manstead & Parker, 1995), personality (Orbell, 2003), self-efficacy (Abraham, Sheeran & Johnston, 1998), personal norms (Gorsuch & Ortberg, 1983) and self-identity (Sparks & Guthrie, 1998) have been examined. However, these factors have demonstrated a limited ability to bridge the gap between intention and behaviour. Consideration of an alternative variable to bridge the intention-behaviour gap would allow for a more precise theoretical understanding of behaviour. This is important from a practical point of view and can be used to inform the design and promotion of the targeted behaviour.

Habit and the "intention-behaviour gap"

According to the theory of planned behaviour, intention is the sole determinant of behaviour and human behavior is therefore considered reasoned in nature (Ajzen, 1991). However, this view has been challenged by theorists who argue that behavior is governed by both intentional and automatic processes (Aarts & Dijksterhuis, 2000; Aarts, Verplanken, & van Knippenberg, 1998; Fazio, 1990; Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989; Sheeran, 2002; Triandis, 1977). According to these researchers, the contribution of the intentional processes are only likely to be in new and unfamiliar environments and instead, when an environment is stable and unvarying, behaviour is likely to be governed by automatic processes such as habit. Researchers have used measures of past behaviour to support this perspective (Bamberg et al., 2003). For example, the theory of planned behaviour posits that behaviour is determined solely through conscious reasoning in that the effects of past behaviour are fully mediated through factors within the theory (attitude, subjective norm, perceived behavioural control and intention). The theory of planned behaviour therefore suggests that past behaviour influences behaviour only indirectly. However, measures of past behaviour have been found to improve the prediction of future behaviour over and above the effects of variables outlined in the theory. In a review performed by Conner and Armitage (1998), past behaviour accounted for, on average, an additional 13% of the variance in behaviour over and above that of the theory of planned behaviour components. These findings have also been observed in a number of behaviours including both physical activity (Norman, Conner, & Bell, 2000) and travel (Bamberg, Ajzen, & Schmidt, 2003). Such findings are considered to be indicative that the behaviour under consideration is, at least in part, under direct control of the stimulus situation (Bamberg et al., 2003). According to this perspective, satisfactory repetition of a behaviour "might become automatic in the sense that a specific response is spontaneously triggered by a specific cue in the environment" (Verplanken & Orbell, 2003). As a result, the effect of past behavior on future behavior is taken to reflect the operation of habits (Norman, 2011).

Despite habit being the driving force behind the influence of past behaviour on future behaviour (Oullette & Wood, 1998), there are few models, particularly in health research, that have attempted to incorporate habit as a predictor variable (Norman, Conner & Bell, 2000). The lack of research in this area has been primarily due to the unavailability of a theoretical and conceptually valid instrument to measure habit (Verplanken & Melkevik, 2008). Historically, the measurement of habit has been predominately performed using behavioural frequency as a proxy measure of habit (Verplanken & Orbell, 2003). However, it is not the recurrence of a behaviour that constitutes a habit but instead the frequently and satisfactorily pairing of the execution of an act in response to a specific cue (Verplanken & Orbell, 2003). The measurement of past behaviour captures the frequency (usually over a specified time period) of which a person has performed a given behaviour. In contrast, habit is defined as "learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states" (Verplanken & Aarts, 1999, p. 104). Therefore, whilst the definition of habit acknowledged the significance of history of repetition, habitual behaviour is characterised by the presence of automaticity that is evident in response to certain cues brought about by satisfactory repetition. As such, the frequency of which a behavior has been performed does not fully constitute the definition of a habit and the use of past behaviour as a proxy for habit is therefore considered inappropriate (Verplanken & Orbell, 2003).

In addition to the issues presented above, the use of past behaviour as a predictor of behaviour, is considered irrelevant and of little practical use (Eagly & Chaiken, 1993). Verplanken & Orbell (2003) outlined two key reasons to support this notion. First, shared variance is likely to exist between the measures of past and later behaviour. Second, since past behaviour cannot be changed, the knowledge of this is not considered to be particularly useful (Verplanken & Orbell, 2003). In contrast, the statistical relationship that has been evidenced between past and future behavior becomes more meaningful through the consideration of habit (Verplanken & Orbell, 2003). For example, whereas past behaviour is considered an empty construct (Verplanken & Aarts, 1999), habit represents a meaningful construct with a number of defining features that can potentially be a modifiable target within interventions.

In summary, current examination of the theory of planned behaviour leaves a substantial proportion of behaviour to be explained (Sheeran, 2002). Although habit has been suggested as a factor that might explain the gap, current application of this construct has been performed predominantly using past behaviour as a proxy (Verplanken & Orbell, 2003). However, the measurement of past behaviour as a proxy for habit is not ideal for many reasons. Due to the nature of habit, the issue of habit measurement is inherently difficult (Eagly & Chaiken, 1993). As a result, the examination of habit as a predictor of behaviour has long been an under researched area. The following section will therefore explore the history of the construct of habit in a way to explain the reasoning for its exclusion in the contemporary literature. A critical review of the current available measures of habit will also provide a comprehensive insight into how best to measure children’s travel habits.

Habit

Most of the behaviour we have performed is not being done for the first time, but is a reoccurrence of a behaviour which we have performed numerous times (Neal, Wood & Quinn, 2006). For example, research using experience-sampling diaries in both community and student samples have shown that approximately 45% of everyday behaviours tend to be repeated in the same location every day (Quinn & Wood, 2005; Wood, Quinn & Kashy, 2002).

Mobility is a major part of modern everyday lives. Choices relating to travel mode becomes an extremely repetitive behaviour (Verplanken, Walker, Davis & Jurasek, 2008). The repetitive nature of health-related behaviour is particularly significant given the cumulative impact on health, social and economic outcomes. This has been illustrated in a study by Hill, Wyatt, Reed & Peters (2003) who estimated that weight gain and obesity in the majority of the population is produced by very small degrees of energy imbalance that could be addressed by small changes in behaviour such as an additional 15 minutes per day of walking. Therefore, understanding the habitual nature of travel mode choice is potentially important factor in improving health.

Historical Perspective of Habit

Habit is an important concept in the understanding of human behaviour. The concept was first acknowledged by William James who in his major work, The Principles of Psychology (1890), emphasised the importance of habits in that, "we must make automatic and habitual, as early as possible, as many useful actions as we can" (p. 122). The psychological perspective taken in this early research was bounded by biology and philosophy, through which many areas of human experiences were addressed. Habits were viewed as actions or thoughts that are seemingly automatic responses that diminish the conscious attention the individual pays to his or her actions.

On the prevalence of habits, James (1890) made the suggestion that "habit is thus the enormous fly-wheel of society, its most precious conservative agent" (p. 121). James emphasised that although the habits allow for many behaviours to be performed more easily, the decrease in attention from behaviour increases an individual's resistance to change. To illustrate the conceptualisation of habit, James drew upon the writing of a philosopher M. Léon Dumont. Through this work, a series of examples in physics were presented to illustrate the parallel nature of behavioural habits evident within the human nervous system*:*

> "Everyone knows how a garment, after having been worn a certain time, clings to the shape of the body better than when it was new; (...) A lock works better after being used some time; at the outset more force was required to overcome certain roughness in the mechanism.(...).. It costs less trouble to fold a paper when it has been folded already. (..)... The sound of a violin improves by use in the hands of an able artist, because the fibres of the wood at last contract habits of vibration conformed to harmonic relations. ..(...)..Water, in flowing, hollows out for itself a channel, which grows broader and deeper; and, after having ceased to flow, it resumes, when it flows again, the path traced by itself before." (p. 105)

James recognised that, similar to the physical examples highlighted by Dumont, patterns can also be applied to the human brain in the way the neural currents respond to a stimulus and thus make similar responses to the stimulus more probable. This perspective allowed James to explore every day behaviours in terms of habit and habit formation.

The early work performed by James (1890) was one of the first perspectives of habitual behaviour. The work provided an insight into the broad perspectives of habit in terms of it being a goal-directed behaviour. Some of the explanations given for the function and formation of habits remain significant to the current understanding of the construct of habit. Therefore, the perspective that was instigated over one hundred years ago remains central to the current formulation and understanding of habitual behaviour. Although this may be the case, the inclusion of the construct into popular theories of behaviour has been limited. A historical understanding of the development of habit in behavioural research provides some understanding of the limitations in this area that have caused the construct to be somewhat disregarded in popular models of human behaviour.

Historical perspective of habit: Behaviourism

The current theoretical perspective of habit is a result of the synthesis of varying models which have been influential theories over the past century. In agreement with the postulations set by James (1890), early literature relating behaviour to habit was predominantly behaviourist (e.g. Hull, 1943; Skinner, 1938, Watson, 1914). Initially, the concept of habit was heavily formed through radical behaviourism. This was primarily based on the theorisations put forward by Thorndike's (1898) "notion of learning". According to this theory, habit was reflective of a direct bond that was formed following some physical event or sensory input in which a muscle response is induced as a response to stimulation.

Behaviourist theorists such as Watson (1914), Skinner, (1938), and Hull (1943) also put forward views based upon Thorndike's theorisation. Through these perspectives, habit was conceptualised as a well-learned simple stimulus response association. The understanding of human behaviour was therefore reduced to a set of rigid behavioural patterns that were thought to automatically follow environmental cues. The theorisation upon which behaviourism was based received much critique (Chomsky, 1959). This was particularly due to the way in which complex patterns of human behaviour were reduced. This inadequacy ultimately brought about a decline in the perspective (Mowrer, 1960).

Historical perspective of habit: The cognitive perspective

A new era of cognitive science developed which attempted to overcome the assumptions which had been criticised within the behaviourists' models of human functions. The popularisation of the cognitive perspective was particularly apparent and for a long time social scientific theorisation and research was dominated by the interest of the intentional process within the context of attitude-behaviour models (Hergenhahn, 2009).

The cognitive perspective demonstrated a shift in causality in that behaviour was no longer believed to be a result of the environment, but a result of a hypothesised internal mental process based on the central executive controller (Neisser, 1967). The use of cognitive science was then formed on the basis of associationism (Broadbent, 1958). This theory postulates that all mental activity is based on connections between basic mental events, such as sensations and feelings. It is through these mental representations that theorists hypothesised that the perception of one element can generate, produce or arouse another. However, although the cognitive perspective was widely regarded, considerable criticism was directed towards the perspective due to the way in which the complexities of human memory were incorrectly considered (Mandler, 2002).

Historical perspective of habit: Summary

There are vast differences between the assumptions that underlie the behaviourist and the cognitive perspectives. Briefly distinguishing between them, the cognitive perspective focuses upon the investigation of the intention-behaviour relationship, ignoring any potential direct impacts of past behaviour in the form of deliberate and conscious intent (Hergenhahn, 2009). In comparison, the underlying notion of behaviourism suggests that habits emerge as a result of frequency in performance and that as a result, past behaviour is a good predictor of future behaviour (Hergenhahn, 2009)

The predominance of intentionality as a behavioural determinant can also be seen in more recent models including social learning theory (Bandura, 1977), theory of planned behaviour (Ajzen, 1991) and the self-determination theory (Deci & Ryan, 1985). These models rely on the assumption that behaviour is formed through conscious intent. The recognition of automatic processes such as habit that are evident in human behaviour is therefore not included. Researchers have argued that contrary to the use of these models, much of our behaviour is not likely to be guided by conscious deliberation and instead theoretical models should recognise the impact of past behaviour on future behaviour (Ouellette & Wood, 1998). It is only more recently that theorists have recognised that alongside behaviour being initiated by conscious intent, goal-directed behaviour can also be initiated in a non-intended automatic way (Aarts & Dijksterhuis, 2000; Bargh, 1990; Wegner & Bargh, 1998) although such an issue is still in contention (Aarts, 2007).

The need for models of human behaviour to adopt change, based on this perspective, has also been evidenced within other domains. For example, research investigating the area of neuropsychology has postulated the view that the brain consists of a habit system and a separate goal directed (intentional) system (Evans, 2008). Congruent to the view of behaviourists, it was proposed that habit consists of action representations that are directly triggered by contextual cues, and in contrast, goal-directed behaviours are always the result of conscious intention (Wood & Neal, 2007).

Researchers has shown that habits are indeed reflective of the cognitive, neurological and motivational changes which are brought about by the behaviour repetition (Neal, Wood, & Quinn, 2005). The associations which are formed in the memory through successful repetitions of behaviour in a stable context are represented in the learning and memory systems, which are separate from intentions (Wood, Tam, & Witt, 2005). Such research is also consistent with the traditional perspectives, such as that of Allport (1937) and James (1890), who suggested that behaviour, which is initially performed through goal-directed acts, can become less dependent on explicit goals as the performance of behaviour becomes habit.

Within the last decade, the literature has demonstrated a synthesis of social cognitive and behaviourist perspectives that demonstrates an integration of key elements of the behaviourist's theorisation within a model of goal-directed nature of human behaviour (Wood & Neal, 2007). This has been demonstrated in a model developed by Wood and Neal (2007). In this model, the characteristics hypothesised by early stimulus response theories have been retained. In addition, the model allows for the inclusion of habits within a broader structure of goal pursuits. In the context of this model, it is proposed that the concept of habit retains its rigid context-cued nature but also includes an interaction with goals in order to provide a mutual influence and an explanation for the manner in which habits are regulated in line with goals. This concept is therefore in line with the principle that a habit is formed through the accrual of automaticity that is gained by the direct association between a context and a response, so that the context can activate the response without the mediating involvement of a goal. It is this process regarding habit development and performance that has been proposed to interface with the purposive dimensions of habit as represented in people's goals. This principle, which is particularly important in the realm of behaviour change, has been supported in both field research (Wood, Tam, & Witt, 2005) and in a laboratory experiments (LaBar & Phelps, 2005; Lewicki, Hill, & Bizot, 1988; Graybiel, 1998; Tucker & Ellis, 2004).

This thesis draws upon this contemporary perspective to understand the nature of habit as a form of goal-directed behaviour, and attempts to apply the current understanding of the construct in relation to active school travel.

Habit in Contemporary Literature

Although habit has long been recognised as an important underpinning factor of human function, the construct of habit has not held a corresponding recognition in contemporary scientific theorisation and research (Verplanken, 2006). A plethora of reasons have been suggested for the lack of research on habit. Central to these reasons has been the difficulties in measuring and assessing habit that have been observed. This has been a result of the discrepancies and misunderstandings commonly associated with the precise definition of habit (Eagly & Chaiken, 1993). This has resulted in a lack of habit measures which have a high degree of reliability and validity (Verplanken & Orbell, 2003). As a result, the investigation of habit has been predominantly performed through indirect measures of the construct such as behavioural frequency (Verplanken, 2010). The rationale for not equating behavioural frequency with habit has been widely recognised (Ajzen, 2002; Verplanken, 2006; Vlaev & Dolan, 2009). Although there is no theory stating how behavioural frequency relates with habit , it is thought that while some behaviour turns quickly into a habit, others require much deliberated practice (Verplanken, 2010). The assumption that the two concepts equate with one another would assume that as frequency increases so in fact would habit strength thus implying an “absurd consequence” (Verplanken, 2006, p. 640).

Research investigating the automaticity of habitual behaviour has been conducted by Wood et al. (2002). To examine this conceptualisation, the thought processes and emotion occurring during a given behaviour were measured. The study found that individuals who displayed habitual behaviour experienced a greater number of thought processes and less emotion that were unrelated to the behaviour than those who were performing non-habitual behaviour. Findings from this study therefore provided some early evidence in support of the conceptualisation of habit as an apsychological experience of automated behaviour. As a result, the inclusion of automaticity as a characteristic of habit was considered important in its conceptualisation (Verplanken, 2006). Consequently, since previous conceptualisations and perspectives of habit had disregarded the characteristic of automaticity in the definition of habit, it was necessary to re-define the concept.

Conceptualisation of Habit

Verplanken and Aarts (1999, p. 104) have defined habit as a “learned sequence of acts that are automatic responses to specific cues and are functional in obtaining certain end goals or states”. In line with this conceptualisation, the concept of automaticity was defined as behaviour which is performed “without awareness, is difficult to control and is mentally efficient" (Verplanken & Orbell, 2003). More recently**,** Wood and Neal (2007, p. 843) complemented this definition of habit through their emphasis that "habits are sub-served by a form of automaticity that involves the direct association between a context and a response but that interfaces with goals during learning and performance".

The conceptualisation of habit emphasises that whereas new behaviour will predominantly follow a path of conscious decision making, the formation of a habit will involve a delegation of control over the behaviour to the environment (Verplanken & Orbell, 2003). Such postulations have been demonstrated in research (Bargh & Chartrand, 1999; Verplanken & Aarts, 1999).

The inclusion of the role of automaticity postulated by Verplanken and Orbell (2003) was based upon the definition put forward by Bargh (1994). According to Bargh (1994), automaticity is characterised through the following features: efficiency, lack of awareness, un-intentionality and uncontrollability. A particular behaviour might be characterised by the presence of any number of these four features. This definition therefore highlights that a number of variants of automaticity are possible. However, prior to the definition provided by Bargh (1994), there was consensus within the domain that a mental process was either automatic, in that all four characteristics were present, or controlled and therefore possessing all the opposite qualities (i.e. intentional, controllable, consumptive of limited attentional resources, and in awareness; Johnson & Hasher, 1987). The re-defining of automaticity by Bargh (1994) therefore demonstrated a relatively novel disposition in the area. This proposition was supported by previous research that was conducted by Bargh (1989). The research by Bargh (1989) highlighted a profusion of behaviours, which evidently were automatic, but demonstrated only some, and not all of the features of automaticity. For example, driving a car was illustrated as a behaviour that, although is an automatic process (i.e. efficient and autonomous), is also guided by intention (one intends to drive the car and does not do so otherwise), and at the same time is also controllable (i.e. one can stop the automatic process whenever he or she decides to).

Further to this research, an accumulation of empirical studies in both applied and laboratory settings demonstrated that not all features were necessary for the presence of automaticity (Kahneman & Treisman, 1984; Logan & Cowan, 1984). Subsequently, research moved away from the dichotomous characterisation of behaviour being characterised as either automatic *or* controlled. This research was therefore provided an important development in the literature in terms of a theoretically sound definition of automaticity that was then later incorporated into the conceptualisation of habitual behaviour (Verplanken & Orbell, 2003).

Given that automaticity is based on the presence of any combination of one or more of the features outlined by Bargh (1994), there are a number of variants of automaticity. In general, three types of automaticity were proposed dependent on the patterns of features which were present (Bargh, 1994). These three varieties are described as *pre-conscious automaticity,* in which all the features of automaticity are present, *post-conscious automaticity,* in which there has been a form of conscious processing (e.g. selective attention) but with un-intentioned effects and finally, and *goal-dependent automaticity,* in which the act as been initiated by conscious will. According to its definition, the construct of habit is thought to be characterised as a behaviour that is "intentional in its origin, is controllable to a limited extent, is executed without awareness, and is efficient" (Verplanken & Orbell, 2003, p. 1317). In terms of the definition outlined by Bargh (1994), the form of automaticity evident in habitual behaviour is referred to as goal-dependent automaticity (Aarts & Dijksterhuis, 2000a). Since this concept is critical to the nature of habitual behaviour, it is crucial to understand and explore further the current perspectives in this area of research.

Goal-dependent automaticity

Goals can be described as a desired or anticipated outcome, which can include a broad range of end states, such as physiological needs (for instance, thirst and hunger) and other needs such as socialisation, knowledge acquisition, or professional attainment (Gollwitser & Moskowitz, 1996). Through frequent co-activation of a given situation alongside a constant behaviour, the strength and accessibility of the association can increase (Bargh, Gollwitzer, Lee-Chai, & Barndollar, 1999). This mental link has been shown to result in the automatic initiation of an associated action through the activation of the goal (Aarts & Dijksterhuis, 2000). Consequently, regular pursuit of a goal can result in decreases in conscious attention (Anderson, 1982; Newell & Rosenbloom, 1981).

In contrast, when a goal has not been frequently pursued, there is no associated action with the given goal. Therefore, when pursuing a goal the instigation of the action will not be immediate and instead individuals are likely to cognitively explore possible actions before the instigation of action (Srull & Wyer, 1986). Based on previous research performed by Austin and Vancouver (1996) and Gollwitzer and Moskowitz (1996), it has since been acknowledged that goal concepts can vary in dimensions based on certain factors (Aarts and Dijksterhuis, 2000). These factors include the level of abstraction, complexity, temporal range and difficultly. In the context of travel habits, Aarts and Dijksterhuis (2000a) have stated that "many well-practiced or skill actions, such as typing, driving a car, and riding a bicycle, are usually qualified as automatic or habitual, but they require the activation of a goal." (p. 54) Therefore, the environment is indeed capable of activating such behaviour automatically and independent of motivation.

In summary, the re-conceptualisation of habit allows the history of repetition to remain as a fundamental characteristic, but also allows the inclusion of the construct of automaticity (Verplanken & Orbell, 2003). Such a perspective allows researchers to distinguish between behavioural frequency and habit. This is thought to be beneficial, particularly as the re-conceptualisation of habit incorporates an understanding of how the behaviour is executed. Potentially, this has major implications for the characteristics of interventions targeted at changing these behaviours (Chatzisarantis & Hagger, 2005). To fully understand the construct of habit as an automatic behaviour, the relevant research exploring the literature in terms of automaticity and its underlying components (i.e. awareness and efficiency, controllability and intentionality) are explored.

Awareness and efficiency

When an individual is performing a given behaviour, they are usually aware of the outcome and sometimes aware of the contextual cues (Chartland, 2005). However, the individual is usually unaware of the process (Dijksterhuis & Smith, 2005). Generally speaking, when an individual is not fully conscious of a process as a whole, they will still have a broad awareness (Dijskerhuis et al., 2005). As a consequence, habitual behaviours are typically described as being "introspectively almost blank" (Dijksterhuis et al., 2005, p. 193). This is considered an important feature in distinguishing habitual behaviours from other automatic processes (Bargh et al., 2001)

According to Bargh (1994), upon which the conceptualisation of awareness in habitual behaviour is taken (Verplanken & Orbell, 2003), the definition of awareness (or unawareness in the case of habitual performance) may be exampled within three of the following categories:

1. The person is unaware of the stimulus itself, defined as subliminal perception.
2. A person may be unaware of the way in which that stimulus is interpreted or categorised.
3. The person may be unaware of the determining influences on his or her judgment or subjective feeling states and thus may misattribute the reason to a plausible and salient possible cause of which he or she is aware

(Bargh, 1994, p 7)

In terms of automatic behaviours, the presence of a lack of awareness represents one of the four features of automaticity (Bargh, 1994). Although a lack of awareness is not necessarily present in all forms of automaticity, this feature is considered fundamental in the form of automaticity that characterises habitual behaviour (Verplanken & Orbell, 2003). However, although habitual behaviour is therefore characterised by a lack of awareness, the type or form of this feature has not been stipulated. Although not yet examined, it is likely that the level of awareness is likely to differ between behaviours and populations.

With regard to the concept of efficiency, habits are said to be efficient in that they require little mental effort to execute (Verplanken & Aarts, 1999). This is closely related to the realm of conscious awareness. For example, in performing many daily activities there are often a multitude of behavioural options available to an individual. An individual will not always be aware of all the options and will, in the case of habitual behaviour, demonstrate a fluency of behaviour without particularly being aware of the process by which they are making an array of decisions (Kremers et al., 2006). Since the brain demonstrates limits to the cognitive processing capacity, the ability of habitual performance to be mentally efficient and therefore free up mental capacity is viewed as an important attribute of habit (Verplanken, 2006).

Controllability

According to Bargh (1994), the term controllability refers to the extent to which one is aware of the influence of contextual cues along with the motivation and ability to counteract such influences. When a habit is established, the delegation of control over the behaviour is shifted to the environment (Verplanken & Aarts, 1999). Habits can be characterised as being controllable to a limited extent. The ability to control a habit can be achieved through deliberate thinking and planning. However, although it is possible to control a habit, research has shown that strong habits are often difficult to overcome with deliberate thinking and planning alone (Heckhausen & Beckmann, 1990; Verplanken & Faes, 1999).

The characteristic of uncontrollability in habitual behaviour has been examined in travel behaviour by Aarts and Dijksterhuis (2000a). This study investigated the extent to which habitual responses are hard to suppress or control. An experimental procedure based on an adaptation of the Jacoby paradigm (Jacoby, 1991) was used. This procedure required participants to respond, within a short duration, to travel destinations under the instructions of either giving the typical mode of transport taken to the specified location or naming an alternative travel mode. The suppression of the habitual and non-habitual mode was tested under several conditions that varied in mental loading (achieved through the requirement of performing a secondary task). Results demonstrated that the suppression of habitual travel mode choice was only successful when enough mental capacity was available. Therefore, when mental capacity was reduced, the ability to successfully inhibit the habitual response was significantly reduced. In contrast, the changes in mental loading did not affect the non-habitual response. These findings therefore underscored the difficulty in suppressing habitual behaviour.

Intentionality

Understanding the complex relationship between conscious intention and habitual behaviour has been imperative in the understanding of the causal antecedents of behaviour (Wood & Neal, 2007). The conscious processes associated with habit were recognised early on in the habit literature by James (1890) who suggested that, "habit diminished the conscious attention with which acts are performed" (p. 116). Following on from this, the behaviourist view held that once a stimulus-response link has been made, contextual cues were directly responsible for triggering a habitual response. However, in this perspective there was little focus on the mental process which potentially could be mediating these effects.

Many researchers however, have argued that in contrast to the previous behaviourism perspective that viewed intentions and goals as distinct concepts, an individual's cognition plays an important role in the direct control of the environmental cues over behaviour (Norman & Shallice, 1986; Ronis, Yates, & Kirscht, 1989; Bargh & Gollwitzer, 1994; Bargh & Chartrand, 1999). These researchers argued that habits should be conceived as goal-dependent automaticity, as defined by Bargh (1989), in that the behaviour is only automatically activated providing that the relevant goal is activated in the first place (Aarts & Dijksterhuis, 2000a). Such a perspective of habit has been demonstrated in empirical research (Moskowitz et al., 2004; Wegner & Bargh, 1998)

Habitual Complex Social Behaviours

Although there is much empirical support for the inclusion of habit within theories of behaviour, some authors oppose this notion particularly in the case of more complex behaviours. For example, according to Ajzen, the author of the theory of planned behaviour, the inclusion of habit in behaviours such as exercise is implausible since there is always a requirement for an individual to have conscious control even after the behaviour has been performed frequently (Ajzen, 2002b). Based on this postulation, Ajzen (2002b) suggested that an automatic response cannot be initiated in these instances and therefore a habit may not develop.

Contrary to this perspective of Azjen (2002b), and in line with the definition of habit proposed by Verplanken and Aarts (1999), the concept of habit encompasses many different types of behaviour. The behaviours can range from "simple actions" or "small scale social events" to much larger scale or "complex behaviours" (Verplanken, 2010). For example, simple actions include behaviours such as the mailing of a letter or the greeting of a friend, whereas complex behaviours often involve work, lifestyle or consumption related-behaviours that develop during a lifetime such as travel, television viewing and eating/drinking.

It has been suggested that the consideration of "complex behaviours" as a habit may have been held back due to the common misrepresented use of the term habit, as evident in everyday language (Verplanken, 2010). For example, the everyday meaning and perception of the term typically varies from the precise definition which is observed in the literature. This issue has been illustrated by Verplanken (2010). For example, first, the focus of everyday language concerning the term "habit" is typically on undesirable behaviours such as unhealthy eating, alcohol or dangerous driving. This results in the term "habit" commonly being associated with “bad habit”. Second, a number of meanings exist in common parlance in the umbrella term of habit such as reflexive behaviours, instinctive behaviours and routines. Finally, the term habit is typically considered only in terms of simple, small scale events such as smoking, biting of nails, and locking a door, rather than larger scale, complex events such as travelling or exercising.

Despite the recognition that habits can range in complexity, a degree of ambiguity was evident in terms of how the characteristics of habit were manifested in complex, larger scale behaviours (Verplanken, 2010). This issue was address more recently by Verplanken & Melkevik, (2008) in the case of exercise, a behaviour generally considered to be complex in nature. These authors raised the issue concerning the level of analysis at which the behaviour is considered habitual. In this case, they provided the example of an individual who runs on a daily basis. In this instance, it was suggested that although the act itself (i.e. running) is executed consciously and deliberately, often at the same time and place every day, it is unlikely that the act itself is considered as automatic. Instead, it is suggested that:

> “What can become automatic, and may thus be considered as habitual, is the decision to go running. When this person first decides to take up running, he or she might go through a phase in which running has to be carefully planned and incorporated into existing routines. During this phase the decision to go running is likely to be taken consciously and deliberately. Once the running has been satisfactorily established as part of the everyday routines, the decision to go running may gain the qualities that make it a habit; it is taken repeatedly, and characterized by a lack of awareness, mental efficiency, and perhaps even some difficulty to control” (Verplanken & Melkevik, 2008, p. 17).

The example put forward by Verplanken and Melkevik (2008) therefore highlighted the importance of the decision making process rather than the execution of the behaviour when considering a complex behaviour as a habit. Based on this concept, Verplanken (2010) postulated that once the decision has been firmly built into an individual's everyday routine, it may then acquire the features of habitual behaviour. Therefore, it is emphasised that although the decision may be qualified as a habit, the execution of the behaviour, in this case to run, may in fact demonstrate characteristics of a mindful and conscious action.

The consideration of complex behaviours as a habit in children's behaviour has also been raised. In support of this perspective, Aarts, Paulussen & Schaalma (1997) emphasised that, once "learnt", activities such as walking and running "do not require intentional efforts and planning to set in motion" (p. 363), and that at young ages, the decision to exercise is often assumed to be made in a "mindless, automatic fashion and can therefore be described as rather habitual" (p. 363). More recently, this perspective has gained empirical support through a study that has confirmed the significance of habit strength in determining children's physical activity and its relation to psychosocial factors associated with physical activity (Kremers et al., 2008).

As with physical activity and exercise, children's school travel is also a behavior that is likely to be under habitual control, at least to some extent, because journeys to school are characterised by both repetition (i.e. they are typically made each day of the school week) and situational stability (i.e. they take place at approximately the same time of day, have the same start and end points and typically constitute the same route). However, the effects of habit in this specific context have not been investigated previously. Consequently, further investigation should examine the extent to which children's school travel is determined by habit and the relationship that habit has with other determinants of behaviour. The inclusion of habit in children's travel behaviour may be important in understanding fully the processes that are guiding behaviour.

Habit verses Planned Behaviour

Despite the lack of research concerning habit, numerous studies have demonstrated that past behaviour is the strongest predictor of intention and behaviour, explaining more variance than other theory of planned behaviour variables (e.g. Ajzen, 1991; Conner & Armitage, 1998; Ouellette & Wood, 1998). For example, in the meta-analysis by Conner and Armitage (1998), past behaviour accounted for (on average), an additional 7 % of explained variance in intention and 13% of explained variance in behaviour over the theory of planned behaviour variables. These findings have also been replicated in the context of exercising behaviour (Hagger et al., 2002).

The role of past behaviour and habit has developed two separate lines of inquiry to explain the way in which these constructs influence the intention-behaviour relationship. One line of research suggests that the predictive utility of the theory of planned behaviour will increase with the direct experience acquired through habituation. This has been demonstrated in a series of studies performed by Ajzen (2002). For example, individuals who have developed a habit in a given behaviour are likely to have performed that behaviour frequently in the past (i.e. repeated performance in stable contexts is an essential ingredient of a habit). These individuals will therefore have gained a significant amount of direct experience of the behaviour. In turn, the direct experience a person has with behaviour is associated with an increased likelihood of the individual developing associated cognitions (e.g. behavioural intentions) that are stable and accessible in memory. Since, stable cognitions do not change from moment to moment (Doll & Ajzen, 1992) and research on temporal stability of attitudes and accessible cognitions exert a strong biasing effect on a person's perception of a behavioural situation (Fazio & Zanner, 1981), the stability and accessibility are known to increase cognition-behaviour correspondence. In addition to these effects, the effect of habituation may include changes in the ability to identify and seize opportunities to act (Gollwitzer, 1999) and regulate behaviour in line with intentions (Carver & Scheier, 1998). As a result, individuals are more likely to implement their intentions thus increasing the relationship between intention and behaviour.

On the other hand, a second line of research suggests that as habit increases, individuals are less reliant upon cognition and are in fact more automatic in their response. Therefore, as behaviour becomes more habitual, the behaviour is likely to be determined less by conscious intent. According to this line of research, the presence of a habit is therefore suggested to decrease the predictive utility of the theory of planned behaviour. This perspective was first evidenced in the theory of interpersonal behaviour (Triandis, 1977, 1980). According to this theory, when an individual performs behaviour repeatedly, sufficient to form a habit, the prediction of behaviour through intention is decreased as the habit component takes over. Habit was therefore hypothesised to moderate the intention-behaviour relationships. In explaining this concept, Triandis (1977) suggested that:

> "...when a behaviour is new, untried, and unlearned, the behavioural-intention component will be solely responsible for the behaviour, while, when the behaviour is old, well learned, or over learned and has occurred many times before in the organism's life span, it is very likely to be under control of the habit component" (p. 205).

According to Triandis' theory, intentions (I) are a function of the weight of (W) social (S), affective (A), and cognitive (C) factors (Equation 4). The probability of an act's occurrence (P_a) is a function of the weight (W) of intentions (I) and habit (H), both multiplied by facilitating conditions (F). This is shown in Equation 5.

$$I = (W_s S + W_s A + W_s C) \qquad \text{Equation 4}$$

$$P_a = (W_H H + W_I I)F \qquad \text{Equation 5}$$

(Triandis, 1980)

However, although Triandis used the term habit, the conceptualisation was in fact equivalent to past behaviour in that:

> "Habits can be measured by the frequency of occurrence of behaviour, by a subject's judgments of the likelihood that a behaviour will take place in different kinds of situations, and by a subject's response of how frequently she or he has done something"
>
> (Triandis, 1980, p. 205)

Therefore although the theorisation incorporated the moderating effect of habit on the intention-behaviour relationship that was consistent with current perspectives (de Bruijn et al., 2009; Gardner, 2009) and the conceptualisation of habit used by Triandis was identical to the current conceptualisation of the construct (i.e. Verplanken & Aarts, 1999), the use of past behaviour frequency to measure habit did not correspond to this conceptualisation.

Despite the inclusion of habit to understand human behaviour, the theory offered by Triandis has been relatively underutilised compared to other socio-cognitive models such as the theory of planned behaviour. In a recent editorial, Araújo-Soares and Presseau (2008) highlighted a number of reasons to account for this. First, the theory contains more variables than the theory of planned behaviour, many of which were not, at the time, given much attention by health psychologists (e.g. affective versus cognitive attitude, personal/moral norm, role belief, facilitating conditions). Second, there were no clear guidelines as to the way each of the variables should be operationalised (thus leaving specification to the researcher). Finally, the model was initially published as a chapter in the proceedings of a scientific meeting in 1980 and it took some time to reach the scientific community, at which time the theory of reasoned action behaviour had become widely used and been extended to include additional variables (thus becoming the theory of planned behaviour).

The reasons outlined therefore resulted in Triandis' theory failing to gain momentum within the literature. However, the significance of habituation in the scientific literature was not completely disregarded. For example, the main assumption of a habitual behaviour is that an individual who performs a behaviour frequently and consistently to attain a goal is likely to develop an association between a goal and an action, and thus, a habit. This assumption was supported in a meta-analysis performed by Ouellette and Wood (1998). This study examined the effects of past behaviour on intentions and future behaviour. In their analysis, behaviours were characterised as being either habitual or non-habitual according to the frequency of the behaviour and the stability of context in which they were performed. Habitual behaviours were therefore considered as those that were performed relatively frequently (daily or weekly) under stable conditions. In contrast, behaviours that were performed relatively infrequently or in unstable circumstances were considered non-habitual. Findings from the study demonstrated that the relationship between past behaviour and intentions differed between varying types of behaviour. For example, when a behaviour was considered as habitual, the relationship was stronger (r = .60, p < .01) compared to non-habitual behaviour which had a relatively weaker relationship (r = .32, p < .01). The relationship between attitude and intention was also dependent upon whether or not the behaviour was habitual in that the relationship was weaker for a behaviour which was habitual (r = .44 , p < .01) compared to the that of a non-habitual behaviour (r = .51, p < .01). This review therefore was important in highlighting the influence that habit has on the relationship between past behaviour and future behaviour. Although the classification of habit was not strictly aligned with current conceptualisations of the construct (i.e. Verplanken & Orbell, 2003), the classification used represented a novel way, through the consideration of context stability, of demonstrating the defining features of habit. Importantly, the research highlighted that a measure of past behavioural frequency will not always be a good indicator. As a result of such limitations, the need for alternate measures of habit strength was emphasised.

Following the review performed by Ouellette and Wood (1998), a number of studies were performed to test the hypothesised interactions between intention and habit. Since both the proponents (Verplanken, 2006) and opponents (Ajzen, 2002) for the inclusion of habit, agreed that the use of past behaviour was an incorrect measure of habit, these studies developed alternative measures to test this relationship. In a study conducted by Verplanken et al. (1994), a script-based measure was used, namely the response frequency measure, to investigate the predictive validity of habit strength in the prediction of travel mode. This method required participants to indicate as fast as possible whether a given travel mode was a realistic option to reach travel destinations. Travel was measured as being either the use of a car or the use of alternative modes. Results of this study confirmed that an interaction was present between attitude and habit in the prediction of behaviour, thus confirming the previous predictions of Triandis (1977). The authors also highlighted that the contribution of habit to the prediction of behaviour accounted for a significant proportion of the variance (14 %). As a result, the authors emphasised the importance of including habit in any future research investigating travel behaviour and suggested that the examination of attitudes alone is likely to be insufficient in explaining behaviour. As expected, the results of this study demonstrated that the attitude-behaviour relationship was stronger in individuals with weak habits compared to those with strong habits. However, a somewhat unexpected finding was also observed. This was seen in a small but significant correlation (r = .28, p < .01) between attitude and behaviour which was found among the individuals who held strong habits. Consequently, the authors suggested that although a trade off may occur, attitude may still guide these individuals' behaviour to some extent even after behaviour has been frequently performed. In explaining this, it was suggested that:

> "When the behaviour is frequently repeated, it is**,** of course, quite conceivable that the reasons that originally resulted into the onset of the behaviour still retain much of their validity. When respondents are asked to report their attitudes, these reasons become salient once more" (p, 296).

Discussing this finding further, the authors of this paper suggested that, in line with previous research (i.e. Ronis et al., 1989), it is plausible that when behaviour is repeated to form a habit, attitude may also be inferred from self-perceptions. Although this was considered a plausible artefact, such a mechanism was suggested to be unlikely in that although some correlations exist when habits are strong, the prediction of behaviour from attitude is much greater when habits are weak.

A later study, by Verplanken, Aarts, Moonen, and van Knippenberg (1998), examined the role of habit versus intention among individuals travelling by cars and public transport. Similar to the methodology used in the study of Verplanken et al. (1994), a subjective measure was used for behaviour and the response frequency measure was used to assess habit. Intentions were found to play an important role in the prediction of car use versus public transport use only when existing car use habits were weak. In comparison, when individuals displayed strong car use habits, there was no relationship between intention and behaviour. This study therefore provided further support demonstrating the significance of automatic versus planned behaviour in travel research. Furthermore, given that this study was conducted in a real-life situation, focusing on actual travel mode choice behaviour, the findings of this study were important in demonstrating the ability to directly translate previous findings that were simulated in a laboratory to a field setting.

Building on these findings, an experimental study was conducted by Bamberg et al. (2003). This study examined the longitudinal effects of an intervention (a pre-paid bus ticket) on increasing bus use among students. Consistent with the theory of planned behaviour, the intervention influenced attitude, subjective norm and perceived behavioural control towards intention and behaviour. The theory accurately predicted intention and behaviour both before and after the intervention. The study found that including a measure of past behaviour improved the predictive power of bus use before the intervention, but did not improve predictions following the intervention. The study also included a direct measure of habit strength (Self-Report Habit Index; Verplanken & Orbell, 2003) alongside standard measures of the theory of planned behaviour variables. However, contrary to earlier research, these findings demonstrated that habit failed to mediate the effects of past behaviour on future behaviour. The authors therefore concluded that travel mode to be largely determined by reasoned decision making. However, due to the lack of availability of habit measure at the time of the study, the measure of habit strength was taken only after the intervention. As a result, it has since been suggested that the failure of the study to measure pre-intervention habits may have lead to a false conclusion that the theory of planned behaviour was valid (Gardner, 2009). Therefore, given such limitations, the conclusions in this study regarding the influence of habit on the decision making process in travel behaviour have been questioned.

A more recent study of travel behaviour, conducted by Danner et al. (2008), has since attempted to extend the current understanding as to the mechanisms of which habit moderates the intention-behaviour relationship. This research comprised of three separate studies. Habit was assessed by combining frequency of past behaviour and context stability to form an index of habit strength. The findings from the first two studies demonstrated that only when context stability was taken into account did habit interact with intention. In contrast, when past behavioural frequency was considered, the interaction term was not significant. The findings therefore highlighted that intentions guide future behaviour only when habits were weak (low frequency or unstable context). The findings also emphasised that the context in which the behaviour is performed plays a crucial role in the establishment of habits. For example, it was suggested that behaviour can be performed very frequently over a given time span, but if the context (i.e. the place, time, and situation) differs, an instigation of the behaviour will be instead dependent on the individual's intention. In addition, it was put forward that even when behaviour is performed only occasionally but in a stable context, the behaviour may also be guided by habit. This research was therefore important in that it extended previous work that addressed (either implicitly or explicitly) the importance of the context in which the behaviour is performed in understanding the role of habits in the intention–behaviour relationships. The third study performed by Danner et al. (2008) was designed to further investigate the mechanisms by which habit is directly activated by the context. This was addressed by assessing whether the mental accessibility of the behaviour (defined by the ease of accessing the behaviour in memory) moderates the intention–behaviour relationship. Mental accessibility was measured with a response latency task in which participants were asked to indicate, as fast as possible, if a presented transport mode is a realistic option to travel to a previously, and briefly, presented travel destinations. In this study, Danner et al. hypothesised that if habitual behaviour is directly activated by the context, then mental accessibility of a particular behaviour should moderate the relationship between intention and behaviour. Therefore, it was predicted that only when the accessibility of mental representation of the habit is low will intention predict behaviour. In contrast, when the accessibility of mental representation of the habit is high, the prediction of behaviour will be weaker. This hypothesised relationship of mental representation was based on the principles outlined in the automotive model proposed by Bargh (1990). In line with this model, the authors proposed that goals and their enactment can be automatically controlled by the environment, only if a person repeatedly and consistently chooses to pursue the same habitual behaviour in the same environment. In order to test this, both the intention to cycle and the mental accessibility of goal-directed cycling behaviour were measured and the interaction between habit and intention in the prediction of behaviour was examined at varying levels of mental accessibility. The finding of this study supported the hypothesis, demonstrating that that when accessibility was low, intention was positively related to later behaviour. Conversely, when accessibility was high, intention was not a predictor of behaviour. This research therefore presented some potentially important findings and confirmed that, as a result of performing a behaviour frequently and consistently in the same context, a habit is directly instigated by the context when the mental representation is readily accessed. However, although this research highlighted a potential mechanism for the role of habit in the intention-behaviour relationship, the conclusions drawn from their findings may have been confounded by methodological limitations concerning the measurement of mental accessibility.

In a recent study, Gardner (2009) performed a study to investigate motivation towards bicycle and car use. Behaviour was assessed through the use of a self-report measure concerning a single commuting journey. The Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003) was used to measure habit strength. The study then examined the interaction between habit and intention in the prediction of behaviour. The intention-behaviour relationship was examined for individuals with weak or no habit (i.e. at least one standard deviation below the mean), individuals with moderate habits (i.e. within one standard deviation of the mean), and individuals with strong habits (i.e. at least one standard deviation above the mean). Results of the study found that both car use and bicycle use were stable over time and were correlated with both habit and intention. In support of the previous study by Verplanken et al., (1998), the study demonstrated that intention predicted behaviour when habit was weak, but had no effect on behaviour when habit was moderate or strong. Compared to previous research, the study used a direct assessment of habit (i.e. SRHI) rather than an indirect assessment of the characteristics associated with habit (e.g. past behavioural frequency and/or context stability). Therefore, in addition to the confirmation of the moderating effect of habit on the intention-behaviour relationship, the study provided much needed empirical support confirming the role of habit in the intention-behaviour relationship. However, despite the significance of this study, these findings were, to an extent, limited due to the assessment of behaviour (i.e. self-report measure of a single commuting journey). For example, although the information on a single commuting journey is often more available than other trips (and consequently widely used; Shannon, 2006) such journeys may not necessarily provide a good representative of all journeys (Boussauw &Wiltox, 2009). In addition, self-reported behaviour has also been demonstrated to be vulnerable to cognitive (Ogden, 2003), affective (Shephard, 2003) and self-presentation biases (Adams et al., 1999) that can lead to inaccuracies in behaviour data such as under- or over-reporting.

Adding to these findings, a later study conducted by de Bruijn et al. (2009) explored both the additive and the interactive effects of habit in the explanation of bicycle use in a student population in the Netherlands. The study used the SRHI to measure habit strength alongside a measure of the theory of planned behaviour variables. Although a subjective measure of behaviour was also used, a more in-depth account of travel behaviour was given in that, respondents were asked to indicate how many days per week and amount of time per day they used various different modes of transportation rather than reporting behaviour for a single journey (i.e. Gardner, 2009). The results demonstrated that the addition of habit strength to the model significantly increased the explained variances in behaviour, making the theory of planned behaviour variables non-significant. The inclusion of an interaction term of habit and intention to the model (i.e. testing the moderating effect of habit) also resulted in a significant increase in the explained variance of travel behaviour. The final model, which explained a total of 33% of the variance, confirmed the moderating effect of habit which had been previously demonstrated by Gardner (2009). Specifically, de Bruijn et al. (2009) demonstrated that with low levels of habit, the regression coefficient of the intention behaviour relationship was moderate and significant (β =.67, $p < .01$) whereas the regression coefficient in high levels of habit strength was weaker and non-significant (β = .10, *ns).* Results therefore confirmed that when strong habits were present, the correlation between intention to use a bicycle and actual bicycle use was weak and non-significant. In contrast, when weak habit strengths were present, intention was a stronger and significant correlate of actual bicycle use. Results therefore demonstrated further support for the moderating effect of habit in the intention-behaviour relationship.

Despite the accumulation of evidence supporting the role of habit in the intention-behaviour relationship in travel-related research in adults, there has been no such investigation performed to investigate the role of habit in children’s travel behaviour. It is therefore unknown how habits may influence behaviour in this population. In an attempt to understand the role of habits in children’s travel behaviour, it therefore necessary to draw upon related areas such as physical activity. In this context, recent research, performed by Kremers et al. (2008), has provided empirical support to demonstrate the significance of habit in guiding children’s behaviour. In this study, both awareness and habit strength of children aged from eight to thirteen years old were investigated. Their results suggested that children who were unaware of their own activity level and those with strong physical activity habits were less likely to make well-considered behavioural choices than those who were aware of their activity level and had weaker habits. Accordingly, the authors proposed that the behaviour of these children was likely to have been automatically triggered through external cues within the environment. These cues may include factors such as the “availability of sports opportunities, attractiveness of the playgrounds, or safety to play outside” (p. 483). In addition to the findings related to habit, a component of attitudes (namely “perceived advantage”) was found to be the only significant moderating factor with regard to habit. These findings indicated that a positive attitude is not only important in the early stages of behaviour (i.e. establishing a habit), but also remains to be important in the determination of behaviour even once the habit is formed. These findings therefore suggest that the development of habit in children may therefore be insufficient to maintain positive behaviour change and instead resources and opportunities need to be continuously provided to ensure that attitudes within this population remain favourable.

The significance of habit in children and adolescents has also been demonstrated in a study measuring sedentary behaviour. In this study, performed by Kremers and Brug (2008), the SRHI was used to measure habit strength with respect to watching TV and using a computer. Behaviour was measured using a self- report questionnaire that assessed the number of minutes that each child or adolescent spent watching TV or videos and using a computer during a normal week. The findings from this study demonstrated that habit moderated both the attitude–intention and intention–behaviour relationships. Specifically, the analyses of these interactions showed a significant relationship between intention and behaviour in children who had weak habits and a non-significant association in children who had strong-habit group. In terms of the attitude–intention relationship, findings revealed a significant relationship between attitude and intention in children who had weak habits and a non-significant relationship in children who had strong habits. Since intention is unrelated to behaviour in adolescents who have a strong habit, interventions that focus solely on the provision of information to increase motivation and subsequently change behaviour are likely to be ineffective. Instead, the authors suggested that interventions should include strategies designed to break sedentary habits and promote active habits through the disruption of environmental factors that may be automatically cueing the habitual performance.

The findings from the studies performed by Kremer et al. (2008) and Kremer and Brug (2008) made an important contribution to the literature in providing a further insight into the determinants of children's behaviour and emphasised the importance of considering the construct of habit alongside psychosocial constructs. In addition to adult-related research, these findings present a strong rationale for further research into the role of habit in children's behaviour. Concerning active travel, since this behaviour is commonly performed in stable situational contexts, such behaviour may be prone to being guided by automatic rather than conscious processes and therefore likely to become habitual. Understanding the predictive utility of the theory of planned behaviour and habit may therefore increase our understanding of this behaviour. To achieve this, and in the context of the previous limitations that have been evidenced in this area, it is clear that the approach used in terms of the methods for assessing habit strength (i.e. the operationalisation of the construct) must be aligned with its conceptualisation. The selection of a correct measure to assess habit strength in therefore imperative to the development of a sound literature based in this area. For this reason, the following section examines the measurement issues surrounding the construct of habit.

The Measurement of Habit

The measurement of habit has long been an issue of debate in the area of social psychology. In their book "the psychology of attitudes", Eagly & Chaiken, (1993) recognised this issue suggesting that:

> "… the role of habit per se remains indeterminate (…) because of the difficulty of designing adequate measures of habit" (p. 181).

Previous research within the area of social psychology demonstrated not only a lack and disregard of the concept of habit, but also a distinct lack of attention to the research issue concerning measurement (Verplanken, 2010). These two issues concerning the definition and measurement of habit are not distinctly separate. For example, as discussed in the above section, historically, habit has been equated with past behaviour, therefore measures of past behaviour have typically been used as measures of habit (Verplanken, 2006).

Given the recognised limitations of past behaviour as a measure of habit, researchers have attempted to assess habit strength through other means. For example, the use of observational methods as a way of employing a more sophisticated way to measure habit has, although somewhat limited, also been demonstrated in previous research (Landis, Triandis, & Adamopoulos, 1978). However, the majority of these alternative measures used to assess habit strength have consisted of reporting ongoing experiences through self-report methods (Verplanken, Myrbakk, & Rudi, 2005). Not only has the use been considered as conceptually inaccurate, such methods of self-report are also widely viewed as having many fundamental measurement weaknesses (Taylor & Wilson, 2005). For example, due to the apsychological nature of habit, the ability of an individual who performs a behaviour habitually to recall a specific episodic memory is notoriously inaccurate (Verplanken, Myrbakk, & Rudi, 2005)

This section provides an overview and critical evaluation of previous and current measures that have been used to assess habit strength. Exploring the historical developments of habit measurement provides an insight into the context in which current measures have evolved. The insight gained is therefore important in demonstrating the rationale and reasoning that underpin recent developments. Furthermore, this also allows for the strengths and weaknesses associated with current habit measures to be contextualised.

A number of measures exist to assess habit strength. The most commonly used measures include the following: self-reported frequency of past behaviour, self-reported habit frequency, the response frequency, and the Self-Report Habit Index (Verplanken & Orbell, 2003). The advantages and disadvantages associated with each measure are discussed. Additionally, in evaluating each of the measures, particular attention is paid to the conceptualisation of habit that is either implicitly or explicitly stated through the use of each measure.

Frequency of past behaviour

The measurement of frequency of past behaviour to determine habit strength has been one of the most commonly used measures in the literature (Verplanken & Orbell, 2003). The use of this measure was first demonstrated in behaviourism and was later applied in the domain of social psychology (Eagly & Chaiken, 1993). Examples of the application of this form of habit measure by early theorists in the field of behaviourism include research performed by James (1890), Watson (1914), Tolman (1932), Hull (1943), and Triandis (1977, 1980), and Landis et al. (1978). In general, the use of frequency of past behaviour was based on the idea that habits develop and gain in strength when the behaviour is satisfactorily repeated.

The primary method of obtaining this measurement has been conducted through self-report methods. For example, asking the individual to report how many times in the past week a given behaviour has been performed. Some researchers also attempted to obtain behavioural frequency through objective methods such as the observation of behaviour (e.g. Fredricks & Dossett, 1993; Landis, Triandis, & Adamoupoulos, 1978).

The conceptualisation of habit evident in this measure has been subject to much debate (Verplanken & Orbell, 2003). Although the use of frequency of past behaviour has been extensively used in the literature, as discussed, such measurement was not consistent with the conceptualisation of habit. For example, critics that opposed the use of this measure argued that the assumption that the two concepts (habit and behavioural frequency) equate with one another would incorrectly assume that as frequency increases, so in fact would habit strength

(Verplanken, 2006). In this regard, it has also been argued that simply because behaviour has been repeated, one cannot infer a habit is present (Ajzen, 2002). Addressing this issue, Azjen also raised the issue that, only with an independent and validated measure of habit can researchers assess whether a frequently performed behaviour has or has not become habitual. Further to this view, Ajzen (2002) suggested that the investigation of past behaviour on future behaviour represents little more than temporal stability, adding to this that:

> "It should be clear, therefore, that it serves no useful purpose to include past behaviour (a measure of a very specific behavioural disposition) in causal models of human action" (p. 109.)

In addition to issues raised concerning the conceptualisation of habit, there are also methodological limitations inherent in the assessment of habit strength by way of self-reported behavioural frequency. For example, whereas it may be possible to accurately recall some types of behaviours, the memories traces of other types of behaviours may either be irretrievable or no longer available (Tulving, 1983). Since habitual behaviours are performed automatically and with a lack of awareness (Verplanken & Orbell, 2003), this issue is particularly relevant to habitual behaviour. Research has also shown that the retrieval of frequency estimates of past behaviours is subject to underlying factors including ease of retrieval and accuracy motivation (Aarts & Dijksterhuis, 1999).

Self-reported habit frequency

Parallel to the use of frequency of past behaviour, some researchers have measured habit through self-reports of an individual's own habit strength. The grounding of this measure can be seen in research performed by Langer (1978). This researcher recognised that much of human behaviour is performed without the presence of volitional control. In recognising this important characteristic of human behaviour, Langer focused on the variations that were evident in terms of an individual's awareness. According to Langer:

> "A continuum of awareness varies directly with the degree of repeated experience that we have with the activity. The more often we have engaged in the activity the more likely it is that we will rely on scripts for the completion of the activity, and the less likely it is that there will be any correspondence between our actions and those thoughts of ours that occur simultaneously. (p. 39)

In the research performed by Langer (1978), although the focus was predominantly in terms of understanding and characterising habitual behaviour, it was not habit per se that was used as the focal term but instead the term "script". The term "script", as used by Langer (1978), was based upon previous research performed by Schank & Abelson, (1977) who defined a scripted behaviour as a "well learned or over learned behaviour that was at one time under the control of a person's intentions." (p. 41). Like habit, scripted behaviour was considered a behaviour that occurs without focused attention or cognitive control and was therefore considered as automatic (Hasher & Zacks, 1979).

Subsequently, measures of habit were developed that incorporated the conceptualisation put forward by Langer (1978). This was first illustrated in research performed by Wittenbraker, Gibbs and Kahle (1983). These researchers examined whether variation in awareness was evident between "scripted behaviour" (i.e. habitual behaviour) and "non-scripted behaviour" (i.e. non-habitual behaviour). To measure the strength of the habit, the following statement was used: "How many times in the last two weeks when driving a car have you put on a seat belt by force of habit?". The authors of this study acknowledged that individuals may find it difficult to distinguish between the concept of behaviour (i.e. the number of times wearing the seatbelt) and that of habit (i.e. the number of times putting the seat belt on by force of habit). Therefore, to enhance the distinction between these two concepts, the two items were placed next to one another, thereby making the distinction more salient. The results provided evidence of discriminant validity between the two concepts and therefore offered preliminary support for the use of this measure as an alternative measure of habit strength.

In a later study that also investigated seat belt use, a similar self-report statement was used to measure habit strength (Mittal, 1988). In this study, counter-intentional habits and pro-intentional habits were both measured. The counter-intentional habit was considered present if an individual intends to wear a seat belt, but on specific occasions forgets to do so and subsequently drives away. A pro-intentional habit was considered present if an individual repeatedly uses a seat belt, has done so for some time, and as a result has formed a habit to put the belt on when getting into the car without awareness. The following statement was used to assess pro-intentional habit: "During the past 4 weeks, when I got into my car, I was not even aware and I put on my seatbelt". To assess counter-intentional habit the following statement was used: "I simply forgot to put on my seatbelt". Both statements were followed by the five response categories of "never", "a few times", "sometimes", "many times", and "always".

Although the conceptualisation of habit in this study was identical to that of Wittenbraker et al. (1983), the measurement of habit was directly assessed through the individual's awareness (or lack) of the behaviour. However, the use of only a single discriminating variable (assessed through a single item), in this case awareness, may pose limitations in terms of the validity of the measure. Additionally, since habit is an apsychological experience, it is unlikely that an individual will be able to accurately recall such behaviours (Aarts & Verplanken, 1999). In anticipation of such criticism, Mittal (1988) stated that:

"..one *can* become aware of the belt being "on" even though one may not have been aware of the act of putting it on. Admittedly, one may not become aware of *all* instances of habit-driven belt use; to that extent, the self-report measures would underestimate (rather than overestimate) the habitual behaviour frequency. It is in the nature of the concept that an entirely satisfactory measure of it may remain unavailable." (p. 1001). *(italics in the original)*

Although the limitations of this measure were recognised, the unavailability of alternative measures of habit resulted in the continued use of such measures. The studies that have used these measures, which have been discussed, are presented in Table 2. Evidentially, it is highlighted that although variations in the way in which items were worded in these studies, the use of such measures all rely on the individual to report the degree to which their behaviour is habitual (e.g. "by force of habit" or "out of habit"). In addition to the limitations discussed above, a number of limitations are common among these measures. First, the majority of these measures are composed of only one or two items and developed on an ad hoc basis and thus not the product of a rigorous development and validation process. Moreover, the use of single-item measures have been found to be unreliable and imprecise (Spector, 1992). Second, these habit measures typically consist of an estimation of both behavioural frequency and habit strength into a single statement which often results in the inability to isolate individual components (Klöckner et al., 2003). Finally, criticism has been raised as to the way in which individuals respond to the word "habit", in that the individual's response is likely to be dependent upon the extent to which the individual truly understands the concept (Klöckner et al., 2003).

Table 2

Measures of habit used in previous studies (sorted by number of items in scale)

Study	**Number of items**	**Wording of items**
Saba et al. (1998)	1	I consume skimmed milk out of habit.
Tourila and Pangbom (1988)	1	I eat ice-cream out of habit.
Trafimow (2000)	1	I habitually use do not use a condom when I have sex.
Wittenbraker et al. (1983)	1	How many times in the last two weeks when driving a car have you put on a seat belt by force of habit?
Aarts and Dijkseterhuis (2000)	2	To what extent do you use a bicycle (train) by force of habit?
		How frequently did you use the bicycle (train) in the past two weeks?
Orbell et al. (2000)	2	Taking ecstasy is something I do automatically.
		Taking ecstasy is something I do as a matter of habit.
Saba and di Natale (1998)	2	I consume oil (seed oil, butter) out of habit?
		How often do you consume olive oil (seed oil, butter)?
Towler and Shepherd (1991;1992)	2	On average, how often do you eat chips out of force of habit?
		I eat chips out of habit.

Mittal (1988)	3	During the past 4 weeks, when I got into my car, I was not even aware and I put on my seat-belt (use-habit). During the past 4 weeks, when I got into my car, I simply forgot to put on my seat-belt (non-use habit). I put on my seat-belt by force of habit.
Trafimow (2000)	3	I am in the habit (not in the habit) of making sure a condom gets used every time I am steadfast (not steadfast) about making sure a condom gets used every time. I reliably (not reliably) make sure a condom gets used every time.

In summary, although self-report of habit strength identifies the key property within the operationalisation of the construct (i.e. its "automatic" nature) there are a number of limitations inherent to their use. One of the most critical limitations being, the requirement of individuals to mentally recall the nature of the performed behaviour, a concept which is incompatible with habit.

Response frequency

The response frequency measure of habit (Verplanken et al., 1994) was developed, and initially used, in a study investigating travel habits. The measure was developed to recognise and address the conceptual and methodological weaknesses that were evident in previous measures of habit. In doing so, Verplanken et al. (1994) stated that the development of a measurement technique was needed that:

> "Does not involve frequency of past behaviour, ..(..). is more general than with respect to one particular journey, (..) does not rely on retrospective introspection, and (..) is easy to administer, at least in a structured interview setting" (p. 289)

The response frequency measure was formulated on the conceptualisation of habit as a form of scripted behaviour. The use of the term "scripted behaviour" by Verplanken et al. (1994) referred to an "idiosyncratic cognitive structure" that represents an association between a given behaviour and goals within a specific context (Aarts & Dijksterhuis, 2000a). The measure involves an individual being presented with a number of habit related situations such as travel destinations. The individual is then asked to respond as quickly as possible with the behavioural choice that they associate with the stimuli. For example, in the context of travel behaviour, the authors proposed that when an individual has a habit of taking the car to a given destination, the presentation of that destination will be followed by dominate schema (e.g. car use). This measurement of habit relies on the assumption that when a participant is asked to respond to a global stimuli with little time allowed to respond, there is little possibility to evaluate the pros and cons which may be associated with the given stimuli, and as a result the given response will be guided by pre-existing schemas or scripts about mode choice in general (Verplanken et al., 1999). Therefore, the assumption is that as a result of the imposed time pressure and the requirement of the individual to provide the *first* travel mode that comes to mind, the automatic response is given (Aarts et al., 1997; Verplanken & Aarts, 1999). It is therefore essential that this measure is performed in a controlled research environment.

According to Verplanken et al. (1994), the use of the response frequency measure offers advantages over previous measures and does not require the arduous, and potentially problematic, task of reporting on internal processes such as awareness. Another advantage of using this measure is the context specificity which is offered by the measure in that prior to the development of the response frequency measure, no previous measure had addressed the issue concerning the idea that a habit may not be restricted to a single behaviour in a specific context. Regarding this issue, Verplanken et al. (1994) provide the example of car use, in that:

> "In explaining car choice, the choice may be determined by general habit of car use (i.e. no matter which journey, one chooses the car), rather than by (or above) habit with respect to one particular journey. In that case, predicting behaviour by general habit is more interesting than focusing on journey-specific habit." (p. 289, Verplanken, 1994)

The measure is however, frequently considered less beneficial due to the methodological constraints. For example, due to the requirements of the timing of the response, it is essential that the measure is performed in a controlled research environment in the presence of a research assistant. Additionally, the specificity offered by the response frequency measure also has drawbacks in that each administration of the measure that is implemented in a new domain or research setting (e.g. travel behaviour versus eating behaviour) must be preceded by pilot testing (Verplanken & Aarts, 1994). As a result, it has been highlighted that although the measure arguably offers a more theoretically sound alternative to measure habit, it is somewhat limited by its methodological disadvantages (Verplanken et al., 1994).

Further limitations have also been raised with regard to the theorisation that supports the measure which equates "scripts" with habits. For example, previous researchers have emphasised the difference between a script and a habit in that unlike a habit "a script is a knowledge structure, not just a response program" (Abelson, 1981, p. 722). Furthermore, the measure has been criticised on the grounds that it relies on the assumption that goals automatically activate mental representations of habitual choices that are brought about by the instruction given to participants to respond as quickly as possible. Although theoretically supported, the empirical validity of a habit measure determined under time pressure remains an empirical question (Ajzen, 2002).

Self Report Habit Index

The Self Report Habit Index (SRHI) was developed as a measure of habit strength by Verplanken and Orbell (2003). The SRHI was developed based on the following definition of habit put forward by Verplanken and Aarts (1999), who defined habit as a "learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states" (p. 104). The SRHI is comprises of 12-items that assess the experience of frequency and automaticity of a particular behaviour. Therefore, although the history of repetition remained a fundamental aspect of habit, the concept of automaticity was an important feature that was recognised in both the conceptualisation and measurement of habit.

The concept of automaticity within the SRHI is recognised through the inclusion of a number of proposed "features". These "features" are consistent with the definition of automaticity proposed by Bargh (1994), and include: lack of awareness, conscious intent, lack of control and mental efficiency. In addition to the inclusion of behavioural frequency and automaticity, the expression of self-identity was also considered an important "feature" of habit and was therefore included (Verplanken & Orbell, 2003).

The 12 items within the scale consist of the item stem, "Behaviour X is something...." followed by an item statement. The 12 item statements were developed based on the proposed "features" of habit and are given in Table 3. Individuals record their level of agreement with the 12 items on a Likert scale. Whereas previous self-report measures of habit strength require participants to recall directly their own perception of habit strength, the SRHI assesses the processes evident in habitual behaviour. The SRHI therefore provides a measure that is more closely aligned to the conceptualisation of habit.

Table 3

Item stem and statement items included in the SRHI (Verplanken & Orbell, 2003)

(Behaviour X) is something...
1. I do frequently.
2. I do automatically.
3. I do without consciously having to remember.
4. that makes me feel weird if I do not do it.
5. I do without thinking.
6. would require effort not to do it.
7. that belongs to my (daily, weekly, monthly) routine.
8. I start doing before I realise I am doing it.
9. I would find hard <u>not</u> to do.
10. I have no need to think about doing.
11. that's typically "me".
12. I have been doing for a long time.

To date, some researchers have examined the reliability and validity of the SRHI. These studies have assessed a wide range of behaviours, and have been conducted mostly in an adult population. The majority of reliability and validity evidence concerning the SRHI stems from research performed in the development of the SRHI by Verplanken and Orbell (2003). This research consisted of four sub-studies, all of which were conducted using university students as participants. The construct validity and internal consistency reliability of the SRHI was assessed in each of the four studies using principal component analysis and Cronbach's alpha, respectively. The first of these sub-studies investigated the test-retest reliability of the SRHI administered on two separate occasions (1-week apart) which were administered in relation to bicycle use. The second sub-study investigated the convergent validity of the SRHI, by relating it to the response frequency measure, which is considered an alternative measure of the automatic qualities of habitual behaviour (Verplanken et al., 1994). The focus of this sub-study was on transportation mode choice, with the target behaviour being bus use. The third sub-study also examined the convergent validity of the SRHI. Participants in this sub-study were presented with 26 behaviours. Participants were asked to indicate the frequency with which they participated in each of the behaviours. Based on the frequency of participation of each behaviour, three behaviours were selected for use in a second task, including watching "Good times, bad times", a well-known Dutch television programme, "eating candies", and "turning on music at home". The selection of the three named behaviours was considered representative of behaviours performed, on average, about three times a month, four to five times a month, and twice a day, respectively. A comparison between the habit strength, as measured by the SRHI, was made between the three behaviours. The fourth sub-study examined the ability of the SRHI to distinguish between habits that are performed daily versus habits that are performed weekly across a large number of different habits which were unique for each participant. Participants of this sub-study attended the lab for two separate sessions with a 1-week delay. In the first session, participants were asked to list two categories of habit: habits that are executed on a daily basis, and habits that are executed on a weekly basis. Participants were then randomly assigned to either a daily or weekly habit session. A habit was then selected for each individual based on two criteria: the frequency of behaviour (highest being selected) and the type of behaviour (to enable a unique habit for each participant). Participants completed the SRHI concerning the selected habit. Comparisons of SRHI scores were then made between individuals performing daily habits versus those performing weekly habits.

Results of sub-study 1 demonstrated high test-retest reliability between two administrations of the SRHI separated by a week (Pearson $r = .91$). Results of sub-study 2 demonstrated that a strong and significant correlation existed between the SRHI and an alternative measure of habit strength (i.e. the response frequency measure; $r = .58$, $p < .001$). Results of sub-study 3 demonstrated that habit strength increases as a function of the level of behavioural frequency. Results from study 4 indicated that the SRHI is able to discriminate between a range of behaviours that differ in behavioural frequency and between behaviours that are performed daily versus those that are performed weekly.

The internal consistency of the SRHI in the four experiments performed by Verplanken and Orbell (2003) ranged from $\alpha = .85$ (unique personal habits) to $\alpha = .95$ (eating candies). The internal consistency of the SRHI has also been examined by a number of researchers in other studies (de Bruijn et al., 2009; de Bruijn et al., 2007; de Bruijn, Kroeze, Oenema, Brug, 2008; Kremers & Brug, 2008; Verplanken, 2006). In all of these studies, Cronbach's α exceeded .70, which is regarded as the minimum criterion for acceptable internal reliability (Nunnally & Bernstein, 1994).

Results from the principal component analysis performed in each of the sub-studies by Verplanken and Orbell (2003) led the authors to conclude a unidimensional conceptualisation of the construct of habit concerning the behaviours examined. Although this was an obvious conclusion for some behaviours (i.e. eating candies) due to the presence of only one eigenvalue greater than a value of 1.00, for other behaviours this conclusion was not as obvious. In particular, Verplanken and Orbell (2003) highlighted this in regard to the analyses of sub-study four, which investigated unique personal habits, where three eigenvalues appeared greater than 1.00. A summary of the findings from the four sub-studies performed by Verplanken and Orbell (2003) is presented in Table 4.

Table 4

Results from the study conducted by Verplanken and Orbell (2003) in the development of the SRHI.

Experiment	**Behaviour**	**Eigenvalues greater than 1.0**	**Explained variance**	**Cronbach's alpha**
1	Bicycle use (pre-test)	3 (5.73, 1.34, and 1.15)	47.76%	.89
	Bicycle use (post-test)	3 (6.58, 1.55, and 1.05)	54.84%	.92
2	Bus use	3 (5.80, 1.23, and 1.12)	47.32%	.89
3	Watching a Dutch television programme	2 (7.56 and 1.65)	62.98%	.94
	Eating candies	1 (6.58)	65.56%	.95
	Turning on music at home	2 (7.41 and 1.01)	61.73%	.94
4	Unique personal habits*.	3 (4.62, 2.02, and 1.16)	38.48%	.85

Note. *A total of 62 different behaviours were included as self-selected unique personal habits. These included a range of behaviours such as walking the dog, making tea when arriving at home, travelling by train.

To date, the SRHI has been applied to assess the habit strength of a range of behaviours including physical activity (Verplanken & Melkevik, 2008), social chatting (Verplanken, 2004), negative self-thinking (Verplanken et al., 2005), travel (Verplanken et al., 2005; de Bruijn et al., 2009) and leisure activities (Verplanken & Orbell, 2003). Although the measure has been used to assess adult's habitual travel behaviour (de Bruijn et al., 2009; Gardner, 2009), there has been no application of the measure to assess children's travel habits (active or inactive modes). However, the SRHI has been used to assess children's habits in other domains including physical activity (Kremers et al., 2008) and tooth brushing (Wind et al., 2005). Although these studies have not assessed the reliability and validity of the measure in either of these contexts, the application of the measure in these studies has provided some evidence demonstrating the suitability and feasibility of the SRHI in measuring children's habits.

Measurement summary

This section has discussed the measurement of habit. Four measures of habit were identified and discussed. These measures include frequency of past behaviour (FPB), self-reported habit frequency (SRHF), the response frequency (RF) and the Self-Report Habit Index (SRHI). Major differences between each of the measures were identified in terms of their conceptualisations of habit and their methodological approaches. The difference between the four measures of habit are summarised in Table 4 according to the distinctions proposed by Bassili (1996). According to this taxonomy, the following broad classifications are considered in order to make comparison between the measures: a) type of measure, b) single/multiple item, c) frequency estimates, d) focus on multiple options, and e) usability in self-report questionnaires. The comparison between the four measures within each classification therefore provides a broad overview of the defining characteristics of each habit measure.

Table 5

Characteristics of the four habit measures (Bassili, 1996)

	Measure			
Characteristics	FPB	SRHF	RF	SRHI
Type of measure	Meta-judgement	Meta-judgement	Operational	Meta-judgement
Single/multiple items	Single	Single	Multiple	Multiple
Frequency estimates	Yes	Yes	No	No
Focus on multiple options	No	No	Yes	No
Useable in self-administered questionnaires	Yes	Yes	Preferable not	Yes

Note. FPB= frequency of past behaviour; SRHF= self-reported habit frequency; RF= response frequency; SRHI= Self-Report Habit Index

In relation to the first classification, type of measure, frequency of past behaviour, self-reported habit frequency, and the Self-Report Habit Index are all considered as meta-judgemental measures and therefore involve the individual reporting subjective beliefs. In comparison, the response frequency measure is characterised as an operative measure and therefore requires an objective assessment of belief. Although the meta-judgmental measures are more straightforward in their interpretation, they are often more vulnerable to judgement and motivation bias (Betsch & Haberstoh, 2005). In comparison, operative measures, in this case the response frequency measure, can potentially overcome such biases but can however be disadvantaged through their lack of external construct validity (Verplanken et al., 1997).

The second characteristic refers to the number of items within the measure. Both the frequency of past behaviour and sometimes, the self-reported habit frequency rely on a single item. However, the measurement of habit through a single item, as with many other constructs, is often less reliable. Therefore, in this context, both the response frequency and Self Report Habit Index, being a multi-item instruments, may provide a more reliable tool (Verplanken & Aarts, 1999).

The third characteristic refers to whether or not the measurement is reliant on subjective estimations of frequency. Both the frequency of past behaviour and the self-reported habit frequency rely upon subjective estimations of frequency. In line with earlier discussions, the process through which an individual recalls habitual behaviour has been shown to be typically based on rate-based estimation strategies (Menon, 1994). However, this strategy is known to be prone to biases (Verplanken & Aarts, 1999). For example, researchers have demonstrated that the way in which an individual perceives the wording of a question is influenced by an individual's motivation (Westland & Smith, 1993; Wright, Gaskell, & O'Muircheartaigh, 1997) and their cognitive biases (Tversky & Kahneman, 1974).

The fourth characteristic refers to whether the measure focuses on a single or multiple behavioural options. Three of the measures (frequency of past behaviour, self-reported habit frequency, and the Self Report Habit Index) focus on a single behavioural choice. In contrast, the response frequency measure includes a range of potential alternatives to the individual.

The final characteristic refers to the ability of the measure to be used in a self-administered questionnaire. This emphasises the potential methodological limitation for the response frequency method which may only be used in a controlled or laboratory setting. In contrast to this measure, the frequency of past behaviour, self-reported habit frequency and the Self Report Habit Index can be easily included into survey-based research (Verplanken & Aarts, 1999).

Which measure of habit should be selected? Given that the self-reported frequency of habit fails to capture any other aspect of habitual behaviour other than the frequency of past behaviour, this measure is considered as an inadequate measure of habit. Furthermore, previous measures that have attempted to assess the characteristics of habit have typically been through single item measures (e.g. the identification of a lack of awareness). Additionally, the combined effect of subjective measurement and single item measures have also been criticised due to their lack of supporting reliability and validity evidence (Verplanken, 2010). In this context, although the response frequency measure may be particularly useful, the selection of this measure, as previously discussed, may be restrained due to methodological considerations such as its feasibility. As a result, it is suggested that the selection of the measure for habit depends on the researcher's goal and the type of behaviour that is being studied. From this perspective, the use of the Self Report Habit Index offers, not only a measure that captures both frequency and automaticity, but has the advantage of being generic, easy to use and supported in a number of contexts by reliability and validity evidence (Verplanken, 2010). Therefore, the use of Self Report Habit Index to measure children's travel habits offers both a conceptually sound assessment of habit strength, whilst remaining feasible and appropriate to the research context.

Reliability and Validity

The validity of a measure has been described as "the most fundamental consideration in developing and evaluating tests" (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1985; American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1999, p. 9). In order to understand what constitutes a valid instrument it is important to identify the meaning of the concept of validity and how it relates to the measurement of children's travel cognitions and travel habits. In addressing the concept of validity in the context of active travel, the section provides firstly an overview of the meaning of reliability, considered to be a prerequisite to validity. This explanation is then followed by a conceptual understanding of validity and finally, a consideration of the reliability and validity evidence pertaining to available measures of children's travel cognitions and travel habits.

Reliability

The reliability of a measure is considered one of the most important characteristics. Reliability refers to the ability of the items of a test or scale to measure a construct, attribute, or trait on a consistent basis. According to classical test theory, an individual's observed score, X_i, on a measure X, is comprised of two components: A true score component (T_i) and a random error component (E_i). This is shown is Equation 6.

$$X_i = T_i + E_i \qquad \text{Equation 6}$$

The true score of a person can be found by taking the mean score that a person would get on the same test if they had an infinite number of testing sessions. However, since it is not possible to obtain an infinite number of test scores, T_i is a hypothetical, yet central, aspect of classical test theory (Kline, 2005). The error component, $E_{i,}$ of a score has been described as 'accidental deviations [that] are different in every individual case (hence are often called the 'variable errors') and occur quite impartially in every direction according to the known laws of probability' (Spearman, 1904, p 76). This error component may be seen as randomly "augmenting and diminishing" observed values, and "tending in a prolonged series to always more and more perfectly counterbalance one another" (Spearman, 1904, p. 89). In practice this may mean that errors can cause an observed score to be either higher or lower than a true score.

Error typically consists of systematic error and random error (Olds, 2002). Systematic error includes both constant error, which is considered to affect all scores equally, and bias, which affects certain scores differently to others (Nunnally & Bernstein, 1994). In contrast, random error refers to sources of error that are due to chance factors. Such errors can be a result of a variety of factors such as the way in which the test was administered (i.e., the conditions of the test), the individual's motivation, the instructions provided, emotional strain, and errors in the grading or rating of the test performance.

In application, given that the true score and the error value cannot be directly measured, the observed value is the only value that can be measured. Since the error term has a random distribution, a distribution in the error term will randomly occur in both a positive and negative way and, as a result, the mean of the measurement error is equal to zero (Gay, 1985). According to this assumption, the variance (σ^2) of the measurement is formulated in Equation 7.

$$\sigma^2_x = \sigma^2_t + \sigma^2_e \qquad \text{Equation 7}$$

There are four general classes of reliability estimates, each of which estimates reliability in a different way. These include: a) test-retest reliability, b) rater reliability, c) parallel forms reliability, and d) internal consistency reliability. The most common are test-retest reliability and internal consistency. Test-retest reliability refers to a measure of consistency over time. High stability over time shows that the test will reliably measure the same thing on separate occasions. Test-retest reliability takes into account errors produced by differences in the conditions associated with the two occasions on which the test is administered but does not measure error due to different samples of test items (Aiken, 1994, p. 85). The use of multiple items to assess the construct acts to reduce measurement error in the scale as a whole and thereby tends to increase reliability (Nunnally & Bernstein, 1994). It is therefore usually recommended that a measure should comprise of more than one item. Internal consistency therefore assesses whether the items within a scale are measuring the same construct consistently with each other. Rater reliability consists of both inter-rater reliability and intra-rater reliability. Inter-rater reliability is the degree to which different raters give consistent estimates of the same phenomenon. Intra-rater is the degree of agreement among multiple repetitions of a measure performed by a single rater. Parallel forms reliability is the consistency of the results of two tests constructed in the same way from the same content domain.

The reliability of a measure is important in order to ensure that any changes in measurement scores over time or differences between individuals are due to real changes (or differences) in the construct rather than to measurement errors. Therefore, hypothetically, changes in levels of a reliable instrument would be a reflection of true intra-individual differences in the underlying construct. However, in practice, given the wide range of factors within the test situation that may affect the test results, random errors of measurement are often present. Consequently reliability is a necessary component of validity and should be examined. Additionally, given that the same instrument used in a different setting or with different participants can demonstrate wide variation in reliability, the reliability of a measure should be examined in the context of its intended use (Feldt & Brennan, 1989; Traub & Rowley, 1991).

The internal consistency of multi-item scales is most frequently indexed by coefficient alpha (Cronbach, 1951). Typically, the minimum consistency level that is considered satisfactory is recommended at .70 (Nunnally & Berstein, 1994). This level is dependent on factors such as how a measure is being used and particularly on the extent to which test scores are used to differentiate between individuals (Nunnally & Berstein, 1994).

Test-retest is typically quantified using intraclass correlation coefficients (ICC). There are a number of versions of the intraclass correlation coefficient (ICC). Each form of ICC can give different results when applied to the same data (McGraw & Wong, 1996). The choice of ICC for a given analysis is determined by the experimental design and the conceptual intent of the study (Shrout & Fleiss, 1979). According to Shrout & Fleiss (1979), the guidelines for choosing the appropriate form of the ICC is determined by the following three decisions: (a) Is a one-way or two-way analysis of variance (ANOVA) appropriate for the analysis of the reliability study? (b) Are the differences between the mean ratings relevant to the reliability of interest? (c) Is the unit of analysis an individual rating or the mean of several ratings? The formula, presented in Equation 8, provides the appropriate form of ICC (two-way mixed ANOVA model adjusted for a single measure) for the test-retest reliability of a measure consisting of multiple items typically administered on a single occasion (Shrout and Fleiss, 1979).

$$\text{ICC }(2,1) = \frac{BMS - EMS}{BMS + (\text{k} - 1)EMS + k(MS - EMS)n}$$

Equation 8(adapted from Shrout & Fleiss, 1979).

Note: BMS = between-subject mean square; *EMS* = residual sum of squares; *MS* = between-ratings sum of squares; *k* = number of ratings

ICC is a relative measure of reliability that is a ratio of variance derived from ANOVA and is unit-less (Streiner & Norman, 1995). Theoretically, the ICC can vary between 0 and 1.0, where an ICC is indicative of no reliability and an ICC of 1.0 is indicative of perfect reliability. However, it should be noted that, although rare, in practice an ICC can extend beyond this range (Lahey, Downey & Saal, 1983). A number of considerations should be made in the interpretation of ICC. Firstly, since the calculation of an ICC involves the between-subjects variability, the heterogeneity of participants should be considered. For example, a large ICC can result when between-subject variability is high and therefore may mask poor test-retest reliability. In contrast, when the between-subjects variability is low, a lower ICC can result, even if absolute measurement error is small. As a result, in practice, a measure is likely to have different reliability depending on the characteristics of the individuals included in the analysis. For example, when measuring children's cognitions towards active school travel for example, the inclusion of individuals in the same analysis who are likely to hold widely different cognitions (i.e., positive and negative dispositions towards active school travel) will increase the between-subject variability and improve the ICC. Conversely, including a sample of children who are all, for example, positively orientated towards active school travel will decrease the between-subject variability and may result in an underestimation of the ICC.

This section has discussed the definition and assessment of reliability. Following the establishment of sufficient reliability evidence for a measure, the assessment of validity evidence for the measure should be performed. The following section provides an overview of the conceptualisation of validity, a suitable framework for to guide the process of construct validation and the types of evidences to support the validation of a measure.

Conceptualisation of validity

Almost five decades ago, it was noted that validity is "one of the major deities in the pantheon of the psychometrician" (Ebel, 1961, p. 640). Fifty years later, the importance of the concept of validity was recognised in the standards for educational and psychological testing which asserted that it is "the most fundamental consideration in developing and evaluating tests" (AERA, APA & NCME, 1999, p. 9). However, the conceptualisation of validity has proved a controversial concept in psychological testing and has undergone many changes over the past half century (Rowe & Mahar, 2006). The historical changes in our understanding of validity has been noted by many measurement experts and theorists (Angoff, 1988; Cronbach, 1988, 1989; Goodwin, 1997, 2002 ; Kane, 1994, 2001; Messick, 1989; Moss, 1992; Shephard, 1993). The current conceptualisation of validity and the validation process that are outlined in the most recent edition of the standards for educational and psychological testing, published in 1999, state that:

> "Validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests. Validity is, therefore, the most fundamental consideration in developing and evaluating tests. The process of validation involves accumulating evidence to provide a sound scientific basis for the proposed score interpretations. It is the interpretations of test scores required by proposed uses that are evaluated, not the test itself. When test scores are used or interpreted in more than one way, each intended interpretation must be validated" (AERA, APA, & NCME, 1999, p. 9)

The treatment of validity reflected in the statement demonstrated a distinctly different view from the previous editions of the standards for educational and psychological testing (AERA, APA, & NCME, 1985; AERA, APA, & NCME, 1966, APA, 1954). The difference was demonstrated by the transition away from the trinitarian perspective of validity, which conceptualised validity in three parts (namely content, criterion-related, and construct), to a unitary conceptualisation. Under this perspective, other established ‘categories’ of validity, for example content and criterion-related validity, are all considered as being a form of construct validity.

The unitary conceptualisation of validity was initially recognised by Messick (1989) who described validity as “an integrated evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment” (Messick, 1989, p.13). This conceptualisation of the validation process can also be seen to parallel some of the earlier work of Cronbach (1971) who suggested that “one validates not a test, but an interpretation of data arising from a specified procedure” (p. 447). In summary, the re-conceptualisation and current stance of validation has been described as “a move away from ‘weak’ programs of validation (involving perhaps a single study or a single piece of evidence, or the haphazard accumulation of correlations among variables) toward ‘strong’ programs” (Rowe & Mahar, 2006, p. 10). According to this conceptualisation, the validity to which test scores and implications hold across various groups and contexts are expected to differ and therefore the concept of validity is limited to specific scenarios and settings. This conceptualisation therefore infers a potentially limitless number of conditions for which validity evidence must be obtained. Consequently, this has led theorists to describe the validation process as “never-ending” (Shephard, 1993, p. 407).

Drawing upon the current conceptualisation of validity, Rowe and Mahar (2006) have provided a framework to guide the process of construct validation. This framework is shown in Figure 1.

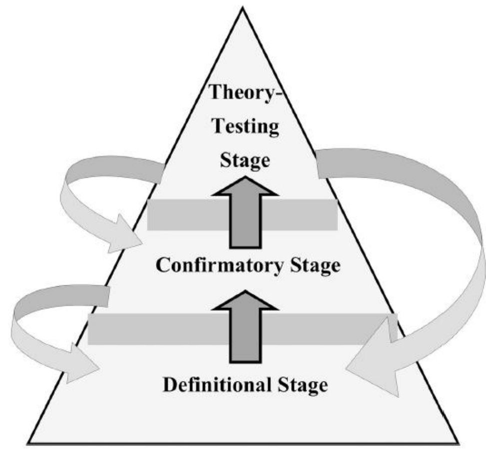


Figure 1. 'Illustration of the three-stage validation paradigm' (Rowe & Mahar, 2006)

The validation paradigm described by Rowe and Mahar (2006) demonstrates the accumulation of evidence at three levels: the definitional stage, the confirmatory stage and the theory-testing stage. Rowe and Mahar (2006) suggested that the validation process starts with the investigation of prior theory and empirical evidence to present an understanding of the construct. At this stage the construct is defined through evidence obtained in the theoretical domain. The validation of the construct then moves to the confirmatory stage in which evidence is collected that will either confirm or disconfirm the description of the construct. The final stage is the theory-testing stage. It is at this stage that the theories of how the construct of interest fits into the broader context of the research area are investigated. In addition, this investigation includes a consideration as to how the construct is related to other constructs and the identification of the determinants and outcomes of an individual's status on the construct.

According to Rowe and Mahar (2006), the validation process, as outlined in the model, can be explained as a ‘complementary and cumulative’ process. It is therefore important that research performed in the confirmatory stage and theory-testing stage should build on relevant research that has been performed in earlier stages. This is illustrated in Figure 1 through the straight arrows that point upward that highlight the need for validity evidence at each stage to be developed hierarchically from evidence gathered at the previous stages. The figure also underscores the iterative nature of the validation process. This is illustrated by the curved arrows on the side of the pyramid that suggest that information obtained from higher stages within the model may signify the need to return to earlier stages in the model in order to develop a better understanding of the construct.

Rowe and Mahar emphasised that a degree of overlap exists between the validity evidence gathered at different stages. The authors provide two examples to illustrate this point. Firstly, this is evident in the known differences method which can be used both to confirm the construct (i.e., confirmatory stage) and also to test the theoretical nomological network (i.e., theory testing stage). Secondly, this is also evident in the use of structural equation models that may be used to examine the internal structure of the construct and later, be used in the theory testing stage to investigate theories about how the construct is associated with other constructs. It is also suggested that the process should be considered as ongoing in that ‘we can only get closer to a perfect understanding of the construct; we can never achieve perfection and declare our validity research ‘‘finished’” (Rowe & Mahar, 2006, p. 12).

In order to provide evidence of construct validity within the three-stage validation paradigm it is important to identify the different types of evidence that can be obtained. According to the 1999 standards for educational and psychological testing (AERA, APA, & NCME, 1999), there are five 'sub-components' of construct validity evidence. The five sub-components of construct validity include: (a) test content evidence, (b) response processes evidence, (c) internal structure evidence, (d) relations to other variables evidence, and (e) consequences of testing. The five sub-components are not considered as types of validity evidence but instead, categories of evidence that can be collected to support the construct validity of inferences made from instrument scores. During the process of accruing evidence, a specific consideration should be made to two threats to validity: Inadequate sampling of the context domain such as construct underrepresentation and factors exerting non-random influence on scores such as bias, or construct-irrelevant variance (Downing & Haladyna, 1994; Messick, 1995). Descriptions and examples for each of the five sub-components of construct validity evidence as reported in the Standards (AERA, APA, & NCME, 1999) are provided below:

Content-related evidence

Content-related evidence is derived from the evaluation of the relationship between the content of a measure and the construct it is intended to measure (AERA, APA, & NCME, 1999). The content included should be representative of the entire construct and nothing else. In order to ensure this criterion is met, the definition of the construct and the intended purpose of the measure must be carefully examined. This information will ultimately guide the process for developing and selecting items and the wording of the items. Content-related evidence is typically presented as a detailed description of the processes which were taken to ensure that the items developed are representative of the construct (Haynes, Richard, & Kubany, 1995).

Response Process

The examination of the actions and processes performed by individuals completing the test or measure can enable an understanding of the relationship between the construct and the nature of the performance (AERA, APA, & NCME, 1999). For example, researchers investigating habitual behaviour might question the extent to which the items in a measure assess the characteristics of the construct. Researchers could determine and assess this characteristic by asking selected individuals to "think aloud" as they answer questions. Alternatively, if the measure involves one person rating the performance of another, the examination of this measurement attribute might involve ensuring and assessing the adequacy of the raters. In addition to this, methods for scoring and reporting the results are also included in the category (Downing, 2003).

Internal Structure

Evidence related to the internal structure should be examined for the response pattern resulting from each of the items within a scale. A measure that includes multiple items to assess a single construct should yield homogenous responses whereas a measure that has been designed to assess multiple dimensions should yield a heterogeneous response pattern (AERA, APA, & NCME, 1999). Evidence of internal structure also includes an investigation of the systematic variation in response to specific items between subgroups. For example, if children consistently respond to an item in a given way, that being different to other subgroups (i.e., adolescents or adults), and such results were unexpected then this may demonstrate disparity in the evidence and consequently undermine or weaken the ability to interpret the scores. In contrast, analyses that are able to confirm similar response patterns between sub-groups would strengthen the validity of intended interpretations. Evidence for the internal structure typically consists of internal consistency reliability and factor analysis (Downing, 2003).

Relations to Other Variables

Examination of the evidence related to the relationship between scores from measures of identical, similar, or contrasting constructs, for which relationships would be expected, or not expected, provides evidence in support of the interpretation of the construct (Campbell & Fiske, 1959). Such evidence comes in a number of forms and includes: concurrent validity studies, predictive validity studies, convergent validity studies and discriminant validity studies. Concurrent validity studies evaluate the correlational relationship between test scores and external criterion variables. Predictive validity studies evaluate the correlational relationship between test scores and external criterion variables that are assessed at a later date. Convergent validity studies evaluate the correlational relationship of test scores and other similar variables that the test should theoretically have high correlations with. Finally, discriminant validity studies evaluate the relationship of tests scores and other dissimilar variables that test scores should theoretically have low or no correlations with.

Consequences

Evaluation of the consequences of assessment can provide further understanding of potential sources of invalidity. For example, a measure of a psychological construct that scores consistently lower in younger children than older children might be indicating a source of unexpected bias. It could also mean that older children do in fact hold higher levels of the construct than younger children. As a result, investigations of such consequences are required. The assessment of evidence of consequence also includes the examination of the consequence of interpretation of scores. This includes the methods use to determine score cut points and thresholds. In practice, for example, if the treatment of an individual who scores particularly low on a given test or measure is not deemed to fulfill the desired effect of the test then the validity is weakened. Although this category of evidence is often unreported or disregarded as a true source of validity, this is one of the most controversial aspects of validity

Application to children's active travel

The most important issue in the evaluation of children's active travel is the use of measures with strong psychometric properties (reliability and validity) which has been established through the accumulation of evidence generated in this context. Measures that have been previously developed to measure cognitions and habit have not been tested in children and not in the context of school travel or even travel. A body of evidence contributing to the construct validity in this domain is therefore required to enable the sound measurement of such constructs.

Summary

Widely applied social-cognitive models, including the theory of planned behaviour, have been suggested to overestimate the role of cognition (Jeffery, 2004). In doing so, these theories neglect the repetitive and potentially habitual nature of behaviour (Michie, can Stralen & West, 2011). Given that the decisions related to travel mode choice (including school travel) are an extremely repetitive type of behaviour, it has been suggested that the habitual quality of travel constitutes an important component that should be included in theoretical models (Darnton, Verplanken, White & Whitmarsh, 2011).

Although the literature has pointed towards the addition of habit to models of behaviour, its inclusion within research in this area has been limited for a number of reasons. One reason for this is the historic lack of an effective methodological tool to measure the construct (Ouellette & Wood, 1998). However, more recently, researchers have developed a measure of habit strength, namely the Self Report Habit Index that addresses some of the methodological and conceptual limitations that are associated with previous measures of habit (Verplanken & Orbell, 2003). The Self Report Habit Index has therefore enabled researchers to investigate the role of habit in a range of behaviours.

Researchers investigating travel behaviour have acknowledged the role of habit as an important factor in adult's travel mode choice (de Bruijn et al, 2009; Gardner, 2009). Children's school travel behaviour is also likely to be under habitual control, at least to some extent, because journeys to school are characterised by both repetition (i.e. they are typically made each day of the school week) and situational stability (i.e. they take place at approximately the same time of day, have the same start and end points and typically constitute the same route). The investigation of habit in children's travel behaviour may constitute an important determinant of behaviour. Despite this, no researcher has examined the role of habit in relation to children's travel behaviour.

Given the practical implications of habit, it is important to address the role of habit in relation to children's active travel. The thesis addresses this broader research objective through a number of studies. Firstly, the thesis examines the reliability and validity evidence of a measure that can be used to assess walking habit and car/bus use habit (study 1). Secondly, the thesis examines the reliability and validity evidence of a measure that can be used to assess theory of planned behaviour constructs in relation to school travel behaviour (study 2). Following these two studies, the thesis investigates the role of walking habit and car/bus use habit within the theory of planned behaviour (study 3) and the effectiveness of an intervention in changing the constructs outlined in the theory of planned behaviour, walking habit and car/bus use habit (study 4). The research questions for each study are provided below:

Study 1

How reliable and valid is the Self Report Habit Index as a measure of walking habit and car/bus use habit in primary school children?

Study 2

How reliable and valid is the theory of planned behaviour questionnaire as a measure of walking cognitions in primary school children?

Study 3

How much of the variance in intention to active travel can be explained through the theory of planned behaviour constructs, walking habit and car/bus use habit?

How much of the variance in active travel can be explained through the theory of planned behaviour constructs, walking habit and car/bus use habit?

Study 4

How effective is the Travelling Green resource at changing the constructs outlined in the theory of planned behaviour, walking habit and car/bus use habit?

CHAPTER THREE

Title: Reliability and validity of the SRHI as a measure of walking habit and car/bus use habit in primary school aged children

The following paper is to be submitted for publication to the British Journal of Social Psychology and is presented in the format of this journal.

Reliability and validity of the SRHI as a measure of walking habit and car/bus use habit in primary school aged children

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ABSTRACT

Introduction: Habit constitutes an important component in travel behaviour which due to methodological and conceptual reasons has been overlooked. This paper investigates the reliability and validity of the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003) as a measure of walking and car/bus use habit in children.

Methods: Data were collected from 166 school children (aged 8-9 years). Participants completed questionnaires in a supervised classroom setting. Walking habit was measured with the item stem "Walking to school is something…." and habitual car and bus use was measured with the item stem "Travelling by car or bus to school is something…." each followed by the validated 12 item statements of the SRHI. Responses were made on a 5-point Likert scale ranging from 1 (*totally disagree*) to 5 (*totally agree*). A subsample (n = 87) completed a retest of the measure after 6 weeks. Internal consistency was assessed using Cronbach's alpha (α), and test-retest reliability was assessed using intraclass correlation coefficients (ICC) adjusted for a single measure. Construct validity was assessed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

Results: Internal consistency for walking habit was $\alpha = .94$ and for car/bus use habit was $\alpha = .97$. Test-retest reliability was ICC = .79 for walking habit and ICC = .70 for car/bus use habit after adjusting for a single administration, with a trivial mean difference for walking habit ($p > .05$, $d = 0.10$) and car/bus use habit ($p > .05$, $d = 0.13$). Children's walking habit scores were significantly and meaningfully higher for children who walked to school compared to non-walkers ($p < .05$; $d = .99$) and car/bus use habit scores were significantly and meaningfully higher for children who travelled by car/bus to school compared to those who did not use the car or bus ($p < .05$; $d = 1.47$). Children who walked all or part of the way to school also

demonstrated significant and meaningfully higher scores on each of the hypothesised walking habit subscales (i.e. Behavioural frequency, $t(152) = 5.94$, $p < .05$; $d = 1.09$; Self-identity, $t(152) = 3.92$, $p < .05$; $d = 0.72$; Automaticity, $t(152) = 4.92$, $p < .05$; $d = 0.65$) compared to children who did not walk any part of the way to school. Children who travelled by car or bus to school also demonstrated significant and meaningfully higher scores on each of the hypothesised car/bus us habit subscales (i.e. Behavioural frequency, $t(152) = 8.71$, $p < .05$; $d = 1.40$; Self-identity, $t(152) = 7.16$, $p < .05$; $d = 1.16$); Automaticity, $t(152) = 8.04$, $p < .05$; $d = 1.30$) compared to children who did not walk any part of the way to school.

Dimensionality of walking habit and car/bus use habit were first examined using exploratory factor analyses. These analyses indicated that a one factor structure explained 60% of total item variance in walking respectively and a one factor structure explained 74% of total item variance in car/bus use habit. Dimensionality was further examined using CFA. Marginal differences were observed between the unidimensional and a three-dimensional model of habit in both walking and car/bus use habit.

Discussion Internal consistency, test-retest reliability, and structural and known groups validity evidence provided strong support for the SRHI measure for walking and car/bus habit in upper primary school aged children. Subsequent CFA provided partial support to substantiate these conclusions. These findings provide initial evidence to enable researchers to measure the construct of habit in the context of children’s travel behaviour.

INTRODUCTION

Statistics from the National Travel Survey show that 47% of primary school children walk to school in the United Kingdom (Department for Transport, 2010). However, the average trip length for children is 1.5 miles, suggesting that for many children, walking is a viable mode of school travel (i.e. < 2.0 miles, the statutory walking distance[1]). More generally, these statistics represent an important health concern given that only 19% of boys and 11% of girls aged 11 to 15 years in Scotland meet the current recommended minimum target of at least one hour of physical activity per day (Currie et al., 2011) and walking to school represents a useful means for achieving this target. Additionally, sedentary lifestyles in childhood tend to continue into adulthood (Twisk, Kemper, & van Mechelen, 2002) and have been shown to be a risk factor for multiple adverse health outcomes (Thorp, Owen, Neuhaus, & Dunstan, 2011). It is therefore important to understand the factors underlying children's school travel choices in order to help develop effective health interventions. While there are potentially numerous factors that contribute towards school travel choices (Giles-Corti, Kelty, Zubrick & Villanueva, 2009; Panter, Jones & van Sluijs, 2008), one explanation is that behaviour is under habitual control and interventions need to promote active school travel habits such as walking to school, and break the habitual use of motorised transport. The identification of reliable and valid measures of children's school travel habits therefore is an important prerequisite for the investigation of the effects of habits in this context and for this target population. The present study addresses this need by testing the reliability and validity of Verplanken and Orbell's (2003) Self-Report Habit Index (SRHI) in a sample of children aged 8-9 years old.

Habit has been defined as a "learned sequence of acts that are automatic responses to specific cues and are functional in obtaining certain end goals or states" (Verplanken & Aarts, 1999, p. 104). This definition has been important in terms of re-conceptualising the construct through the inclusion of the concept of automaticity, which has been defined as behaviour that is performed without awareness, is difficult to control and is mentally efficient (Verplanken & Orbell, 2003). More recently, Wood and Neal (2007) further defined habit, emphasising that "habits are sub-served by a form of automaticity that involves the direct association between a context and a response but that interfaces with goals during learning and performance" (p. 843). In line with the re-conceptualisation, the SRHI (Verplanken & Orbell, 2003) was developed as a measurement tool providing a questionnaire-based assessment of habit. The measure was designed to assess the characteristics of habit, referred to as "features of habit", including "history of repetition of behaviour, the difficulty of controlling behaviour, the lack of awareness, efficiency, and the identity element" (Verplanken & Orbell, 2003, p. 1317).

The re-conceptualisation of habit emphasised that whereas a new behaviour will predominantly follow a path of conscious decision-making, the formation of a habit will involve a delegation of control over the behaviour to the environment (Bargh & Chartrand, 1999; Verplanken & Aarts, 1999; Verplanken & Orbell, 2003). Since school travel is usually performed repeatedly on a daily basis and in a stable situational context, it is plausible that this behaviour may become habitual (Aarts & Dijksterhuis, 2000a). The choice of travel mode taken by a child is dependent on factors such as physical and social factors, environmental and infrastructural limitations and personal preference (Gebel et al., 2005). However, regardless of the mode, the choice of behavior, once sufficiently repeated, is likely to form the basis of a habit. Therefore, habit has the potential to explain why so many children do not currently walk to school (i.e. they are in the habit of travelling to school by car or bus, rather than by foot). It is perhaps unsurprising that several authors have argued that habit needs to be taken into account in psychological models of travel mode choices (Aarts, Verplanken, & van Knippenberg, 1998; Bamberg, Ajzen & Schmidt, 2003; Bamberg & Schmidt, 2003; Garling & Axhausen, 2003; Klockner & Matthies, 2004; Klockner, Matthies, & Hunecke, 2003; Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994; Verplanken, Walker, Davis & Jurasek, 2008).

Habit is also potentially important for behaviour change. For example, health behaviour-change interventions are often designed to target conscious and rational decision-making processes by encouraging people to develop healthy intentions achieved using persuasive health communication messages (Jepson, Harris, Platt, & Tannahill, 2010). The focus on motivational and attitudinal change is also widely evident in the promotion of children's active travel (Jordan et al., 2008; Kong et al., 2009; Mendoza, Levinger, & Johnston, 2009; Wen et al., 2008; Zaccari & Dirkis, 2003). However, stronger habits make health behaviour less intentional (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; de Bruijn, Kroeze, Oenema, & Brug, 2008). Therefore, interventions are unlikely to be effective if behaviour is under the control of habitual processes rather than rational thought (Aarts et al., 1998; de Bruijn et al., 2007; Verplanken & Aarts, 1999; Verplanken & Wood, 2006). Instead, intervening to change behaviours that are under habitual control may require a different approach such as addressing the context in which the habit is performed. For example, significant disruptions in the stability of a context can result in a change in the habits that are associated with that context (Wood, Tam & Witt, 2005). As a result, such a disruption may provide an opportunity for behaviour to be reconsidered and thus make behaviour change more likely (Verplanken & Wood, 2006). This concept has been referred to as the discontinuity hypothesis (Verplanken et al., 2008).

Despite these findings, there is currently no established measure of habit (with demonstrated psychometric properties) that researchers can use within child populations, meaning that no study has empirically examined the role of habit in children's school travel behaviour. Empirical research in other domains has addressed the issue of habituation in the performance of several social behaviours using Verplanken and Orbell's SRHI. These include behaviours such as physical activity (Chatzisarantis & Hagger, 2007; Verplanken & Melkevik, 2008), social chatting (Verplanken, 2004), negative self-thinking (Verplanken, Myrbakk & Rudi, 2005), and leisure activities (Verplanken & Orbell, 2003). Researchers have also applied the SRHI to measure travel habits in adult populations (Davidov, 2007; de Bruijn et al, 2009; Gardner, 2009; Verplanken & Orbell, 2003; Verplanken et al., 2005). The application of the SRHI to measure children's habits has been limited to general physical activity habits (Kremers & Brug, 2008) and tooth brushing habits (Wind, Kremers, Thijs, & Brug 2005).

The SRHI is a 12-item questionnaire. It provides a measure of habit that assesses the key theoretically derived features of habituation, namely frequency of past behaviour (habitual behaviours are repeated frequently), behavioural automaticity (behaviours under habitual control are carried out automatically in response to stable situations) and identity expression (habitual behaviours express someone's identity). These characteristics were posited as important features of habit (Verplanken & Orbell, 2003). For example, a behaviour becomes habitual through frequently and satisfactorily pairing the execution of an act in response to a specific cue. When a habit has formed, the behaviour is characterised as being under the control of environmental cues rather than conscious or rational decision-making processes. A habit is therefore characterised as including both the feature of past behavioural frequency and automaticity. The addition of the "feature" of self-identity was included to characterise the belief that habitual behaviours are representative of the way in which an individual organises their everyday life and thus might reflect a "sense of identity or personal style" (Verplanken & Orbell, 2003, p. 1317). For example, individuals may identify themselves as a “walker” or a “cyclist”. In contrast to the SRHI, previous assessments of habit strength have commonly used a measure of past behavioural frequency (Verplanken, 2010). However using only past behavioural frequency as a proxy for habit is not ideal. Firstly, this disregards the important characteristics of habitual behaviour such as the apsychological processes. Secondly, this would also imply that as frequency increases so would habit strength, which is conceptually inaccurate (Verplanken, 2006).

Empirical examination of SRHI

To date, some researchers have examined the reliability and validity of the SRHI. These studies include a wide range of behaviours and have been conducted mostly in an adult population. The majority of reliability and validity evidence concerning the SRHI stems from research performed in the development of the SRHI by Verplanken and Orbell (2003). This research consisted of four sub-studies all of which were conducted using university students as participants. The construct validity and internal consistency reliability of the SRHI was assessed in each of the four studies using principal component analysis and Cronbach’s alpha respectively. The first of these sub-studies investigated the test-retest reliability of the SRHI administered on two separate occasions (1 week apart) which were administered in relation to bicycle use. The second sub-study investigated the convergent validity of the SRHI by relating it to the response frequency measure that is considered an alternative measure of the automatic qualities of habitual behaviour (Verplanken et al., 1994). The focus of this sub-study was on transportation mode choice, the target behaviour being bus use. The third sub-study also examined the convergent validity of the SRHI. Participants in this sub-study were presented with 26 behaviours. Participants were asked to indicate the frequency with which they participated in each of the behaviours. Based on the frequency of participation of each behaviour, three behaviours were selected for use in a second task including "watching Good times, bad times" (a well-known Dutch television programme), "eating candies", and "turning on music at home". The selection of the three named behaviours was considered representative of behaviours performed, on average, about three times a month, four to five times a month, and twice a day, respectively. A comparison between the habit strength, as measured by the SRHI, was made between the three behaviours. The fourth sub-study examined the ability of the SRHI to distinguish between habits that are performed daily versus habits that are performed weekly across a large number of different habits which were unique for each participant. Participants of this sub-study attended the lab for two separate sessions with a 1-week delay. In the first session, participants were asked to list two categories of habit: habits that are executed on a daily basis, and habits that are executed on a weekly basis. Participants were then randomly assigned to either a daily or weekly habit session. A habit was then selected for each individual based on two criteria: the frequency of behaviour (highest being selected) and the type of behaviour (to enable a unique habit for each participant). Participants completed the SRHI concerning the selected habit. Comparisons of SRHI scores were then made between individuals performing daily habits versus those performing weekly habits.

Results of sub-study 1 demonstrated high test-retest reliability between two administrations of the SRHI separated by a week (Pearson $r = .91$). Results of sub-study 2 demonstrated that a strong and significant correlation existed between the SRHI and an alternative measure of habit strength (i.e. the response frequency measure; $r = .58$, $p < .001$). Results of sub-study 3 demonstrated that habit strength increases as a function of the level of behavioural frequency. Results from sub-study 4 indicated that the SRHI is able to discriminate between a range of behaviours that differ in behavioural frequency and between behaviours that are performed daily versus those that are performed weekly.

The internal consistency of the SRHI in the four experiments performed by Verplanken and Orbell (2003) ranged from α = .85 (unique personal habits) to α = .95 (eating candies). The internal consistency of the SRHI has also been examined by a number of researchers in other studies (de Bruijn et al., 2009; de Bruijn et al., 2007; de Bruijn, Kroeze, Oenema, Brug, 2008; Kremers & Brug, 2008; Verplanken, 2006). In all studies Cronbach's α exceeded .70, which is regarded as the minimum criterion for acceptable internal reliability (Nunnally & Bernstein, 1994).

Results from the principal component analysis performed in each of the sub-studies performed by Verplanken and Orbell (2003) led the authors to conclude a unidimensional conceptualisation of the construct of habit concerning the behaviours examined. Although this was an obvious conclusion for some behaviours (i.e. eating candies) due to the presence of only one eigenvalue greater than a value of 1.00, for other behaviours this conclusion was not as obvious. In particular, Verplanken and Orbell (2003) highlighted this in regard to the analyses of sub-study four, which investigated unique personal habits, where three eigenvalues appeared greater than 1.00. A summary of the findings from the four sub-studies performed by Verplanken and Orbell (2003) is presented in Table 1.

Concerning the conclusions drawn from principal component analyses, although there are some formal statistical and conceptual criteria for deciding the interpretability of a factor analysis solution, any interpretation of a factor solution is ultimately subjective. Consequently, the interpretation of factor analysis is often subject to wide variation. As a result the conclusions of the factor structure should be made in the context of factors such as the nature of the test instrument, the relationships observed in prior research, and the theoretical context of the investigation. Concerning the theoretical context of habit, there appears to be conflict between the conclusion of a one-dimensional conceptualisation of the construct and the *a priori* conceptual beliefs about the number of factors given in the development of the measure Verplanken and Orbell (2003) which was evident in an implicit reference to the three "features" of habit.

*** Insert Table 1 here ***

To date, only two studies have used the SRHI to measure children's habits. These studies have investigated tooth brushing behaviour (Wind et al., 2005) and physical activity (Kremers et al., 2008). The analyses in both studies demonstrated the scale to have acceptable to good levels of internal consistency reliability ($\alpha = .77$ to .84). However, the test-retest reliability and validity (internal or construct) were not examined.

Despite the growing support for the SRHI as a reliable and valid measure of habit, the extent to which the findings can be generalised to different populations and contexts is relatively unknown (Verplanken & Orbell, 2003). With regard to children's self-report questionnaires, these can be influenced by a number of factors including cognitive ability, psychological factors, and social influences such as family income and education (Sallis, Buono, Roby, Micale & Nelson, 1993; Welk, Corbin & Dale, 2000). As a result, the reliability and validity of these measures may be attenuated. It is therefore unknown whether the SRHI will provide a reliable and valid tool for examining the role of habit in the performance of behaviours in children (e.g. school travel mode choices).

In addition to the lack of research testing the reliability or validity of the SRHI in children, the empirical use of the measure has varied between studies such as the removal of items from the scale. For example, while some authors, in line with the findings of Verplanken and Orbell (2003), have used the full 12 items, others have removed sets of items from the scale (e.g. de Bruijin et al., 2010; de Nooijer et al., 2010; Gardner, 2009; Haustein et al., 2009; Honhanson, Olsen & Verplanken, 2005; Lally et al., 2009; Møller & Thøgersen, 2009; Pham, Mizerski, Wiley, & Mizerski, 2008; Verplanken, 2006). A summary of studies that have removed item (s) from the SRHI is given in Table 2. The removal of items varies between studies and in addition, some authors have significantly adapted item(s) within the SRHI (i.e. de Nooijer et al., 2010; Honhanson, Olsen &Verplanken, 2005; Verplanken, 2006) and in some cases adapted the structure and the items within the SRHI (i.e. Møller &Thøgersen, 2009). The removed items consist mostly of those relating to behavioural frequency; however, the removal of items regarding self-identity is also evident within the travel literature (i.e. Haustein et al., 2009; Møller & Thøgersen, 2008). Often, the explanation given for the removal of items relating to behavioural frequency concern the need for a measure of habit as cognition that is independent of behavioural frequency (Gardner, 2009). The rationale given for the removal of items relating to self-identity has been predominantly in terms of the uncertainty surrounding the degree to which a given behaviour is fundamental to an individual's self-identity (Lally et al., 2009).

*** Insert Table 2 here ***

The removal of individual items, as evidenced in current applications of the SRHI, raises questions over the validity of such uses and disparity over the conceptualisation of habit. Additionally, the alterations in the SRHI between studies limit the ability to make comparisons of the SRHI scores across studies. Since the conceptualisation of the construct is based on the inclusion of all three features, the empirical application should be a reflection of the proposed theoretical construction (Benson, 1998). As such the removal of features demonstrates a conflict between the substantive findings confirmed in the development of the measure (i.e. habit as a unidimensional construct) and the empirical representation (i.e. single scale scores). This conflict could be partially attributed to the terminology used by Verplanken and Orbell (2003) which may be considered as ambiguous. For example, characteristics of habitual behaviour were conceptualised as three "features" and thereby implying the presence of dimensions. This conceptualisation therefore demonstrates an inconclusive agreement in the substantive stage of construct validation, in which "the theoretical domain of the construct is specified, and the operational definition in terms of the observed variables (e.g. the behaviours that reflect the construct)" (Benson, 1998, p. 11). As a result, and in addition to the need for validity evidence for the use of the measure within a child population, there is an additional need to include examination of the rival hypothesis implied through the inconsistencies evident in the empirical application of habit, which typically demonstrated the conceptualisation of habit as a three-dimensional construct, with the findings concluded by Verplanken and Orbell (2003) as a unidimensional construct. The testing of rival hypotheses is coherent with the program of construct validation reflected in the standards for educational and psychological testing published in 1974 (American Psychological Association, 1974) and 1985 (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1985). These standards highlight the "importance of theory preceding and guiding test development and validation, followed by the testing of rival hypotheses" in order to examine the construct validity of a measure (Cronbach & Meehl, 1955, p. 11).

Objectives

To date, no researcher has examined the reliability or validity of the SRHI in children's travel behaviour. While the use of the SRHI has been previously confirmed to be conceptually and methodologically suitable for use in a child population in other behaviours (Kremers et al., 2008; Wind et al., 2005), there has been no investigation of the reliability and validity of the SRHI to measure children's travel habits. Therefore the objective of the current study was to investigate the reliability and validity of the SRHI as a measure of travel habits in primary school aged children. The assessment of construct validity in the paper follows the processes proposed by Benson (1998). Within this framework, the study assessed both the reliability (test-retest and internal), and internal construct (i.e. structural) and external construct (i.e. known groups) validity of the scale.

*** Insert Figure 1 here ***

METHODS

Sampling

The current study forms part of a larger project called the Strathclyde Evaluation of Children's Active Travel (SE-CAT), which is a long-term evaluation of a classroom-based resource that is aimed at increasing active travel (McMinn, Rowe, Murtagh & Nelson, 2011). Participants were 166 primary school children aged 8-9 years old. A purposive sampling approach was used to recruit schools. Permission to contact potential schools was granted from all relevant local education authorities. These schools were subsequently contacted and asked to take part in the study. Five schools took part in the study: three schools from areas of high deprivation and two from areas of low deprivation as determined by the Scottish Index of Multiple Deprivation (SIMD, 2009: www.scotland.gov.uk/Topics/Statistics/SIMD). All schools were located within urban areas as determined by the Scottish Neighbourhood Statistics Urban

Rural Classification (www.sns.gov.uk). Following the identification of schools, the relevant council employees including school travel coordinators, active school coordinators and road safety officers were contacted and provided details of the study.

Data collection for the present study was performed during the autumn term of 2009 (Sept to Nov). The retest data collection was made 6 weeks later (n = 87). Data collection was conducted in a classroom in the presence of a team of four or five trained research assistants (depending on class size). Research assistants provided help for children when reading and answering items on the questionnaire. Parental consent for participant recruitment was obtained from all participants in the study prior to data collection. Ethical approval was obtained from the University of Strathclyde Ethics Committee.

Measures

Habit. The SRHI (Verplanken & Orbell, 2003) was used to measure walking habit and car/bus use habit. To measure walking habit participants were presented with the following stem: 'Walking to school is something….' followed by 12 items that assessed frequency of past behaviour (e.g. "I do frequently"), automaticity of behaviour (e.g. "I do automatically") and self-identity (e.g. "that is typically me"). Responses were recorded on a 5-point Likert scale ranging from 1 (*totally agree*) to 5 (*totally disagree*). The same items were also used to measure car/bus use habit using a difference item stem ("Travelling by car or bus to school is something….").

Usual travel mode. Usual travel mode was measured using an item from a child school travel questionnaire which was designed for the study. This item asked "On a normal day, how do you usually travel TO school?". Responses to this questionnaire item included "On foot", "By school bus", "By public transport", "By car (given lift)", "By Bicycle", and "Other" (indicated through a tick box). An alternative open response of "A mixture of ...... and......" was also given. Children's responses to this questionnaire item were classified in two ways. Firstly, children were classified as walkers if their response included walking for all or part of the journey to school, and non walkers if they did not report any walking on the journey to school. Secondly, children were classified as car or bus users if their response included using the car or bus to travel of all or part of the journey to school, and non car or bus users if they did not report any car or bus use on the journey to school.

Data analysis

The statistical software packages SPSS (Version 18.0; IBM Corp., Chicago, IL) and AMOS (Version 17.0, IBM Corp., Chicago, IL) were used for data analyses. The internal consistency reliability of the SRHI was assessed using Cronbach's α. Test-retest reliability was assessed using intraclass correlation coefficients (ICC), *t*-tests and Cohen's *d* for systematic mean change. Given that the administration of the SRHI would be typically be administered on a single occasion, the ICC was adjusted for a single measure. The following values were used to interpret Cohen's *d*: 0.2 = small; 0.5 = medium; and > 0.8 = large. The external construct validity (known groups) of the SRHI for measuring walking habit was assessed by comparing the habit scores of those who reported usually walking all or part of journey to school against those who reported other modes of transport. Similarly, the external construct validity (known groups) of the SRHI for measuring car/bus use habit was assessed by comparing the habit scores of those who reported usually travelling by car or bus for all or part of the journey to school against those who did not report travelling by car or bus on the journey to school.

The assumptions underlying factor analysis were tested and confirmed using the Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett test of Sphericity (Hair, Anderson, Tatham,

& Black, 1998). Both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to examine construct validity. EFA allowed an initial investigation to examine the number of factors within the SRHI. Factor extraction was obtained through the use of Parallel analysis (Horn, 1965). Parallel analysis is a Monte-Carlo based simulation method that compares the observed eigenvalues with those obtained from uncorrelated normal variables. This technique calculates eigenvalues from randomly generated correlation matrices based on parameters provided in the data set. These eigenvalues are then compared with eigenvalues extracted from the dataset. The number of factors which are extracted is based on the number of eigenvalues (generated from the dataset) that are larger than the corresponding random eigenvalues (Horn 1965). This statitstical technique was utilized through SPSS syntax written by O'Connor (2000). In line with recommended values, 1000 datasets were simulated and the percentile of eigenvalues was set at .95 (Glorfeld 1995; Velicer et al. 2000). Model parameters were estimated using the Maximum Likelihood extraction method and oblique rotations.

Following the EFA, subsequent CFAs were performed. Confirmatory factor analysis has a major advantage over traditional EFA in that it allows for the comparison of competing measurement models and the statistical testing of the "goodness-of-fit" of an *a priori* defined measurement model (Bryant, Yarnold, & Michelson, 1999). It also allows for testing an exactly-specified model, whereas EFA allows items to load on all factors. Confirmatory factor analyses were conducted allowing the comparison of the two competing models in explaining the relationship among the observed variables in both walking habit and car/bus use habit. The two models were: a) the unidimensional model as postulated by Verplanken and Orbell (2003), and b) a three-dimensional model implied through empirical application of the SRHI thereby forcing items to load uniquely onto three factors representative of behavioural frequency, self-identity, and automaticity. In multi-factorial models, correlations among the factors were freely estimated. Model parameters were estimated using the Maximum Likelihood extraction method. For data that are relatively normally distributed, the use of maximum likelihood is considered the best choice because “it allows for the computation of a wide range of indexes of the goodness-of-fit of the model and permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals” (Fabrigar, Wegener, MacCallum & Strahan, 1999, p. 277).

Fit indices

There has been much controversy and discussion regarding the choice of fit indices in the evaluation of model fit (Hu & Bentler, 1999). Selection of the fit indices appropriate for the characteristics of the data and research paradigm is important (Brown, 2006). Although chi-square is widely used it has been criticised due to limitations such as the failure to assess parsimony and the insensitivity to misspecification of structural relationships (Mulaik et al., 1989). Therefore, the consideration and use of additional indices to determine the fit of the model is recommended (Schumaker & Lomax, 2004). An overview of each of the fit indices used in this study follows.

Chi-square. The chi-square (χ^2) is typically used to report the overall fit of a model and is used to provide an assessment of the magnitude of discrepancy between the expected and observed covariances matrices (Hu & Bentler, 1999). A χ^2 value close to zero indicates little difference between the expected and observed covariance matrices. In addition, the probability level should be greater than p = .05 when the χ^2 is close to zero. Although the χ^2 is commonly used as a fit statistic there are a number of limitations inherent in its use. A major limitation concerns the sensitivity of the test to sample size which means that the χ^2 test nearly always rejects the model when large samples are used (Bentler & Bonnet, 1980; Jöreskog & Sörbom, 1993). In contrast, when small samples are used the χ^2 statistic is underpowered and therefore may not discriminate between good fitting models and bad fitting models (Kenny & McCoach, 2003). The addition of the χ^2 standardised to the degrees of freedom (χ^2/df ratio; Wheaton, Muthen, Alwin & Summers, 1977) is also presented. The χ^2/df allows an adjustment for model complexity. A χ^2/df ratio >2.0 indicates an inadequate fit and a χ^2/df ratio value ≤2.0 is widely considered to represent a minimally plausible model (Byrne, 2001).

Comparative Fit Index (CFI). The CFI (Bentler, 1990) represents the improvement in fit of a hypothesised model over an independence model, in which all variables are uncorrelated. The CFI is also very sensitive to misspecified factor loadings and moderately sensitive to misspecified factor correlations (Hu & Bentler, 1998). The CFI ranges from 0 to 1, with larger values indicating better fit. Hu and Bentler (1999) recommended that a cut-off equalling or greater than .95 indicates adequate model fit (Hu & Bentler, 1999).

Tucker-Lewis Index (TLI). The TLI (Tucker & Lewis, 1973), which is also referred to as the non-normed fit index (NNFI), includes features to compensate for the effect of model complexity through the integration of a penalty function that is added for the inclusion of freely estimated parameters that do not markedly improve the fit of the model. Values are interpreted in a similar fashion to the CFI, with values approaching 1.00 indicative of good fit (Hu & Bentler, 1999).

Root mean square error of approximation (RMSEA). Root mean square error of approximation (RMSEA) is one of the most widely used parsimony correction indices (Brown, 2006). The RMSEA relies on a non-central χ^2 distribution. This refers to the distribution of the fitting function when the fit is not perfect. The RMSEA is an indication of how well the model, with unknown but optimally chosen parameter estimates, would fit the population covariance matrix (Byrne, 1998). The RMSEA favours parsimony in that it will choose the model with the lesser number of parameters. Although the upper range of the RMSEA is unbound, the values rarely exceed one, and tend to range from 0 to 1 with a smaller RMSEA value indicating better model fit.

RESULTS

Descriptives

Descriptive results for each of the scale means for walking habit and car/bus use habit are given in Table 3. The mean SRHI score for walk habit was 3.52 (*SD* = 1.29). Therefore, on average, participants reported moderate levels of walking habit (i.e. the sample mean was slightly above the scale mid-point, 3). The mean SRHI score for car/bus use habit was 2.31 (*SD* = 1.41) indicating that, on average, participants reported low levels of walking habit (i.e. the sample mean was slightly below the scale mid-point, 3).

**Insert Table 3 here **

Pearson correlation coefficients for all SRHI items for walking habit and car/bus use habit are shown in Table 4 and Table 5, respectively. Significant positive correlations were observed between all items ranging from r = .58 to r = .91 in walking habit and from r =.42 to r = .80 in car/bus use habit.

**Insert Table 4 here **

**Insert Table 5 here **

Reliability (test-retest and internal consistency)

Test-retest reliability was ICC = .79 for walking habit and ICC = .70 for car/bus use habit after adjusting for a single administration, with trivial mean differences for both walking habit ($t(85) = 0.25$, $p > .05$, $d = 0.10$) and car/bus use habit ($t(85) = 0.43$, $p > .05$, $d = 0.13$). High levels of internal consistency were found both for the measure of walking habit ($\alpha = .94$) and of car/bus use habit ($\alpha = .97$).

External construct validity

Data concerning the usual mode of travel to school were collected from 154 children. The mean walking habit score for children who reported walking all or part of the journey to school ($n = 114$, $M = 3.75$, $SD = 1.25$) was significantly and meaningfully higher (with a large effect size; $t(152) = 5.38$, $p < .05$; $d = .99$) than for of children who reported no walking on the journey to school ($n = 40$, $M =2.64$, $SD = 1.25$). The mean car/bus use habit score for children who reported using a car or bus to travel all or part of the journey to school ($n = 75$, $M = 2.86$, $SD = 1.23$) was significantly and meaningfully higher (with a large effect size; $t(152) = 8.92$, $p < .05$; $d = 1.47$) than for children who reported no car or bus use on the journey to school ($n = 79$, $M =1.35$, $SD = .84$).

Differences between the means of each of the hypothesised subscales (i.e. behavioural frequency, self-identity, and automaticity) for walking habit were also examined between children who walked all or part of the journey to school versus those who did not walk any part of the journey to school. Differences between the means were also examined for each of the hypothesised subscale of car/bus use habit between children who travelled by car or bus part or all of the journey to school versus those who did not use a car or bus for any part of their journey. Concerning walking habit, the mean score for the behavioural frequency subscale for children who reported walking all or part of the journey to school ($n = 114$, $M =3.18$, $SD = 1.16$)

was significantly and meaningfully higher (with a large effect size; $t(152) = 5.94$, $p < .05$; $d = 1.09$) than for of children who reported no walking on the journey to school ($n = 40$, $M = 1.83$, $SD = 1.41$). The mean score for the self-identity subscale for children who reported walking all or part of the journey to school ($n = 114$, $M = 2.53$, $SD = 1.33$) was significantly and meaningfully higher (with a large effect size; $t(152) = 3.92$, $p < .05$; $d = 0.72$) than for of children who reported no walking on the journey to school ($n = 40$, $M = 1.56$, $SD = 1.31$). And the mean score for the automaticity subscale for children who reported walking all or part of the journey to school ($n = 114$, $M = 2.63$, $SD = 1.33$) was significantly and meaningfully higher (with a large effect size; $t(152) = 4.92$, $p < .05$; $d = 0.65$) than for of children who reported no walking on the journey to school ($n = 40$, $M = 1.57$, $SD = 1.25$).

Concerning car/bus use habit, the mean score for the behavioural frequency subscale for children who reported using a car or bus to travel all or part of the journey to school ($n = 75$, $M = 2.51$, $SD = 1.33$) was significantly and meaningfully higher (with a large effect size; $t(152) = 8.71$, $p < .05$; $d = 1.40$) than for of children who reported they did not use a car or bus to travel on the journey to school ($n = 79$, $M = .68$, $SD = 1.26$). The mean score for the Self-identity subscale for children who reported using a car or bus to travel all or part of the journey to school ($n = 75$, $M = 2.09$, $SD = 1.38$) was significantly and meaningfully higher (with a large effect size; $t(152) = 7.16$, $p < .05$; $d = 1.16$) than for of children who reported that they did not use a car or bus to travel on the journey to school ($n = 79$, $M = .59$, $SD = 1.20$). And the mean score for the automaticity subscale for children who reported that they used a car or bus to travel to school for all or part of the journey to school ($n = 75$, $M = 2.12$, $SD = 1.24$) was significantly and meaningfully higher (with a large effect size; $t(152) = 8.04$, $p < .05$; $d = 1.30$) than for of children who reported that they did not use a car or bus to travel on the journey to school (*n* = 79, *M* =.61, *SD* = 1.09).

Internal construct validity

Exploratory factor analysis (EFA). Two separate EFAs were conducted on the 12 items of the SRHI for walking habit and car/bus use habit respectively. Results of the parallel analyses provided support for a one factor solution in both walking habit and car/bus use habit in that for both constructs only one eigenvalue from the observed data set was greater than that of the eigenvalue at the 95th percentile in the simulated dataset. For walking habit, the single factor solution which was confirmed through the results of the parallel factor analysis accounted for 60.46% of the total observed item variance in walking habit. Items 1, 2, 3, 7, 10, 11, and 12 of the walking habit measure loaded primary on to this factor (> .50). The EFA for car/bus use habit also found a single factor solution which accounted for 74.68% of the total item variance. For car/bus use habit, all items loaded (> .50) on the single factor. EFA results for walking habit and car/bus use habit are shown in Table 6. Results for the parallel analyses for walking habit and car/bus use habit are shown in Table 7 and Table 8 respectively.

** *Insert Table 6 here***

** *Insert Table 7 here***

** *Insert Table 8 here***

Confirmatory Factor Analysis (CFA).

For walking habit, χ^2 probabilities were less than $p < .05$ in both models. However, as discussed previously the χ^2 test is widely recognised to be problematic and can often lead to type I errors (Brown, 2006). Consequently, it is essential to examine additional indices. Marginal differences were observed between the fit indices in the unidimensional model ($\chi^2(54) = 155.67$, $\chi^2/df = 2.88$, CFI = .92, TLI = .90, RMSEA = .11) and the three-dimensional model ($\chi^2(51) = 139.47$, $\chi^2/df = 2.74$, CFI = .93, TLI = .91, RMSEA = .10). Both the CFI and TLI were less than the .95 criterion for acceptable fit in both models. A relatively small difference was observed in the RMSEA values between the two models (i.e. a slightly higher value in the unidimensional model [.11] compared to the three-dimensional model [.10]). These values therefore suggested little difference in the "mis-fit" between the two models. However since values for both models were larger than the ≤ .06 criterion, these indices failed to reach the criterion for acceptable fit (Hu & Bentler, 1999).

For car/bus use habit, the χ^2 probabilities for both models were less than $p < .05$ and therefore were not illustrative of good fit. The global fit indices for car/bus use habit were indicative of good fit in both the unidimensional model ($\chi^2(54) = 149.67$, $\chi^2/df = 2.77$, CFI = .95, TLI = .94, RMSEA = .10) and the three-dimensional model ($\chi^2(51) = 135.03$, $\chi^2/df = 2.65$, CFI = .96, TLI = .94, RMSEA = .10). In both models, CFI values met the criterion for acceptable fit (i.e. >.95; Hu & Bentler, 1999). TLI scores for both models were marginally below values considered acceptable fit (i.e. >.95; Hu & Bentler, 1999). RMSEA values for both models were .10 and therefore larger that than the ≤ .06 criterion (Hu & Bentler, 1999). Factor loadings were examined across all four models. For walking habit, all item loadings were above .50 in both the unidimensional and three-dimensional models. Factor loadings for car/bus use habit were high (> .70) in both the unidimensional and three-dimensional models. A summary of the CFAs for walking habit and car/bus use habit is given in Table 9.

*** Insert Table 9 here***

DISCUSSION

This study examined the reliability and validity of the SRHI questionnaire to determine its suitability for measuring walking habit and car/bus use habit in primary school aged children. Results of the present study demonstrated strong internal consistency and test-retest reliability evidence. Findings of the EFAs, as indicated through the parallel analyis for factor extraction, provided support for a one factor model for walking habit and car/bus use habit. Subsequent testing of the factor structure through use of CFA demonstrated little difference between the fit indices of the unidimensional and three-dimensional models. Therefore, the findings of the CFA and EFA, together with a consideration of the concept of parsimonious fit, demonstrate evidence in support of a unidimensional conceptualisation (i.e. a single underlying trait) of the construct of habit (Bollen, 1989).

Findings from this study did not support the distinction between the three “features” of habit. Therefore, despite the intuitive appeal of a distinction between the features of habit (i.e. behavioural frequency, self-identity and automaticity), the removal of items within the SRHI or the reporting of sets of items corresponding to the three “features” of habit (i.e. behavioural frequency, automaticity and self-identity) was not supported by the empirical findings of this study. Instead, future use of the SRHI should ensure that habit strength is represented as a single score determined through the full 12 items of the measure.

Findings from this study suggest that the SRHI can be appropriately used to assess children’s walking habits and car/bus use habits. Data from the SRHI can serve as a guide to develop active travel interventions for children. Improved understanding of habitual behaviour will facilitate an understanding of the underlying processes that guide children’s behaviour. In terms of health related behaviours, understanding the repetitive nature of behaviour is particularly important given the cumulative impact on health, social and economic outcomes. In terms of a broader perspective, the ability to measure habit supports the notion of a dual-processing model of cognition which distinguishes between rational and conscious decision making and automatic decision making. The dual-process model has become an increasing focus in psychology literature and its significance can be seen as evidenced through developments in the popular scientific literature (Ariely, 2008; Brooks, 2011; Martin, 2008; Thaler & Sunstein, 2008) and government policy making (Darnton et al., 2011). Broadly speaking, the application of this perspective to understanding behaviour addresses the limitations of traditional or orthodox models of behaviour and instead draws upon the reasons why human beings may make non-rational decisions.

Identification of a psychometrically sound measure of habit may constitute an important development for researchers interested in changing behaviour. This may be particularly important for establishing opportunities to change behaviour. For example, according to the discontinuity hypothesis (Verplanken et al., 2008) when significant changes occur to the context in which a habit is performed, the environmental cues that trigger and maintain habits are open to change, thus disrupting old habits and rendering an opportunity to disrupt behaviour. Consequently, the context and time at which interventions are implemented are likely to impact the effectiveness of changing travel behaviour (e.g. implementation at the beginning of school term compared to mid-term). Therefore the availability of a measure of habit is essential in identifying suitable behaviour change strategies and evaluating the effectiveness of such strategies for changing habit.

Strengths

The present study is the first application of a CFA approach in the evaluation of the construct validity of the SRHI. To date, other than that of the development of the SRHI by Verplanken and Orbell (2003), no researchers have examined the internal validity (structural) of the SRHI. The significance of the assessment of construct validation, by use of CFA, within the present study demonstrates that of a more sophisticated and advantageous technique in order to rigorously test the two distinct theoretical models of habit (Byrne, 2001). The differences between CFA and EFA, in terms of their uses and strengths, have been widely demonstrated within the psychometric literature (Bollen, 1989; Kline, 1991). The most fundamental difference between the two techniques is evident in the contrast between the approaches being either data driven or theory driven. For example, generally speaking, EFA is an exploratory technique used to represent the observed data and does not include formal *a priori* hypothesis testing. Therefore, although important in the process of construct validation, the conclusions that can be drawn from this approach are often limited. In contrast, the use of CFA to model the dimensions thought to underlie a construct allows a researcher to extract a more "purified" latent variable (Miyake et al., 2000), because different sources of variability can be modelled on an *a priori* basis, utilising what is known about the construct. However, although this distinction may be true in some applications of EFA and CFA and thus demonstrative of a clear distinction between the two techniques, the application of each technique can differ in a way that the use of EFA and CFA are not always exclusively data and theory driven, respectively. Consequently the distinction between EFA and CFA has been explained as falling on a continuum running from exploration to confirmation (Mulaik, 1972). Illustrating this point, Bollen (1989) has proposed that a study using traditional factor analysis, in which the number of factors and the approximate structure are hypothesised in advance, is more confirmatory than exploratory, while in contrast, a study in which a poor fitting CFA is modified "ad hoc" is more exploratory than confirmatory (see Bollen, 1989). Concerning the current study, the comparison of two different conceptualisations of habit is therefore, although largely theory driven and therefore confirmatory in nature, also evident of an exploratory nature. As such, the provision of such analyses in this study provides an important development in the understanding of the construct of habit by empirically testing models previously developed through EFA against current applications of the SRHI in order to provide firmer conclusions concerning the dimensionality of the construct to be drawn.

Limitations

This study has some limitations. One limitation that should be considered regarding the CFAs should be the adequacy of the sample size used. There has been much research focused on providing researchers with specific guidelines for ensuring adequate sample size. The suggested guidelines are variable, however, generally speaking, samples that include fewer than 100 participants are considered "small", and may only be appropriate for very simple models, samples that include between 100 and 200 participants are considered "medium", and may be acceptable if the model is not too complex, and samples that include more than 200 participants are considered "large", and are acceptable for most models (Kline, 2005). According to these guidelines, the sample size in the present sample would be considered a "medium" sample. Consequently it is possible that the sample size used in the present study may have influenced the results, particularly in the examination of the more complex models, in this case the three-dimensional models of walking habit and car/bus use habit. Given this limitation, further research utilising a greater sample size is needed to corroborate the findings of this study.

Effective validity studies not only demand the integration of multiple sources of evidence, but also must continually take place over time. A measure cannot be considered valid from the evidence of a single study. Instead, numerous studies must be conducted using different samples, and in different contexts (Crocker & Algina, 1986; Gregory, 1992; Messick, 1995). In this context, although this study provided some evidence supporting the external validity of the SRHI, the external validity evidence obtained in this study (i.e. known groups) related to behavioural frequency. Although these analyses provided some important findings, given that behavioural frequency represents only part of the conceptualisation of the habit, further examination exploring more fully the external validity evidence of this scale in regard to children's travel is needed. Since there are no alternative measures of habit with supporting validity evidence for use in children, future studies designed to obtain additional external validity evidence could be usefully explored through the use of qualitative methods such as interviews or focus groups. Such research would provide an understanding of the way in which the characteristics of habit (behavioural frequency, automaticity and self-identity) operate in children's habitual travel. Additionally, the validity evidence for use of the SRHI in this context could also be strengthened through an examination of the way in which children's travel habit functions with other latent variables within a nomological network (Benson, 1998). Further to these issues, given that the application of the SRHI to understanding children's behaviour is relatively recent in comparison to adult based research, further research utilising 'think aloud' methods would be useful in identifying the nature and extent to which children understand the items contained in the measure. This is particularly pertinent to this measure given the complexities concerning the use of firstly, negative phrasing such as Item 9 (i.e. 'Behaviour X is something... I find hard not to do'), Item 4 (i.e. '...that makes me feel weird if I do not do it') and Item 6 (i.e. '...would require effort not to do it') and secondly, the difficult and ambiguous terminology used such as Item 2 (i.e.' I do automatically') and Item 1 (i.e. 'I do frequently').

Finally, the analyses of dimensionality of habit within the current study pertain only to the examination of walking and car/bus use and the age group used in the present study (children aged 8 and 9 years old). The ability to generalise findings to other behaviours and populations may therefore be limited. While this is true for the validation of most constructs, this may be particularly pertinent for the case of habit given that, in contrast to adult behaviour, the decision making stage that preceded the formation of habit is not performed solely by the child. Instead, researchers have demonstrated that parents play an important role in this decision (McMinn et al., 2012). Although it is unknown how this may influence the element of self-identity in habitual behaviour, further research is needed to examine the process by which habits are characterised by self-identity in children's school travel. The aforementioned use of qualitative approaches could also be used to address this issue.

Conclusion

In general there has been a lack of research addressing the potential role of habit in children's travel behaviour. This has been predominantly due to the lack of an available measure that has been validated to assess the habit strength of children's travel behaviour. The reliability and validity evidence examined in this study for the use of the SRHI to assess children's travel habits should therefore enable progress in these unexplored areas. The ability to measure habit strength is important in identifying when alternative strategies for behavioural change research may be appropriate.

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FOOTNOTES

[1] The statutory walking distance is defined as 2 miles (3.2 km) for pupils under 8 years old and 3 miles (4.8 km) for those aged 8 and above. In Scotland free transport is available for children who live further than the statutory walking distance from their nearest suitable school. UK Parliament. (1980). *Education (Scotland) Act 1980.* London: HMSO.

FIGURES

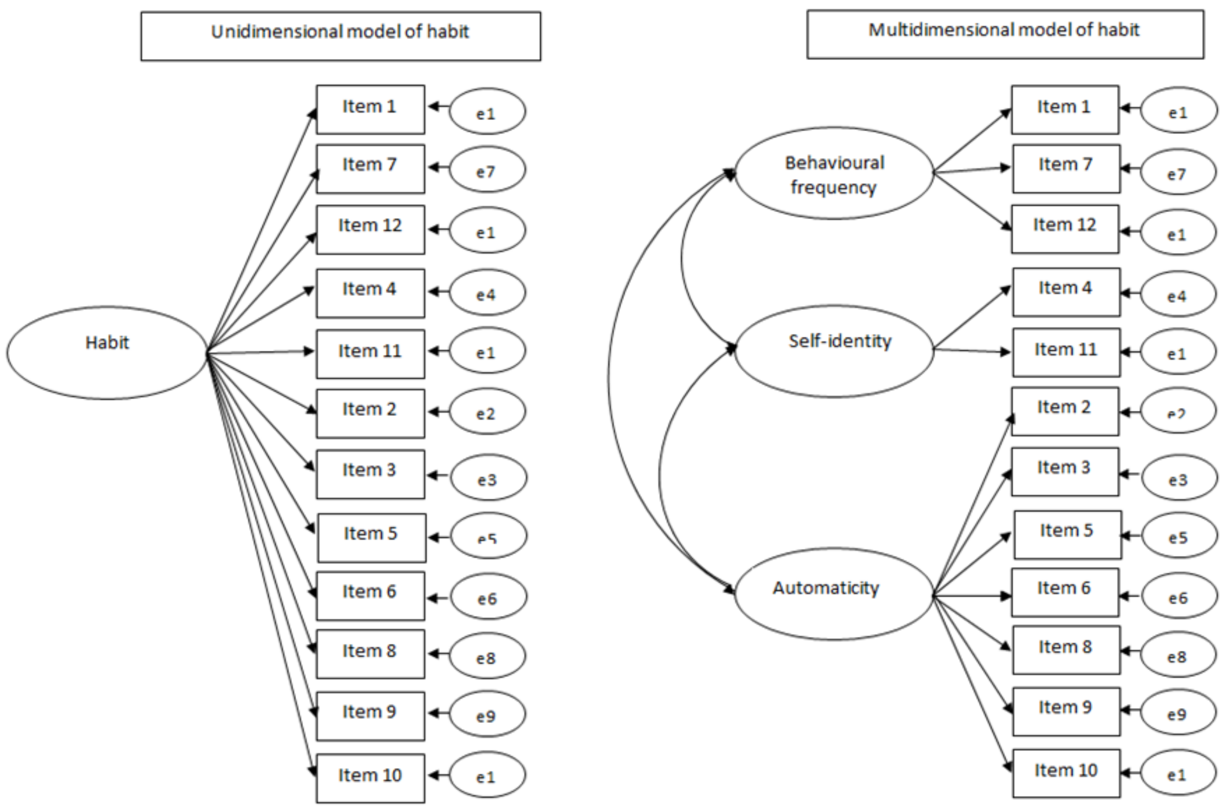

Figure 1. Unidimensional and three-dimensional conceptualisation of habit within the SRHI measure.

TABLES

Table 1

Results from the study conducted by Verplanken and Orbell (2003) in the development of the SRHI.

Experiment	**Behaviour**	**Eigenvalues greater than 1.0**	**Explained variance**	**Cronbach's alpha**
1	Bicycle use (pre-test)	3 (5.73, 1.34, and 1.15)	47.76%	.89
	Bicycle use (post-test)	3 (6.58, 1.55, and 1.05)	54.84%	.92
2	Bus use	3 (5.80, 1.23, and 1.12)	47.32%	.89
3	Watching a Dutch television programme	2 (7.56 and 1.65)	62.98%	.94
	Eating candies	1 (6.58)	65.56%	.95
	Turning on music at home	2 (7.41 and 1.01)	61.73%	.94
4	Unique personal habits*.	3 (4.62, 2.02, and 1.16)	38.48%	.85

Note. *A total of 62 different behaviours were included as self-selected unique personal habits. These included a range of behaviours such as walking the dog, making tea when arriving at home, travelling by train.

Table 2

Studies using an adapted version of the SRHI (Verplanken & Orbell, 2003)

Study	**Number of Items used**	**Items used**											
		1 (BF)	**2 (A)**	**3 (A)**	**4 (SI)**	**5 (A)**	**6 (A)**	**7 (BF)**	**8 (A)**	**9 (A)**	**10 (A)**	**11 (SI)**	**12 (BF)**
de Bruijin et al. (2010)	10		■	■	■	■	■	■	■	■	■	■	
de Bruijn & van den Putte (2009)	10		■	■	■	■	■	■	■	■	■	■	
Gardner (2009)	10		■	■	■	■	■	■	■	■	■	■	
Haustein et al. (2009)	6		■		■	■		■			■	■	
Honkanen, Olsen and Verplanken (2005)	4*	■		■	■						■		
Lally et al. (2009)	7		■	■		■	■		■	■	■		
Møller and Thøgersen (2009)	7**	■	■		■			■			■	■	
de Nooijer et al. (2010)	3***							■					■
Pham et al. (2008)	9		■	■	■	■	■		■	■	■	■	
Verplanken (2006)	6**		■	■		■		■	■		■		

Note: * Wording and structure of 10 items used was different to the SRHI as cited in Verplanken and Orbell (2003)

** Wording and structure of all items used was different to the SRHI as cited in Verplanken and Orbell (2003)

*** Wording and structure of item 12 was different to the SRHI as cited in Verplanken and Orbell (2003) and an additional item was incorporated into the scale (i.e. 'is something that suits me and/or my co-parent')

Abbreviations: A = Automaticity; BF = Behavioural frequency ; and SI = Self-identity

Table 3

Descriptive statistics for walking habit and car/bus use habit (N= 166)

	Walking habit			Car/bus use habit		
Item	M (SD)	Skewness	Kurtosis	M (SD)	Skewness	Kurtosis
1. I do a lot	3.89 (1.43)	.92	.62	2.57 (1.71)	.47	1.54
2. I do automatically	3.58 (1.50)	.59	1.22	2.43 (1.68)	.60	1.40
3. I do without having to remember	3.82 (1.51)	.83	.91	2.50 (1.65)	.50	1.44
4. that makes me feel weird if I do not do it	3.08 (1.68)	.05	1.68	2.10 (1.56)	.98	.75
5. I do without thinking	3.37 (1.63)	.37	1.50	2.18 (1.60)	.90	.91
6. that would require effort not to do it	3.19 (1.60)	.14	1.57	2.20 (1.57)	.87	.92
7. that belongs in my daily routine	3.81 (1.54)	.90	.80	2.42 (1.66)	.57	1.41
8. I start before I realise I'm doing it	3.28 (1.66)	.29	1.60	2.23 (1.61)	.83	1.00
9. I would find hard not to do	3.13 (1.62)	.11	1.61	2.10 (1.52)	.98	.70
10. I have no need to think about doing	3.51 (1.58)	.49	1.34	2.36 (1.60)	.65	1.25
11. that's typically me	3.56 (1.57)	.57	1.24	2.43 (1.67)	.56	1.43
12. I have been doing for a long time	3.91 (1.53)	1.03	.60	2.54 (1.73)	.44	1.60
Item mean	2.51 (1.21)	.54	.82	1.05 (1.27)	.81	.91

Note: Potential score for each item ranged from 1-5.

Table 4

Item correlations for walking habit

Item	1	2	3	4	5	6	7	8	9	10	11	12
1. I do a lot		.75	.74	.42	.65	.48	.66	.59	.49	.58	.69	.80
2. I do automatically			.78	.53	.78	.48	.70	.68	.50	.61	.66	.69
3. I do without having to remember				.51	.74	.47	.64	.52	.57	.69	.60	.71
4. that makes me feel weird if I do not do it					.56	.59	.47	.52	.57	.53	.51	.41
5. I do without thinking						.50	.64	.65	.58	.73	.62	.61
6. that would require effort not to do it							.51	.49	.51	.47	.54	.42
7. that belongs in my daily routine								.66	.57	.58	.66	.69
8. I start before I realise I'm doing it									.53	.56	.59	.62
9. I would find hard not to do										.59	.53	.52
10. I have no need to think about doing											.63	.54
11. that's typically me												.68
12. I have been doing for a long time												

Note: All correlations are significant at the .01 level (2-tailed).

Table 5

Item correlations for car/bus use habit

Item	1	2	3	4	5	6	7	8	9	10	11	12
1. I do a lot		.91	.82	.67	.80	.66	.83	.77	.67	.77	.78	.86
2. I do automatically			.90	.70	.86	.62	.83	.79	.66	.78	.81	.84
3. I do without having to remember				.73	.90	.65	.82	.82	.64	.81	.80	.78
4. that makes me feel weird if I do not do it					.70	.62	.70	.70	.70	.65	.67	.63
5. I do without thinking						.59	.79	.83	.60	.84	.78	.76
6. that would require effort not to do it							.67	.67	.61	.62	.61	.64
7. that belongs in my daily routine								.80	.70	.79	.83	.78
8. I start before I realise I'm doing it									.68	.77	.77	.72
9. I would find hard not to do										.61	.64	.64
10. I have no need to think about doing											.78	.75
11. that's typically me												.73
12. I have been doing for a long time												

Note: All correlations are significant at the .01 level (2-tailed).

Table 6

Factor loadings for a one-factor structure of walking habit and a one-factor structure of car/bus use habit

	Walking Habit	Car/Bus Use Habit
Item	Factor 1	Factor 1
1	**.74**	**.86**
2	**.64**	**.91**
3	**.77**	**.89**
4	.25	**.80**
5	.49	**.85**
6	.25	**.79**
7	**.75**	**.88**
8	.37	**.80**
9	.34	**.78**
10	**.58**	**.83**
11	**.77**	**.91**
12	**.76**	**.91**

Note: High loadings (>.50) are in bold typeface.
Medium loadings (>.30) are underlined.

Table 7

Parallel analysis results for walking habit

Factor	Observed dataset	Simulated dataset	
		50th percentile (M)	95th percentile
1	<u>7.14</u>	1.46	1.58
2	1.03	1.34	1.42
3	.58	1.24	1.30
4	.57	1.16	1.22
5	.53	1.09	1.14
6	.43	1.01	1.06
7	.42	.95	1.00
8	.35	.88	.93
9	.33	.82	.87
10	.23	.76	.81
11	.21	.69	.74
12	.20	.61	.67

Note: Eigenvalues in the observed dataset which are larger than those in the simulated dataset are underlined.

Table 8

Parallel analysis results for walking habit

Factor	Observed dataset	Simulated dataset	
		50^{th} percentile (M)	95^{th} percentile
1	8.59	1.46	1.55
2	.63	1.33	1.40
3	.48	1.24	1.29
4	.40	1.15	1.22
5	.37	1.08	1.14
6	.35	1.02	1.07
7	.28	.95	1.00
8	.25	.89	.94
9	.20	.82	.87
10	.16	.76	.81
11	.15	.69	.75
12	.12	.61	.67

Note: Eigenvalues in the observed dataset which are larger than those in the simulated dataset are underlined.

Table 9

Confirmatory factor analysis results for unidimensional and three-dimensional model

	Model	χ^2	df	χ^2/df	CFI	TLI	RMSEA
Walking habit	Unidimensional	155.67*	54	2.88	.92	.91	.11
	Three-dimensional	139.47*	51	2.74	.93	.91	.10
Car/bus use habit	Unidimensional	149.67*	54	2.77	.95	.94	.10
	Three-dimensional	135.03*	51	2.65	.96	.94	.10

Note. * p <.05

CHAPTER FOUR

Title: Reliability and validity of a theory of planned behaviour measure to assess cognitions towards active school travel in primary school aged children

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The following paper was submitted for publication to the British Journal of Social Psychology and is presented in the format of that journal.

Reliability and validity of a theory of planned behaviour measure to assess cognitions towards active school travel in primary school aged children.

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Abstract

Background: Increasing physical activity through active forms of travel such as walking offers a valuable, feasible and long-term solution to reducing sedentary behaviour and increasing physical activity in children (Tudor-Locke et al., 2001). A recent review of active travel interventions in children demonstrated the potential of such programs for increasing levels of walking and cycling (Chillon et al., 2011). Several interventions in the review included strategies designed to change behaviour through attitudinal change by encouraging healthier choices. However, due to the lack of available measures, there has been little theoretical application to understand the association between children's cognitions and active travel. The purpose of this study was to obtain reliability and validity evidence for a theory of planned behaviour (TPB) questionnaire to measure children's cognitions towards walking to school. Specifically, the study examined the internal consistency, test–retest reliability and construct validity of an adapted TPB questionnaire to measure travel cognitions. *Method*. One hundred and sixty six children aged 8-9 years completed the questionnaire during class hours as part of a larger study investigating children's active travel behaviour in Scotland. The questionnaire consisted of 15 statement items followed by a 4-point Likert scale (*Totally Disagree* to *Totally Agree*) that assessed attitude, subjective norm, perceived behavioural control (PBC) and intention. A subsample (n = 87) completed a retest of the measure after 6 weeks. Internal consistency was assessed using Cronbach's alpha (α), and test-retest reliability was assessed using intraclass correlation coefficients (ICC) adjusted for a single measure. Confirmatory factor analysis (CFA) was used to assess construct validity. *Results.* Attitude (M = 3.44, SD = .49), subjective norm (M = 2.74, SD = .57), PBC (M = 3.29, SD = .66), and intention (M = 3.14, SD = .78) were all high, with mean scores for each of the constructs falling above the midpoints of the

response scales. The subscales demonstrated good internal consistency ($\alpha = .71 - .84$) and poor to good test-retest reliability (ICC = .33 - .71). The CFA supported the fit of a four-factor, correlated model (χ^2 ($df = 84$, $N = 166$) = 127.39, $p < .01$, RMSEA = .06 (90 % CI = .035 - .075), CFI = .95, TLI = .93). Intention (.86) had the greatest average item-factor loading followed by PBC (.72), attitude (.65) and subjective norm (.54). All the item-factor loadings were greater than .50 with the exception of two items. *Discussion.* The questionnaire provides an internally consistent, generally stable, valid and easy-to-administer tool for assessing cognitions related to travel habits in 8 and 9 year-old children. Evidence was provided for factorial validity of a questionnaire designed to measure components of the TPB. Stability of subscale scores was only poor for subjective norm. However, this could be accounted for through changes in extraneous factors (e.g. changes in season or the school environment). Thus future research controlling for such factors could further inform these findings. Overall, this questionnaire provides a practical method to assess child travel cognitions with acceptable measurement properties.

Introduction

Research has demonstrated the importance of lifelong physical activity in the reduction of risk for a range of chronic diseases developed in adulthood (Department of Health 2004; Riddoch, 1998). Because many of these diseases are a result of processes which have been developed early in life, childhood has been recognised as a significant time in which to promote physical activity (Boreham & Riddoch, 2001). Increasing levels of physical activity to reach the current recommendations can be achieved in a number of ways and in various settings. However, behaviours that can be incorporated into everyday routines as a lifestyle strategy such as active travel are more likely to facilitate permanent adoption (Laitakari et al., 1996). With this perspective, increasing physical activity through active forms of travel such as walking offers a valuable, feasible and long-term solution in reducing sedentary behaviour and increasing physical activity in children (Tudor-Locke et al., 2001).

Given the importance of physical activity for childhood health (Torsheim et al., 2004), the promotion of active school travel may have significant implications. However, despite the benefits of active travel, school travel trends demonstrate an increase in car use and a decrease in the number of children walking to school (Mackett et al., 2004). This decrease has been observed over the past 10-15 years (Department for Transport, 2011). In Scotland, this decline is also evident and has been demonstrated through parental proxy measures (Bromely et al., 2009) and by "The Hands-Up Survey" (Sustrans, 2009).

Understanding how to effectively promote active school travel is therefore a priority within current health research. In recent years, there has been a growth in the number of studies that have examined the determinants of active travel in children. Researchers have identified a range of factors including demographic, individual, family, school, social and physical environmental factors (Sirard & Slater, 2008). However, to date there has been little investigation of children's attitudes towards active school travel. For example, in a recent review that examined the predictors of active school travel (Davison et al., 2008), only one study was identified that included an examination of children's attitudes towards active school travel. However, the study identified in this review, conducted by Merom et al. (2006), did not directly investigate children's attitudes towards active school travel, but instead investigated the parents' perception of their child's eagerness towards active school travel. Similar limitations were also evident in the review of active school travel interventions recently conducted by Chillon et al. (2011). For instance, although some of the 14 studies identified in the review included an evaluation of attitude change, these studies focused solely on the evaluation of parental attitudes and opinions obtained through interviews or focus groups (Mendoza et al., 2009; Zaccari & Dirkis, 2004). Furthermore, the three studies in this review that evaluated changes in child cognition did not include the evaluation of attitude but instead the evaluation of other psychological outcomes such as self efficacy (Jordan et al., 2008), satisfaction (Kong et al., 2009), and stage of behavioural change (McKee et al., 2007).

Given that active school travel interventions are generally aimed at encouraging healthier choices, the evaluation of such interventions should therefore include psychological target variables which are likely to influence children's school travel behaviour. The present study assesses a questionnaire designed to measure the constructs outlined in the theory of planned behaviour (TPB; Ajzen, 1985; 1991). The framework identifies a number of determinants of behaviour which are potentially amenable to change via school-based interventions and is therefore considered suitable for this research context.

The application of socio-cognitive models, such as the TPB (Ajzen, 1991) to travel behaviour offers a theoretically sound and practical means to assess change following such interventions. The TPB offers an explanation of behaviour which assumes that travel behaviour arises through deliberation of advantages and disadvantages of various travel alternatives, which then form an individual's intention. The theory is an extension of the theory of reasoned action (TRA; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) that incorporates a measure of perceived behavioural control (PBC). According to the model, intention is directly determined through three major constructs: attitude, subjective norm and PBC. The model proposes that the stronger an individual's intention, the more likely the individual will perform the behaviour. For example in the context of school travel, children who have more favourable attitudes towards walking to school are more likely to have strong intentions than children who have unfavourable attitudes. Subjective norm refers to firstly, the perception by an individual that significant others, such as family, friends and teachers, expect them to perform a behaviour and secondly, the individual's motivation to comply with that expectation. Children who perceive that significant others expect them to walk to school and are motivated to comply with these expectations are likely to have stronger intentions to walk to school compared to those who do not perceive such expectations. PBC refers to the individual's expectation of their ability to perform a given behaviour. It is expected that children who perceive strong feelings of control over their ability to walk to school are likely to report stronger intentions to walk to school and engage in higher levels of walking than those who perceive they have lower levels of control over their behaviour.

The utility of the TPB in understanding travel behaviour has been demonstrated in adult populations (e.g. Bamberg, Ajzen, & Schmidt, 2003; Bamberg & Schmidt, 2003; de Bruijn et al., 2009; Forward, 2004; Kaiser & Gutscher, 2003; Gardner 2008). To our knowledge, the TPB has not yet been applied to understanding children's travel behaviour. However, in terms of the feasibility of application to children's behaviours, the TPB has been previously applied to study behaviour in a variety of contexts including physical activity (e.g. Martin et al., 2005; Martin et al., 2007; Motl et al., 2002; Rhodes et al., 2006). These researchers have used direct measures of the TPB constructs (e.g. by asking people to report whether their attitude to the behaviour is favourable or unfavourable) with Likert response formats. The validity of this form of TPB measure has been previously investigated by Motl et al. (2000) in relation to physical activity. In the study of Motl et al. (2000), the factorial validity and invariance of the TPB measure was investigated using two cohorts of adolescent girls (13-15 years old). The measure included 20 items to address the constructs of attitude, subjective norm, and PBC (intention was not included). Motl et al. examined structural and content validity evidence. Results from these analyses supported the use of the measure in this context. Despite this, no researcher has examined the test-retest reliability specifically in an active travel context or related context (i.e. physical activity). Given that the validity established by Motl et al. (2000) was in a sample of adolescent girls and in relation to physical activity, the validity and reliability of the questionnaire is required for its use within other contexts such as active school travel and using different populations such as within a younger sample.

Study aims

The aims of the present study were to examine the internal consistency, test-retest reliability and construct validity of a direct measure of the TPB constructs that was developed to assess children's cognitions towards walking to school.

Method

Participants

Participants were 166 primary school children in Scotland. All participants were aged 8 or 9 years old (*M* = 8.64, *SD*= 0.49) and 59.6% of the sample was male.

Design and Procedures

The study forms part of the Strathclyde Evaluation of Children's Active Travel (SE-CAT), a long-term evaluation of a classroom-based resource aimed at increasing active travel. Further details of the overall study design and rationale have been published elsewhere (McMinn, Rowe, Murtagh & Nelson, 2011). A purposive sampling approach was used to recruit schools. Permission to contact potential schools was granted from all relevant local education authorities. These schools were subsequently contacted and asked to take part in the study. Five schools took part in the study: three schools from areas of high deprivation and two from areas of low deprivation as determined by the Scottish Index of Multiple Deprivation (SIMD, 2009; www.scotland.gov.uk/Topics/Statistics/SIMD). All schools were located within urban areas as determined by the Scottish Neighbourhood Statistics Urban Rural Classification (www.sns.gov.uk). Following the identification of schools, relevant council employees (school travel coordinators, active school coordinators and road safety officers) were contacted and provided details of the study.

Data collection for the present study was performed during the autumn term of 2009 (September to November). The retest data collection was conducted 6 weeks later (*n* = 87). Data collection was conducted in a classroom by a team of four or five trained research assistants. Research assistants provided help where necessary for children when reading and answering items on the questionnaire. Parental consent for participant recruitment was obtained from all participants in the study prior to data collection. Ethical approval was obtained from the University of Strathclyde Ethics Committee.

Measures

The measurement of all TPB constructs followed guidelines provided by Ajzen (2002). However, the wording of all questionnaire items and the response options was amended following previous research on children in the present age range (Rhodes et al., 2006). This was achieved by replacing the item stem of “Doing physical activity every day” with the context specific stem of “Walking to school every day”. Participants responded to all items using a 4-point scale, scored 1 (*disagree in a big way*), 2 (*disagree*), 3 (*agree*) and 4 (*agree in a big way*).

Intention was measured using two items: “I plan to walk to school every day” and “I intend to walk to school every day”. The mean of participants’ scores on these two items served as the measure of intention for use in the subsequent data analysis. Attitude was measured with four items. Consistent with the distinction in the literature (e.g. Ajzen & Driver, 1991), two items assessed the affective component of this construct (“Walking to school every day would be fun” and “Walking to school every day would be enjoyable”) and two items assessed the instrumental component (“Walking to school every day would be good for me” and “Walking to school every day would be important for me”). The mean of the four items served as the measure of attitude for use in the subsequent analyses. Similarly the mean of six items served as the measure of subjective norm. Three of these items measured the injunctive component of subjective norm and three items measured the descriptive component (see Cialdini, 2003; Cialdini et al., 1990). The three injunctive items were “My family wants me to walk to school every day”, “My friends want me to walk to school every day” and “My teachers want me to walk to school every day”. The three descriptive components were “My family will walk to school or work every day”, ‘My friends will walk to school every day" and "My teachers will walk to school every day". Finally, PBC was measured with three items: "I could walk to school every day if I wanted to"; "I have the time to walk to school every day if I wanted to"; and "I live in a place which allows me to walk to school every day if I wanted to". The mean of these three items served as the final measure of PBC.

The measurement of the TPB constructs in this study allowed consistency in terms of the Target, Action, Context, and Time (TACT) of the behaviour of interest. This principle, known as the principle of compatibility, ensures that regardless of how the TACT elements of the behaviour are defined, all constructs (i.e. attitude, subjective norm, perceived behavioral control, and intention) are defined in terms of exactly the same elements (Ajzen, 2002). In this study, the measurement of each of the constructs defined the target behaviour as *school travel behaviour* with the action being defined as *walking.* Given that the context of the behaviour was the journey *to school* this also ensure that the measurement in terms of 'time' was also consistent in that travelling to school takes place at the same time every day.

Data analysis

The data were analysed in SPSS (version 18.0; IBM Corp., Chicago, IL). Demographic data were analysed using descriptive statistics. Item analysis was used to assess individual items for response range, means, and standard deviations between subscale correlation coefficients, and corrected item-total correlations. Reliability of the scales was assessed through two types of reliability evidence (internal consistency and test-retest reliability). Estimation of internal consistency was performed through the calculation of Cronbach's alpha coefficients. Test-retest reliability was calculated by calculation of intraclass correlation (ICC) coefficients. Since the SRHI was administered on a single occasion, the ICC was adjusted for a single measure.

Systematic mean difference between the test and retest were assessed through paired *t* tests. Effect sizes between the mean of the test and the retest were interpreted based on Cohen's *d* (Cohen, 1988), whereby 0.2 equates to a small effect, 0.5 equates to a medium effect, and effects larger than 0.8 equate to large effects.

In accordance with Nunnally and Berstein (1994), the following ICC interpretation guidelines were used: poor agreement (> 0.40), moderate to good agreement (0.40–0.75), and excellent agreement (> 0.75).

Construct validity was assessed through confirmatory factor analysis (CFA) with AMOS (version 18.0; IBM Corp., Chicago, IL). This analysis examined the hypothesised four factor measurement model specifying the relationship between the underlying latent variables (constructs) and the questionnaire items. The parameters of the model were estimated with maximum likelihood (ML) estimation. The adequacy of overall model fit was estimated using chi-square (χ^2) test statistics. Given that the χ^2 is known to be overly stringent (Bentler, 1990), supplemental fit indices were used, including root-mean-squared error of approximation (RMSEA), the comparative fit index (CFI) and Tucker-Lewis Index (TIC; Tucker & Lewis, 1973). In line with the recommendations of Hu and Bentler, (1999) a good model fit was indicated by a RMSEA less or equal to .06, a CFI greater or equal to .90 and a TLI greater or equal to .90. Factor loadings were examined for appropriate sign and magnitude (Bollen, 1989; Jöreskog, 1993). The R^2 values were reported for the TPB variables as estimates of explained variance of the items.

Results

Descriptive statistics

Descriptive statistics for all TPB constructs are provided in Table 1. Children, on average, had positive attitudes, subjective norm, perceptions of behavioural control and intentions towards walking to school (i.e. the sample means for these constructs were above the scale mid-point, 2.5).

*****Insert Table 1 here *****

Correlations between the TPB variables are given in Table 2. All correlations were positive and significant and ranged from $r = .42$ (attitude and subjective norm) to $r = .67$ (PBC and intention), indicating moderate relationships between the variables.

*****Insert Table 2 here *****

Reliability

Internal consistency. As shown in Table 1, internal consistency (coefficient alpha) for TPB variables ranged from .71 to .84 and therefore met the criterion of a value greater than .70 for group comparisons as suggested by Nunnally and Bernstein (1994).

Test-retest reliability. The reliability of the four constructs as determined through ICC ranged from a poor agreement (ICC = .33) to moderate to good agreement (ICC = .71). The test-retest statistics are provided in Table 1. Inspection of systematic mean change through paired t tests (see Table 3) demonstrated a significant and meaningful decrease from test to retest in attitude ($p < .05$, $d = 0.69$) and PBC ($p < .05$, $d = 0.44$). A significant increase from test to retest was observed in subjective norm ($p < .001$, $D = 0.69$). A non-significant and trivial mean difference was observed between the test and retest in intention ($p > .05$, $d = 0.11$).

*****Insert Table 3 here *****

Construct validity

Confirmatory factor analysis. Results for the CFA of a four-factor structure are displayed in Figure 1. CFA results demonstrated that the four factor structure represented a good fit (χ^2 (*df* = 84, *N* = 166) = 127.39, $p < .05$; RMSEA = .06 (90 % CI = .035 - .075); CFI = .95; TLI = .93). Although the χ^2 was significant, this is not an unusual finding given that the χ^2 statistic is sensitive to sample size and nearly always rejects models when large samples are used (Kenny & McCoach, 2003). The standardised loadings of all items of all items are shown in Figure 2. Intention (.86) had the greatest average item-factor loading which was followed by PBC (.72), attitude (.65) and then subjective norm (.54). All the item-factor loadings were greater than .50 with the exception of two subjective norm items: "My friends will walk to school every day" and "My teachers will walk to school every day". Despite this, the corrected item-total correlations for these two items were $r = .52$ for the item "My teacher will walk to school" to .57 for the item "My friends will walk to school" and were therefore both within acceptable ranges (i.e. .30 - .70; Ferketich, 1991).

*****Insert Figure 1 here *****

Discussion

The aim of the present study was to examine the reliability and validity of a questionnaire to assess cognitions related to active school travel in 8 and 9 year-old children. The study demonstrated that the measure developed to assess children's attitude, subjective norm, PBC, and intention towards walking to school demonstrated validity (internal construct) and moderate to excellent internal consistency reliability for all constructs. Results of the analyses of test-retest reliability for each of the scales were varied (ranging from poor agreement to moderate to good agreement). The analyses found that a change in the mean of three of the constructs (attitude, subjective norm and PBC) was found with moderate to large effect sizes. Although this was a significant finding, such differences may be a result of the testing protocol of the current study. For example, due to school feasibility requirements the data collection for this study took place at the beginning of the academic school year (in early autumn) and 6 weeks later for the retest (in early winter). The timing of such testing could have had an impact on the stability of variables particularly when considering the changes in weather conditions that occur in Scotland at this time of year. Furthermore, it is also possible that test-retest reliability coefficients may have also been restricted due to the low variability of the data which has been suggested to produce spuriously low coefficients (Anastasi, 1988; Kenny, 1987; McCall, 1994). Additionally, one of the underlying assumptions of classical test theory is that the true score of the construct remains constant. However, given that the test and re-test data collections were administered 6 weeks apart it is possible that the test-retest reliability coefficients were reduced due to random within-subject variability.

The internal consistency of the scales was moderate to excellent. These results were comparable with previous research in children's physical activity ($\alpha = .62$- .83; Rhodes et al., 2006). Results from the CFA demonstrated good internal construct validity evidence for all TPB constructs (i.e. attitude, subjective norm, PBC and intention). All factor loadings for the four constructs were within acceptable ranges with the exception of two items: "My teacher will walk to school" and "My friends will walk to school". This finding suggested that these two items were unreflective of the intended construct (i.e. subjective norm). A number of reasons may explain this finding. For example, it may be that since teachers typically arrive at school earlier than children it is plausible that children will be unaware of their teacher's mode of travel to school. It is also possible that since the data were collected at the start of the academic year (i.e. a time when children are settling into their new class) children may not yet have formed opinions of or consideration towards their teacher's school travel behaviour. Given the nature of these considerations, the removal of these items was not considered necessary. Instead, further research addressing these considerations is needed to provide insight into these findings.

Since active school travel interventions often include strategies aimed at changing children's attitudes, it is important to include an evaluation and accurate assessment of changes in the cognitions that underpin behaviour. Previous studies investigating attitudes towards active travel have assessed parental attitudes through either interviews or focus groups, or assessed parents' perceptions of children's attitudes obtained through self-report questionnaires (Mendoza et al., 2009; Merom et al., 2006; Zaccari & Dirkis, 2004). The present study therefore provides an important development in the active travel literature through the provision of reliability and validity evidence for the use of a self-report questionnaire that children can respond to in order to assess cognitions towards active travel.

To date, little emphasis has been placed on the construct validation of theory-based measurement of children's cognitions towards active travel. Since theory guides intervention, it is essential to identify the theoretically based relationships that account for the variance in active travel behaviour in children (Motl et al., 2002). To test such relationships, there is a need for measures with supporting reliability and validity evidence. However, the validation of such measures can be problematic. This has recently been recognised by researchers investigating physical activity. According to these researchers, the lack of supporting validity evidence in such measures is largely due to the lack of criterion measures against which constructs can be compared (McMinn et al., 2009). Typically, to overcome this problem, measures have been validated against other sources of information such as parents (Dunton et al., 2003) or teachers (Raustorp et al., 2005). However, not only was the availability of such information beyond the scope of the present study, it is unknown how parental and child attitudes may relate and thus the accuracy of such measures is unclear (McMinn et al, 2009). Thus, while the present study provides some reliability and validity evidence for the use of a measure of the TPB constructs, future studies incorporating qualitative methods such as focus groups and interviews can address this issue and provide further evidence.

Limitations

This study has several limitations. Firstly, although the current study evaluated construct validity and reliability, the study did not examine the external construct validity of the measure. Given that social desirability has been demonstrated in children's self-report behaviour measures including physical activity (Klesges et al., 2004) it is plausible that such bias may be manifested in active travel research. Data in this study were collected from September to November. Therefore, due to seasonal changes that may have made walking a less attractive option to children (such as increased precipitation and a decreased temperature), the timing of the data collection is considered a major limitation of the present study which may have resulted in the low test-retest reliability coefficients. However, while this is tenable given the decrease observed in attitude and PBC, it is unknown why there was an increase in subjective norm. Such limitations are often inherent in school based testing when timing and scheduling must fit in with school requirements and feasibility. Further to this point, the timing of the initial testing (taking place at the beginning of term-time) could have also been reflective of more favourable attitudes (i.e. renewed interest and excitement of returning back to school after a summer break).

Future research

There are many types of validity evidence. Although this study provided important information concerning the internal construct validity evidence of the TPB measure, further research is needed to examine the external construct validity evidence of the scales in order to provide a stronger case of validity. Further examination of the external construct validity of this measure could be addressed through the use of a multi-trait multi-method approach (MTMM; Campbell & Fiske, 1959). This approach provides a way to assess patterns of convergent and discriminant validity as well as estimate the effect of method variance on validity assessments. The use of the MTMM approach in this context would allow the researcher to isolate the systematic error variance attributable to the measure and separate random error variance from the total variance.

Further research is also needed to address the issue of social desirability affecting children's responses on self-report measures. Such research is important in ensuring that the validity of scores is not influenced by this potential source of "construct-irrelevant test variance" (Messick, 1989). This may also be addressed through the use of the MTMM approach.

Future research should also consider the breadth of content included in the definition of each of the constructs. For example, it is possible that the content of each of the TPB constructs may have been defined too narrowly and may therefore have overlooked other components that define each of the constructs. This has been referred to as "construct underrepresentation" (Messick, 1989, p. 34). For instance, parents are known to play an important role in the decision making of school travel (McMinn et al., 2011). It may therefore be necessary to include components that address the decision making process within the definition of this construct. Similarly, the set of items used to assess attitude may have also been an inadequate representation of the theoretical domain of the construct. For example, the definition of attitude within the present study addressed only personal experience components such as fun and enjoyment. However, the benefits of walking are much wider and include other factors such as environmental and economic. Future studies are therefore needed to investigate the content representation of each of the subscales. For example, content-related evidence could be gathered in the form of relevance and representativeness through either expert judgment ratings, or qualitative methods carried out with children such as interviews or focus groups.

Finally, given that a systematic mean change was observed in three of the four TPB constructs, future studies should examine the reliability of this questionnaire at various time intervals including shorter test-retest time intervals and at different times in the academic year (e.g. mid-term and in spring or summer; a time at which school routines may have been established).

Conclusion

This study demonstrated reliability and validity evidence to support the use of a self report measure to assess children's cognitions towards active travel. This addition to the active travel literature therefore provides a valuable and feasible approach to the evaluation of targeted interventions designed to increase walking to school.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SM, DAR, DM and NMN designed the study and wrote the protocol. SM, DM and DAR managed the data collection phase. SM and DR analysed the data, interpreted the findings. SM wrote the first draft of the manuscript. DR provided substantial input on the re-drafting of the first draft. All authors have read and approved the final version of the manuscript.

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TABLES

Table 1

Descriptive statistics for all theory of planned behaviour variables

		Time 1 (N = 166)		Time 2 (*n* = 87)		Internal consistency	Test-retest
	Number of items	*M*	*SD*	*M*	*SD*	α	ICC
Attitude	4	3.44	0.49	2.97	0.50	.74	.47
Subjective norm	6	2.74	0.57	2.89	0.62	.71	.33
PBC	3	3.29	0.66	2.82	0.58	.75	.49
Intention	2	3.14	0.78	3.07	0.83	.84	.71

Table 2

Pearson r between the observed subscale scores.

	1	2	3	4
1. Attitude	-	.42	.58	.43
2. Subjective norm		-	.51	.44
3. PBC			-	.67
4. Intention				-

Note: All correlations were significant at the .01 level.

Table 3

t-tests and effect sizes for all TPB variables.

	Test 1		Test 2		t	df	d
	M	SD	M	SD			
Attitude	3.32	0.52	2.97	0.50	6.19*	85	0.69
Subjective norm	2.58	0.51	2.89	0.62	-4.46*	86	0.56
PBC	3.10	0.69	2.82	0.58	4.05*	86	0.44
Intention	2.98	0.78	3.07	0.83	-0.94	86	0.11

Note: * Significant at the .01 level.

FIGURES

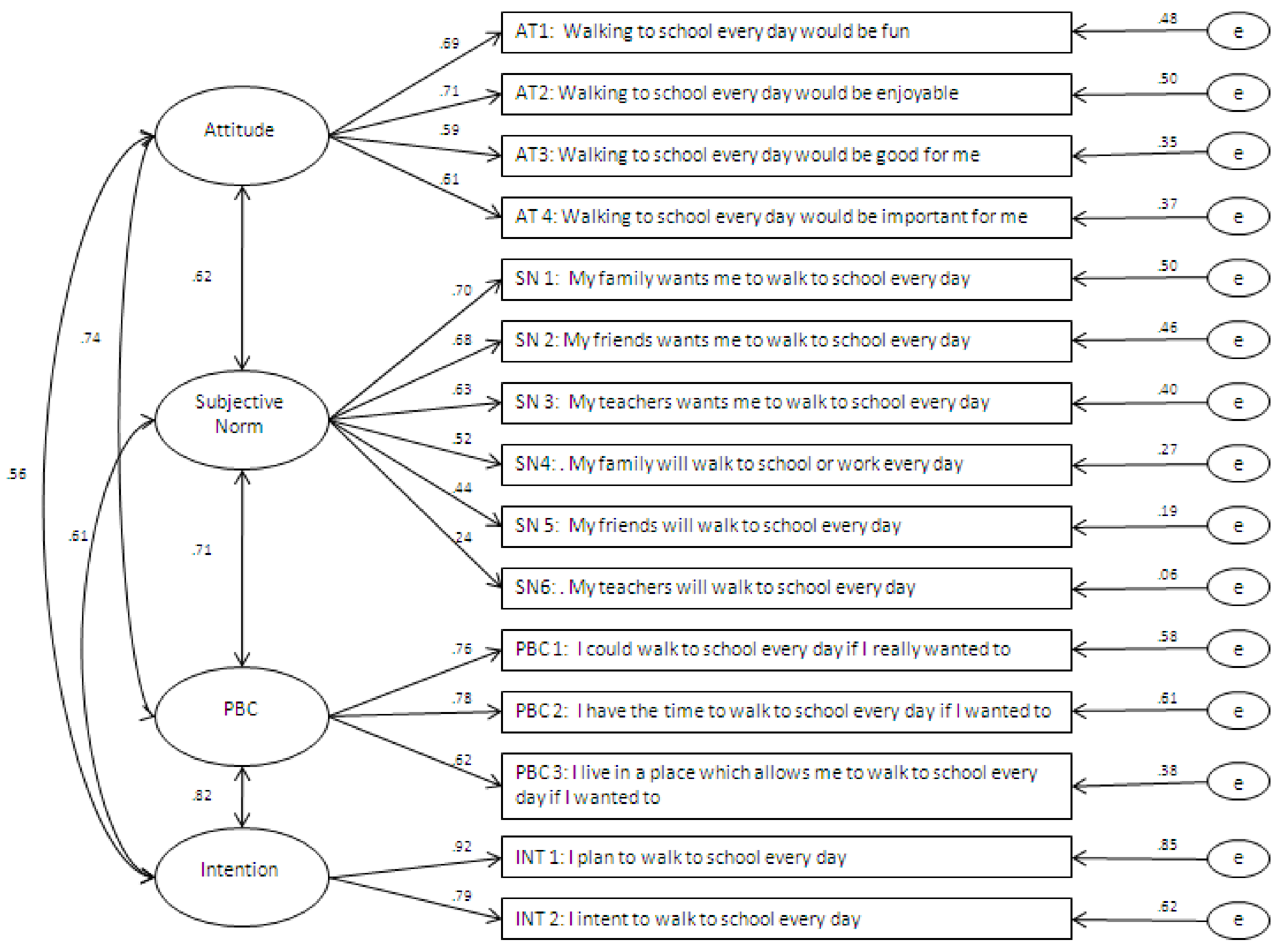

Figure1. Confirmatory factor analytic model of TPB variables applied to walking behaviour in children.

CHAPTER FIVE

Title: Predicting active school travel: The role of planned behavior and habit strength

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The following paper was submitted for publications to the International Journal of Physical Activity and Behavioral Nutrition and is presented in that format.

Predicting active school travel: The role of planned behavior and habit strength

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Abstract

Background: Despite strong support for predictive validity of the theory of planned behavior (TPB) substantial variance in both intention and behavior is unaccounted for by the model's predictors. The present study tested the extent to which habit strength augments the predictive validity of the TPB in relation to a currently under-researched behavior that has important health implications, namely children's active school travel.

Method: Prospective design. Participants (N = 126 children aged 8-9 years; 59% males) were sampled from five elementary schools in the west of Scotland and completed questionnaire measures of all TPB constructs in relation to walking to school and both walking and car/bus use habit. Over the subsequent week, commuting steps on school journeys were measured objectively using an accelerometer. Hierarchical multiple regressions were used to test the predictive utility of the TPB and habit strength in relation to both intention and subsequent behavior.

Results: The TPB accounted for 41% and 10% of the variance in intention and objectively measured behavior, respectively. Together, walking habit and car/bus habit significantly increased the proportion of explained variance in both intention and behavior by six percentage points. Perceived behavioral control and both walking and car/bus habit independently predicted intention. Intention and car/bus habit independently predicted behavior.

Conclusions: The TPB significantly predicts children's active school travel. However, habit strength augments the predictive validity of the model. The results indicate that school travel is

controlled by both intentional and habitual processes. In practice, interventions could usefully decrease the habitual use of motorized transport for travel to school and increase children's intention to walk (via increases in perceived behavioral control and walking habit, and decreases in car/bus habit). Further research is needed to identify effective strategies for changing these antecedents of children's active school travel.

Key words: Theory of panned behavior; habit; active school travel; walking; children.

Background

Physical activity in childhood is associated with a range of health benefits including a reduced risk of cardiovascular disease [1] and obesity [2], and improved mental wellbeing [3]. However, in Scotland, 37% of girls and 26% of boys do not meet the current recommended minimum target of at least one hour of physical activity per day [4]. The transition from childhood into early adolescence is a key developmental period during which physical activity notably decreases [5] and the promotion of active travel (e.g., walking) has been identified as a means for helping children to maintain physical activity and establish lifelong health habits [6]. While interventions to promote active travel have been implemented over the last decade, they have had only small or non-significant effects on behavior [7]. Two possible explanations are that interventions have been developed without a theoretical basis [7] and active travel is strongly governed by habits, which are notoriously difficult to change [8]. Research that identifies theoretically derived predictors of children's active travel and takes into account the effects of habituation is therefore required. The present study addresses these issues by providing the first test of the theory of planned behavior (TPB; [9]) and habit strength in the context of children's active school travel.

The Theory of Planned Behavior

The TPB is a model of rational decision-making which proposes that behavior is determined by a number of potentially changeable cognitions. It is therefore a suitable model for helping researchers to identify targets for health interventions [10]. The model proposes that intention is the proximal determinant of behavior. Intentions are indications of how much people want to perform a behavior and how hard they are willing to try in order to perform it [9]. Intentions are, in turn, determined by attitude (an overall positive or negative evaluation about performing the behavior), subjective norm (perceived social pressure to perform the behavior) and perceived behavioral control (the extent to which the behavior is perceived to be easy or difficult). Perceived behavioral control is also a direct co-determinant of behavior, along with intention, so long as it reflects the actual control that people have over performing a behavior [9, 11].

Although the TPB has not been applied previously to children's active travel, there is reason to expect it to provide useful insights into this target behavior because it has been found to predict related behaviors such as travel mode choices in adults [12] and non-travel related physical activity in both adults and children [13]. In line with meta-analytic reviews of studies on general social behavior [14, 15] this research shows that the TPB accounts for large proportions of variance ($R^2 > .25$; see [16]) in both intention and behavior. However, despite the support for the TPB, it should be noted that the evidence base is characterized by cross-sectional designs and the use of subjective (self-reported) behavior measures, both of which represent potentially serious methodological limitations. Cross-sectional designs have been commonly used in studies of general physical activity [17] and travel choices [12]. More generally they are employed in over half of all published TPB studies [18]. They are problematic because the contemporaneous measurement of TPB constructs and behavior means that behavior measures are indications of past behavior, and predicting past behavior from TPB constructs violates the causal ordering proposed by the model (e.g., intention → behavior) and creates a confound when researchers examine the effects of habit on behavior (discussed below). Additionally, when TPB constructs and behavior are measured at the same time, consistency biases may serve to artificially inflate TPB-behavior correlations.

With respect to subjective behavior measures, a recent meta-analysis by McEachan et al.

[15] found that, of 237 tests of the TPB, behavior was assessed using self-report methods (rather than objective observations) in 86% of cases. Self-reported behavior measures, however, are vulnerable to cognitive [19], affective [20] and self-presentational [21] biases, which can lead to inaccuracies in behavior data (i.e., under- or over-reporting). In support of this contention, research examining both self-reported and objectively measured walking behavior (e.g., assessed through pedometers) has found no association between the two [22] and Adamo et al. [23] reported that children substantially over-estimate their physical activity levels (by 114% for boys and 584% for girls, on average). In the context of active travel therefore self-reported behavior measures may lack validity. Also, the TPB has been shown to account for more variance in subjectively measured behavior than objectively measured behavior, which could be due, in part, to common method variance between TPB and subjective behavior measures [14, 24]. For these reasons we used both a prospective design and an objective measure of behavior in this first application of the TPB to children's active school travel. In line with the TPB and research in other domains we hypothesized that attitude, subjective norm, and perceived behavioral control would together account for a significant proportion of the variance in children's intentions to walk to school and that intention and perceived behavioral control would together account for a significant proportion of the variance in a prospective measure of objective behavior.

Habit

We also tested the extent to which habit augments the predictive validity of the TPB. Habits are learned patterns of behavior that are initiated automatically in response to situational cues and they are formed when behavior is performed frequently in stable contexts [25]. Children's school travel behavior is therefore likely to be under habitual control, at least to some extent, because journeys to school are characterized by both repetition (i.e., they are typically made each day of the school week) and situational stability (i.e., they take place at approximately the same time of day, have the same start and end points and typically constitute the same route). However, the effects of habit in this specific context have not been investigated previously. While it is acknowledged that studies of travel mode choices [26] and non-travel related physical activity [13, 27] have demonstrated that past behavior is a predictor of subsequent behavior, the use of past behavior as a proxy for habit is potentially problematic for a number of reasons. First, knowing that past behavior is a strong predictor of subsequent behavior is of little practical value because past behavior is not amenable to change (i.e. it does not represent a useful intervention target). Second, it is questionable whether past-subsequent behavior correspondence is sufficient to demonstrate habituation. For example, an alternative explanation for this relationship is that measures of past and subsequent behavior share large amounts of error variance [28, 29]. Another explanation is that behavior is extremely stable over time, with the same factors (e.g., attitudes and intentions) influencing it at both time points [28]. Researchers have therefore argued that past behavior, on its own, offers little explanatory power and that it is not a sufficient proxy for habit. More specifically, it has been argued that while past behavioral performance in stable contexts is necessary for the development of habit, it is not habit itself and other defining features of habituation also need to be taken into account in a measure of habit strength [28].

In response to these criticisms of past behavior, Verplanken and Orbell [30] developed a measure of habit strength known as the Self-Report Habit Index (SRHI). The SRHI not only taps into past behavioral frequency but also other key features of habituation, namely behavioral automaticity (the extent to which behavior is carried out in response to situational cues; see above) and identity expression (an important feature of habit because established patterns of behavior have a tendency to become an integral part of a person’s self-concept; [31]). The SRHI has also been shown to possess both internal and test-retest reliability (i.e., α/r = 0.70 or greater; [32]), it has been found to converge with measures of past behavior and response-frequency measures of habit [30], and TPB research shows that it has significant effects on both intention and subsequent behavior over and above the effects of the cognitive variables proposed by the model [30, 33]. However, very few studies have tested the predictive validity of the SRHI in contexts related to children's active travel, and those studies have tended to use self-reported behavior measures or cross sectional designs [34, 35]. Given also the potentially important role of habit in governing school travel behavior, we used the SRHI in the present study to test the effects of habit on both intention and behavior.

Finally, we also tested the extent to which habit moderates the intention-behavior relationship. No previous study has tested this moderation effect in the context of children's active travel and research in other domains has tended to use measures of past behavior as proxies for habit [25]. Additionally, previous research has provided mixed evidence at best. Several studies have shown that the effects of intention and habit on behavior are independent [33, 36]. Other studies have demonstrated a moderation effect but, as highlighted by Ajzen [28], some have shown that effect of intention on behavior decreases with habit and others have shown that the effect of intention increases with habit. The former moderation effect is consistent with the traditional behaviorist view that rational decision-making (e.g., intention) does not influence behavior when under the influence of habit because behavioral control is turned over to situational cues (i.e. behavior is, in effect, carried out without conscious thought). The latter moderation effect is in keeping with a cognitive-motivational account of habit, which views habits as goal (i.e., intention) serving and thus places greater emphasis on decision-making processes in the execution of behavior [37]. Identifying whether habit moderates the intention-behavior relationship, and the direction of any moderating effect is therefore of theoretical importance (i.e., for understanding the interplay between intentional and habitual control of behavior). It also has important practical value because it sheds light on the conditions under which health interventions, designed to change intentions (e.g., to actively travel to school), might have the scope to promote behavior change.

Study aims and hypothesis

In line with the above background, we tested the following two hypotheses in the present study. Firstly, we hypothesized that the TPB will account for a significant proportion of the variance in children's intentions to walk to school and their objectively measured active school travel behavior. Secondly, we hypothesized that habit, as measured by the SHRI, will account for additional variance in both intention and behavior. Additionally, we tested the moderating effect of habit on the intention-behavior relationship. However, given the mixed evidence for this effect from previous research, and the lack of guidance from a single unifying theoretical approach, we specified no related hypothesis.

Method

Participants

Participants were 126 children sampled from five elementary schools in Glasgow (a large city in the west of Scotland, UK). All participants were aged between 8 and 9 years old (M = 8.66, SD= 0.49) and 59% of the sample was male. All children included in the present analyses lived within three miles of their school, meaning that walking was a potentially viable mode of travel for all participants.

Design and Procedure

This study used baseline data from the SE-CAT project (Strathclyde Evaluation of Children's active Travel). The SE-CAT project is a longitudinal study designed to evaluate the effectiveness of a school-based intervention aimed at encouraging children to walk and cycle to school.

A prospective design was used with subsequent behavior (walking to school) being measured after the measurement of TPB and habit constructs. Data collection took place during the fall school term (Sept-Nov 2009). Following permissions granted by Local Education Authorities, five elementary schools agreed to take part in the research. These schools provided a broad coverage of socio-economic status, with three of the schools being located in the highest ranked quintile of deprived areas in Glasgow and two of the school being located in the lowest ranked quintile of deprived areas. At each school, data collection involved issuing self-completion questionnaires to Year 5 children at the beginning (Monday) of the school week. Each child completed one questionnaire as part of a one hour class. The questionnaires measured all constructs from the TPB, operationalized with respect to 'walking to school every day', and habit strength, operationalized with respect to both walking to school (walking habit) and travelling to school via car or bus (car/bus habit)[1]. The questionnaires were administered by teams of 4-5 trained research assistants who provided the children with help understanding the questions, if needed.

After completing the questionnaires all participants were fitted with an accelerometer (Actigraph GT1M, Pensacola, FL) for the remainder of the school week. This allowed objective active travel behavior (step count) to be measured on four morning commutes to school (Tuesday to Friday) and four afternoon commutes home (Monday to Thursday). The accelerometers were attached to the participants' right hip with an elastic belt. Children were instructed to wear the belts from first thing in the morning, after waking, until last thing at night, before going to bed. They were also told that the belts should only be taken off when bathing, showering or swimming. Parental consent was obtained for all participants prior to data collection. Ethical approval for the study was granted by the University of Strathclyde's Research Ethics Committee. Further information concerning the measurement of active travel behavior and the data checking and replacement techniques that were implemented in this study are provided in Appendix K and Appendix L respectively.

Measures

Theory of Planned Behavior Constructs. Standard measures of all TPB constructs were used following guidelines provided by Fishbein and Ajzen [38]. However, the wording of all questionnaire items and the response options was amended following previous research on children in the present age range [39, 40]. Participants responded to all items using 4-point scales, scored 1 (*disagree in a big way*), 2 (*disagree*), 3 (*agree*) or 4 (*agree in a big way*).

Intention was measured using two items: 'I plan to walk to school every day' and 'I intend to walk to school every day'. The mean of participants' scores on these two items served as the overall measure of intention for use in the subsequent data analysis ($\alpha = .84$). Attitude was measured with four items. Consistent with the distinction in the literature [41] two items tapped into the affective component of this construct ('Walking to school every day would be fun' and 'Walking to school every day would be enjoyable') and two items tapped into the instrumental component ('Walking to school every day would be good for me' and 'Walking to school every day would be important for me'). The mean of the four items served as the overall measure of attitude for use in the subsequent analyses ($\alpha = .74$). Similarly, the mean of six items served as the measure of subjective norm ($\alpha = .71$). Three of these items measured the injunctive component of subjective norm and three items measured the descriptive component [41, 42]. The three injunctive items were: ‘My family wants me to walk to school every day’; ‘My friends want me to walk to school every day’; and ‘My teachers want me to walk to school every day’. The three descriptive items were: ‘My family will walk to school or work every day’; ‘My friends will walk to school every day’; and ‘My teachers will walk to school every day’. Finally, perceived behavioral control was measured with three items: ‘I could walk to school every day if I wanted to’; ‘I have the time to walk to school every day if I wanted to’; and ‘I live in a place which allows me to walk to school every day if I wanted to’. The mean of these three items was calculated for each participant and served as the final measure of perceived behavioral control ($\alpha = .75$).

Habit. The SRHI [30] was used to measure both walking and car/bus habit. To measure walking habit, participants were presented with the following stem: ‘Walking to school is something….’. This was followed by 12 items that tapped frequency of past behavior (e.g., ‘I do frequently’), automaticity of behavior (e.g., ‘I do automatically’) and identity expression (e.g., ‘that is typically me’). Responses were recorded on 5-point Likert scales scored from 1 (*totally disagree*) to 5 (*totally agree*). The same items were used to measure car/bus habit but were preceded by the stem: ‘Travelling by car or bus to school is something….’. The mean of the 12 walking habit items ($\alpha = .94$) and the mean of the 12 car/bus habit items ($\alpha = .97$) served as the final measures of walking and car/bus habit, respectively.

Subsequent Behavior. Accelerometer data collected over the week following questionnaire administration were used to derive the objective measure of subsequent behavior (active school travel). For each participant, the mean number of steps across all of the commutes to and from school was calculated ($\alpha = .87$). This provided a measure of the average number of steps per school commute, for each participant.

Data analysis. The data were analysed in SPSS (version 18; IBM Corp. Chicago, IL) using techniques which are commonly employed in TPB research, namely correlation and multiple regression.

Results

Descriptive statistics

Descriptive statistics for all TPB constructs, walking and car/bus habit, and subsequent behavior are provided in table 1. Participants, on average, had positive attitudes and intentions towards walking to school, perceived social pressure (subjective norm) to walk to school and perceived that they had control over their performance of this behavior (i.e., the sample means for these constructs were above the scale mid-point, 3). Additionally, participants, on average, reported moderate levels of walking habit (i.e., the sample mean was at the scale mid-point) and low levels of car/bus habit. The average number of steps per school commute (behavior) was 2,262.

*****Insert Table 1 here *****

Zero order correlations

In line with the TPB, the zero order correlations in table 1 show that both intention and perceived behavioral control were positively correlated with behavior and attitude, subjective norm and perceived behavioral control were each positively correlated with intention. Also in line with the predictions, walking habit was positively correlated with intention (but not behavior) and car/bus habit was negatively correlated with both intention and behavior. The directions of these correlations show that intention to walk to school increased with attitude, subjective norm, perceived behavioral control and walking habit, and decreased with car/bus habit. Behavior increased with intention and perceived behavioral control, and decreased with car/bus habit.

Prediction of Intentions

A hierarchical multiple linear regression was used to test the predictive validity of the TPB and habit in relation to intention (see table 2). At step 1, the independent variables were attitude, subjective norm and perceived behavioral control. Walking and car/bus habit were entered as additional independent variables at step 2. At step 1, the three TPB constructs together accounted for 41% of the variance in intention ($R^2 = .41$, $F = 28.77$, $df = 3, 122$, $p < .01$). Perceived behavioral control was an independent predictor at step 1 ($\beta = .58$, $p < .01$), but attitude ($\beta = .00$, $p > .05$), and subjective norm ($\beta = .12$, $p > .05$) were not. At step 2, the addition of walking and car/bus habit accounted for a six percentage point increase to explained variance in intention ($R^2_{change} = .06$, $F_{change} = 6.66$, $df = 2, 120$, $p < .01$). Walking habit ($\beta = .18$, $p < .05$) and car/bus habit ($\beta = -.16$, $p < .05$) were both independent predictors of intention at step 2 and perceived behavioral control remained an independent predictor ($\beta = .49$, $p < .01$).

*****Insert Table 2 here* ****

Prediction of Behavior

Another hierarchical multiple linear regression was used to test the predictive validity of the TPB and habit in relation to objectively measured subsequent behavior. Intention and perceived behavioral control (i.e., the direct predictors of behavior according to the theory) were entered at step 1 of the analysis and walking and car/bus habit were both entered at step 2. As can be seen in table 3, intention and perceived behavioral control together accounted for 10% of the variance in behavior ($R^2 = .10$, $F = 6.44$, $df = 2, 123$, $p < .01$). Intention was the sole independent predictor ($\beta = .32$, $p < .01$). When added to the analysis at step 2, the habit measures increased the explained variance in behavior by six percentage points (R^2_{change} = .06, F_{change} = 4.61, *df* = 2, 121, $p < .01$). Car/bus habit independently predicted behavior (β = -.29, $p < .01$) at step 2 but walking habit did not (β = -.02, $p > .05$). Intention remained a significant predictor of behavior at step 2 (β = .24, $p < .05$).

Also reported in table 3 are the effects of two-way interactions between intention and walking habit and intention and car/bus habit. Following standard procedures [43], these interactions were included at step 3 of the regression analysis to test the moderating role of habit on the intention-behavior relationship. Before the two-way interactions were calculated, intention and both walking and car/bus habit were mean centered to reduce the possible effects of multicollinearity [44]. As can be seen in table 3, the interaction terms did not account for any additional variance in behavior, over and above the variance accounted for by the TPB and habit measures (R^2_{change} = .00, F_{change} = .16, *df* = 2, 119, $p > .05$). Neither interaction independently predicted behavior.

*****Insert Table 3 here *****

Discussion

This study represents the first test of the TPB and the effects of habit in relation to children's active school travel. It therefore offers an important contribution to knowledge, providing new insights into the psychological antecedents of this behavior – antecedents which are likely to constitute useful targets for theory-based health interventions (e.g., educational programs that aim to promote walking to school). The study also contributes to the wider evidence base on the TPB and habit because some of the key limitations that characterize previous research in other domains were addressed through the use of a prospective design, an objective measure of behavior and a measure of habit strength that taps into the key theoretically derived features of habituation (i.e., not just frequency of past behavior but also behavioral automaticity and identity expression). The following subsections address the support provided for the TPB, the effects of habit on children's active school travel and the implications of the findings for developing effective health interventions.

Support for the Theory of Planned Behavior

Overall, the results support our first hypothesis because they demonstrate the predictive validity of the TPB in the context of children's active school travel. First, the model accounted for 41% of the variance in children's intentions to walk to school. This is regarded as a large-sized effect in the social sciences [16] and compares well with previous findings from TPB studies on other behaviors, which also show that the model accounts for large proportions of variance in intentions [12, 13, 14, 15]. Second, the model accounted for 10% of the variance in active school travel behavior. Although research on the TPB generally demonstrates somewhat larger effects on behavior [12, 13, 14, 15], the present finding is still regarded as a moderate-sized effect in the social sciences [16] and is encouraging given that we provided a rigorous test of the TPB, using both a prospective design and an objective measure of active school travel.

With respect to the independent effects of the TPB constructs, perceived behavioral control was an independent predictor of children's intentions to actively travel to school. Intention, in turn, was an independent predictor of subsequent behavior. These effects also remained statistically significant after controlling for the effects of habit. On the other hand, neither attitude nor subjective norm independently predicted intention, and perceived behavioral control did not predict behavior directly. While these relationships are posited by the TPB, it is expected that the relative importance of the models' constructs will vary across different behaviors, contexts and populations, and not all components will be needed to predict intentions and behavior in all cases [9]. Indeed, research demonstrates that there is variation in the independent effects of TPB constructs across different studies [45]. Thus, the present null results do not necessarily refute the TPB as a model of behavior. Instead, the present findings imply that, of the cognitive variables proposed by the model, all that is needed to predict intention to walk to school (in children aged 8-9 years old) is perceived behavioral control and all that is need to predict behavior is intention. A potential explanation for the lack of prediction from attitude and subjective norm is that, for children in the present age range, school travel is not under complete volitional control, with many parents not permitting their children to walk to school (e.g., due to perceptions that it is unsafe to do so; see [46]). In contrast, perceived control takes into account such constraints upon behavior and is therefore equipped to predict non-volitional behaviors [9]. That said, the present null result for the direct relationship between perceived behavioral control and behavior suggests that children's perceptions of control over their active school travel are not accurate [11]. Further research is needed to examine the accuracy of children's perceptions of control over their active school travel and the extent to which this accuracy augments the direct relationship between perceived control and behavior.

Despite the present support for the TPB, it is acknowledged that the model accounted for substantially less variance in children's active travel behavior than it did their intentions. While, the objective (rather than subjective) measurement of behavior might partially account for these findings [14, 24], there is a growing body of evidence on other social behaviors that also demonstrates a gap between intention and action [47, 48]. This raises the question as to how the gap might be bridged. One concept that helps addresses this issue is the concept of implementation intentions [49]. These are plans of action that require an individual to create links in memory between situations in which an intended behavior (e.g., walking to school) will be performed and the actual performance of that behavior. This serves to automatically initiate the behavior when the situations specified in the plan are encountered [49]. Although no studies have tested the effects of implementation intentions in the present context specifically, research on other social behaviors has shown that implementation intentions augment the intention-behavior relationship and weaken the effects of habit on behavior [50, 51]. Given that habit was a predictor of children's active school travel in this study (discussed below), implementation intentions might not only represent a useful strategy for increasing intention-behavior correspondence but also for promoting active school travel. Further research would be needed to address this issue.

The finding that the TPB accounted for substantially less variance in behavior than it did in intention also implies that additional *direct* predictors of behavior need to be included in the model to augment its predictive validity. In addition to the concept of habit, a potentially suitable candidate is behavioral *willingness.* Behavioral willingness represents a less reasoned form of decision-making than does intention and it is defined as a general reaction to situations that are conducive to the performance of a behavior [52]. Several studies provide support for willingness as a predictor of various health behaviors, particularly in young adolescent and child populations which tend to be more reactive than deliberative in their behavioral decision-making [53]. Therefore, future studies addressing children's active school travel might usefully incorporate the concept of willingness into the TPB. Additionally, other cognitions, such as self- and social identity, have been found to increase the prediction of both intentions and behavior in other contexts [54, 55] and are worthy of investigation with regard to children's active travel in order to augment the predictive validity of the model.

The Role of Habit

In addition to demonstrating the importance of reasoned-decision making (i.e., TPB constructs), the present findings demonstrate the importance of habit in the prediction of children's active school travel behavior. In line with our second hypothesis, walking and car/bus habit together increased the prediction of both intention and behavior, over and above the TPB. These findings are consistent with previous studies that also support the role of habituation in the execution of behavior, including studies of travel mode choices [12] and non-travel related physical activity [13, 27]. Importantly however, the present findings represent an important contribution to the literature because the effects of habit were assessed prospectively, using both an objective behavior measure that is not susceptible to self-reporting biases and a measure of habit strength that not only taps into how often a behavior has been performed in the past but also behavioral automaticity and identity expression (i.e., the other key features of habituation).

It is also worth noting that both walking and car/bus habit were found to independently predict children's intentions to active travel to school. The implications are that intentions to walk to school are, in part, automatically formed (i.e., on the basis of habits) and being in the habit of walking to school and (not) being in the habit of travelling to school by car or bus serve to motivate behavior separately. On the other hand, only car/bus habit was found to predict behavior directly, showing that this habit also has a more proximal effect on behavior, which is independent of the effect of intention. That is not to say that habitual and rational decision-making are in competition. In fact, the present findings show that neither measure of habit moderates the intention-behavior relationship. Thus, the findings do not support the behaviorist view that habit diminishes the effects of rational decision-making on behavior. At the same time, the lack of a moderation effect provides little support for the social cognitive view that habits are goal-serving [37]. In the present context, the findings suggest that intentional and habitual processes have complementary but essentially independent effects on active school travel behavior. This supports previous studies in other domains which have also failed to find significant interactions between intention and habit [33, 36].

Practical Implications

From a practical point of view the present findings suggest that interventions could usefully increase children's perception of control over their ability to walk to school, promote walking habits and reduce car/bus habits (i.e. these variables were significant predictors of intentions to walk to school and intentions, in turn, predicted behavior). In particular, interventions that successfully reduce the habit of traveling to school by motorized transport are likely to be particularly effective given that car/bus habit not only predicted intention but also behavior directly.

Effective ways to increase perceived behavioral control are well established [56] and include the promotion of personal mastery experiences (e.g., successful performance of a behavior following guidance, sub-tasking or visualization), vicarious experiences (observing and then modelling the required behavior), verbal persuasion (e.g., immediate positive feedback following successful behavioral performance), and emotional arousal (e.g., stressing the benefits of a performing a behavior and the risks of not doing so). In school settings such techniques have been found to increase children's academic performance [57, 58]. It is possible therefore that these techniques will also be effective for promoting other behaviors in children. Future research is needed to test the effectiveness of these techniques for promoting active school travel.

Techniques to change habits have received less research attention. However, according to the habit discontinuity hypothesis [59], the dependence of habits on environmental cues can provide an opportunity to change behavior. More specifically, when the context in which a behavior is habitually performed is subject to change, the environmental cues that automate behavior are no longer present and there is an increased likelihood that individuals will re-consider their behavior and adopted alternatives (e.g., walking to school). Indeed, interventions delivered shortly before, during or after a context change have been shown to be effective at changing habitual behavior [60]. In the present context, interventions promoting walking to school might usefully be delivered during the transition phase from elementary to high school, given that this context change broadly corresponds with the development phase in which physical activity notably decreases (i.e., the transition from childhood to early adolescence). Also, on the basis that many parents do not permit their children to walk to school (see above), these interventions might need targeting at parents/guardians in addition to children. More generally, it is likely that interventions designed to support active school travel habits will need to be sustained over long periods of time (i.e., until the required behavior becomes automated).

Potential limitations

Although this study provides valuable insights into children's active school travel and has important implications for the development and delivery of interventions, the findings need to be interpreted in light of the potential limitations of the study. First, all participants were sampled from schools in one urban region of Scotland, namely Glasgow. Future research is needed to test the extent to which the findings generalize to children living in other (e.g., rural) areas. Second, the data were collected during the fall school term and there is seasonal variation in children's school travel behavior, with walking to school being less prevalent during fall and winter compared with spring or summer [46]. However, replicating this study in the spring or summer would only be expected to provide stronger evidence for the predictive validity of the TPB and habit on the basis that there is greater variation in active travel behavior during this time of year.

Third, the length of the follow up period used in the present study was just one week, meaning that only short-term effects were investigated. That said, previous research has shown considerable stability in children's school travel behavior over longer periods of time [61]. Even so, it would be worth testing the effects of TPB constructs and habit using a longer follow-up period than used in the present study. Finally, it is also possible that the findings in this study concerning the prediction of behavior could be due to the lack of correspondence between the timeframes defined in the measurement of the TPB constructs and the measurement of behavior. For example, measurement of the TPB constructs in this study related to 'walking to school every day' however, behavior in this study was defined as the commute to school and the commute home. Consequently, variations in travel behaviour on the commute home from school may have lowered the predicting utility of the TPB.

Conclusion

Overall, the present study provides support for the application of the TPB to children's active school travel behavior (walking to school). However, in line with expectations, habit strength augmented the predictive validity of the model. The findings imply that children's active school travel is underpinned by both reasoned and habitual processes. Further research is needed to identify effective techniques for changing the predictors of children's active school travel.

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Footnotes:

Habit was operationalized with respect to both walking and car/bus use on the basis that approximately half of children in the present age range walk to school and approximately half travel by car or bus (National Travel Survey, 2009). Thus, given that school travel is almost equally distributed between these two modes, habituation with respect to both modes has the potential to impact on active school travel.

Table 1. *Means, standard deviations and zero order correlations for each study variable (n= 126)*

Variables	*M*	*SD*	1.	2.	3.	4.	5.	6.	7.
1. Commuting steps	2262.05	1006.37	–	.31**	.19*	.15	.15	.15	-.36**
2. Intention	3.12	0.77		–	.64**	.35**	.40**	.38**	-.45**
3. Perceived Behavioral Control	3.25	0.67			–	.52**	.48**	.26**	-.44**
4. Attitude	3.42	0.49				–	.37**	.22*	-.18*
5. Subjective Norm	2.69	0.55					–	.36**	-.22*
6. Walking Habit	2.53	1.20						–	-.33**
7. Car/Bus Habit	1.35	1.34							–

* $p < .05$. ** $p < .01$

Table 2. *Hierarchical multiple regression predicting intention to walk to school from TPB constructs (step 1), and walking and car/bus use habit (step 2)*

Step	Variables Entered	R^2	R^2_{change}	F_{change}	β_{Step1}	β_{Step2}
1.	Attitude	.41	.41	28.77**	.00	.00
	Subjective Norm				.12	.06
	Perceived Behavioral Control				.58**	.49**
2.	Walking Habit	.47	.06	6.66**		.18*
	Car/Bus Habit					-.16*

* $p < .05$. ** $p < .01$

Table 3. *Hierarchical multiple regression predicting active school travel behavior (commuting steps) from TPB constructs (step 1), walking and car/bus use habit (step 2), and intention X habit interactions (step 3)*

Step	Variables Entered	R^2	R^2_{change}	F_{change}	β_{Step1}	β_{Step2}	β_{Step3}
1.	Intention	.10	.10	6.44**	.32**	.24*	.24*
	Perceived Behavioral Control				-.01	-.09	-.10
2.	Walking Habit	.16	.06	4.61**		-.02	-.01
	Car/Bus Habit					-.29**	-.29**
3.	Intention X Walking Habit	.16	.00	0.16			.05
	Intention X Car/Bus Habit						.01

* $p < .05$. ** $p < .01$

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DAR, NMN, DM and SM designed the study and wrote the protocol. SM, DM and DAR managed the data collection phase. SM and MAE conceptualised the research question and carried out analyses and interpreted the data. The writing of the manuscript was led by SM with the assistance of MAE. All authors provided additional comments on the final draft and have read and approved the final version of the manuscript. The study was conducted as part of SM's PhD thesis, under the supervision of DAR, NMN and MAE.

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CHAPTER SIX

Title: Effectiveness of a school-based intervention at improving the psychological antecedents of children's active travel

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The following paper was submitted for publications to the Journal of Physical Activity and Health and is presented in that format.

Title page

Full title: Effectiveness of a school-based intervention at changing the psychological antecedents of children’s active travel

Running head: Promoting active travel

Manuscript type: Original research

Key words: Transport, psychology, physical activity

Abstract word count: 180

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Abstract

Background: The study investigated changes in theory of planned behavior (TPB) constructs and habit following a 6-week school-based active travel intervention.

Method: Children aged 8-9 years completed self-report measures of the outcome variables pre- and post- 6-week intervention/control.

Results: Significant group by time interactions were found for attitude and subjective norm. Post hoc *t*-tests found the decrease in attitude was significantly greater in the intervention group than the control group and the increase in subjective norm was greater in the control group than the intervention group. No significant interactions were found for Perceived Behavioral Control (PBC), intention, car/bus use habit or walking habit. Significant main effects for time with small to medium effect sizes were observed indicating a decrease in PBC and car/bus use habit. No significant main effect for time was found for intention or walking habit.

Conclusion: There appeared to be no beneficial intervention effect on habit strength, attitude, subjective norm, PBC or intention towards active or passive travel to school. Possible explanations for these unexpected results include: a) group differences, b) ceiling effects, and c) seasonal variations.

Introduction/Rationale

Identification of effective ways to promote physical activity in children is essential in order to reverse the current decline in physical activity among children.[1] Walking is an effective method of increasing physical activity and has been described by researchers as the 'near perfect exercise'.[2] Walking at a moderate speed (5 km/hr) can expend sufficient energy to meet the threshold for moderate intensity physical activity.[3] One way to promote walking among children is to encourage active journeys to and from school. In this context, walking can provide convenient and effective opportunities for incorporating at least two bouts of physical activity into a child's day, on up to five days of the week.

A recent review of active school travel has shown that children who actively travel to school demonstrate higher levels of daily physical activity than those who use inactive modes of travel[4]. However, current trends demonstrate that fewer children travel to school by active modes than in previous years.[5, 6] For example, in the United Kingdom only 47% of children walk to school.[7] This is a marked decrease compared to two decades ago (down from 62% in 1991).[8]

One way of promoting active school travel is through school-based interventions. A systematic review of interventions aimed at increasing active travel to school has recently been conducted.[9] Interventions included in this review brought about an increase in the use of active school travel, which appears promising. However, results were varied with only three interventions demonstrating a large or very large effect size. A number of limitations were highlighted by the authors of this review which hindered their ability to draw firm conclusions as to how the interventions may work, and which ones might be most effective. One such limitation was the lack of investigation of the 'complex and varied array of factors that influence children's modes of travel to school' [9] (p. 14). For example, although some studies have investigated related concepts (e.g. self-efficacy and parental motivations/barriers), only one study has examined changes in the cognitive factors surrounding active school travel.[10] In this study, the effect of an active school travel intervention on children's stage of behavioral change[11] was examined. Since interventions rely largely on achieving behavior change through changes in knowledge, awareness, and attitudes, understanding the extent to which change may be achieved in these constructs is important. In order to evaluate and understand how an intervention works, researchers must therefore identify and assess the determinants of behavior. The use of relevant theory can help to identify the determinants of behavior in this context.

The theory of planned behavior (TPB)[12,13] has emerged as one of the most influential social-cognitive models in understanding behavior[14] and has been shown to predict a wide range of behaviors including travel,[15,16,17,18] exercise,[19, 20] and physical activity.[21,22,23,24] The TPB is considered a useful model to help identify target areas for intervention, because it provides an account of how potentially modifiable variables combine to predict behavior. According to the theory, intention is the proximal determinant of behavior. Intentions are an indication of how much a person wants to perform a given behavior and how hard they are willing to try in order to perform it.[11] Intentions are, in turn, determined by attitude (an overall positive or negative evaluation about performing the behavior), subjective norm (perceived social pressure to perform the behavior) and perceived behavioral control (PBC; the extent to which the behavior is perceived to be easy or difficult). PBC is also a direct determinant of behavior, along with intention, provided it reflects the control that a person has over the behavior.[13, 25]

A review of the literature on TPB studies of walking has recently been published in a study by French, Darker, Eves and Sniehotta (*In press*).[26] These authors conducted a search of the literature in 2007 and identified seven empirical studies that had examined the predictors of walking intentions and/or behaviour [27, 28, 29, 30, 31, 32, 33]. On reviewing these studies, French et al. (*In press*) highlighted that although the prediction of walking intentions differed between studies, the most prominent feature of these studies was that the evidence pointed towards PBC as having the largest relationship with walking intentions. According to these authors, this was evidenced through the following results: a) PBC being a significant predictor of behaviour is all seven studies whereas in comparison subjective norm [28, 29, 30, 31, 32] was only significant predictors in four studies each as was attitude; [27, 28, 30, 31] b) the overall sample-weighted mean between PBC and walking intention was larger (r = .47) than subjective norm (r = .30) and attitude (r = .33), and c) PBC had the largest relationship with walking intentions in six of the seven studies. [27, 29, 30, 31, 32, 33] The differences observed between the studies may have been a result of a number of factors such as geographical variation, measurement differences (e.g. general walking versus leisure-time walking), or sampling fluctuations.[31] However, regardless of the variation between studies in terms of samples employed and measurement context, the empirical application of the TPB to walking provides strong support for the theory. Additionally, French et al (*In press*) highlighted that the results of their empirical application of the TPB were impressive and provides support for developing interventions to increase intentions to walk in that PBC is the construct which interventions should aim to change.

Despite the utility of the TPB, it has been argued that the theory lacks integration of the repetitive nature and habitual patterns that are evident in many behaviors. The habitual nature of travel has been previously recognised among adults.[16, 17, 18, 34] Here habit is viewed as a form of automaticity in responding, that develops as a person repeats a particular behavior in stable circumstances. It is characterized by a lack of awareness and conscious intent, is mentally efficient, and is sometimes difficult to control.[35] Active school travel is an example of a behaviour that is performed frequently and under stable circumstances. As a result, active school travel may become habitual. Researchers have found that, in line with adult travel behaviour,[16,17] active school travel is determined by both reasoned decision making (i.e., TPB constructs) and habit.[36]

The purpose of the present study therefore was to evaluate the effectiveness of a school-based active travel intervention, ‘Travelling Green’ (sic), in changing TPB constructs and habit (walking and car/bus use) among children.

Methods

The study presented in this paper forms part of the Strathclyde Evaluation of Children’s Active Travel (SE-CAT). The SE-CAT project was designed to evaluate the long-term effectiveness of a school-based intervention aimed at encouraging children to actively travel to school. A quasi-experimental design was used, with intervention and comparison schools. Data were collected pre- and post-intervention, and at 5- and 12- month follow-ups. A detailed description of the methodology used in the SE-CAT is available in a separate paper.[37] The analyses in the present paper are concerned solely with the effects of Travelling Green on the TPB constructs and habit constructs from the pre- to post- intervention/control phase.

Data collection took place during the week immediately prior to and following the intervention/control period. The intervention was implemented during the autumn (fall) school term.

Participants

Participants were 166 children aged 8 to 9 years old from five elementary schools.

Sampling

Permission was granted by relevant local education authorities to contact elementary schools, who were subsequently invited to take part in the research. A purposive sampling approach was used to ensure that schools were selected from areas of high and low deprivation areas. Area level of deprivation was determined using the Scottish Index of Multiple Deprivation (SIMD; http://www.scotland.gov.uk/Topics/Statistics/SIMD). Schools in the lowest and highest ranked quartiles of deprived areas were invited to participate. Five schools agreed to take part, three of which were located in high deprivation areas and two which were located in low deprivation areas. All schools were located in urban areas defined according to the Scottish Neighbourhood Statistics Urban Rural classification (www.sns.gov.uk). Random assignment of schools to either intervention or comparison group was not possible because schools had already scheduled the delivery of Travelling Green into their curriculum (i.e. Autumn or Spring term) before agreeing to participate in the study. Of the least deprived schools, one school was allocated to receive the intervention, and one school was allocated as the comparison. Of the three schools from areas of high deprivation, one school was allocated to receive the intervention and, due to their small pupil numbers, two remaining schools were combined to form one comparison. The comparison schools received the intervention at a later stage (i.e., after data collection). Ethical approval for the study was granted by the University of Strathclyde Research Ethics Committee. Study information sheets and consent forms were distributed to 232 children and their parents. Signed parent and child consent forms were obtained for 166 participants (72% consent rate).

Design and Procedure

At each school, data collection involved issuing self-completion questionnaires to Year 5 children at the beginning (Monday) of the school week. Each child completed one questionnaire as part of a 1-hour class. The questionnaires were administered by teams of four or five trained research assistants who provided the children with help understanding the questions, where needed.

Measures

Demographic characteristics

Parent questionnaires were used to obtain the following information: distance to school, number of cars or vans owned, ethnicity. Children's ages were obtained from the child questionnaire.

Theory of Planned Behavior Constructs

Measurement of the TPB variables was obtained through self-report questionnaires completed by the children. Standard measures of all TPB constructs were used following guidelines provided by Fishbein and Ajzen.[38] The wording of questionnaire items and the response options was consistent with previous research investigating children's general physical activity in a sample of children within the same age range to the present study.[24, 39] The TPB constructs were operationalized with respect to 'walking to school every day'.   Participants responded to all items on a 4-point scale, scored 1 ('*disagree in a big way*'), 2 ('*disagree*'), 3 ('*agree*'), or 4 ('*agree in a big way*').

Intention was measured using two items: 'I plan to walk to school every day' and 'I intend to walk to school every day'. The mean of participants' scores on these two items served as the overall measure of intention for use in subsequent analysis ($\alpha = .84$). Attitude was measured with four items. Consistent with the distinction in the literature[40] two items assessed the *affective* component of this construct (‘Walking to school every day would be fun’ and ‘Walking to school every day would be enjoyable’) and two items tapped into the *instrumental* component (‘Walking to school every day would be good for me’ and ‘Walking to school every day would be important for me’). The mean of the four items served as the overall measure of attitude for use in the subsequent analyses ($\alpha = .74$). Similarly, the mean of six items served as the measure of subjective norm ($\alpha = .71$). Three of these items measured the *injunctive* component of subjective norm and three items measured the *descriptive* component.[40] The three injunctive items were ‘My family wants me to walk to school every day’, ‘My friends want me to walk to school every day’, and ‘My teachers want me to walk to school every day’. The three descriptive items were ‘My family will walk to school or work every day’, ‘My friends will walk to school every day’ and ‘My teachers will walk to school every day’. Finally, perceived behavioral control was measured using three items: ‘I could walk to school every day if I wanted to’, ‘I have the time to walk to school every day if I wanted to’, and ‘I live in a place which allows me to walk to school every day if I wanted to’. The mean of these three items was calculated for each participant and served as the final measure of perceived behavioral control ($\alpha = .75$).

The measurement of the TPB constructs in this study allowed consistency in terms of the Target, Action, Context, and Time (TACT) of the behaviour of interest. This principle, known as the principle of compatibility, ensures that regardless of how the TACT elements of the behaviour are defined, all constructs (i.e. attitude, subjective norm, perceived behavioral control, and intention) are defined in terms of exactly the same elements. In this study, the measurement of each of the constructs defined the target behaviour as *school travel behaviour* with the action being defined as *walking.* Given that the context of the behaviour was the journey *to school* this also ensure that the measurement in terms of 'time' was also consistent in that travelling to school takes place at the same time every day.

Habit.

The Self-Report Habit Index (SRHI)[35] was used to measure both walking habit and car/bus habit. To measure walking habit, participants were presented with the following stem: 'Walking to school is something….'. This was followed by 12 items that measured frequency of past behavior (e.g., 'I do frequently'), automaticity of behavior (e.g., 'I do automatically') and identity expression (e.g., 'that is typically me'). Responses were recorded on 5-point Likert scales scored from 1 (*totally disagree*) to 5 (*totally agree*). The same items were used to measure car/bus habit but were preceded by the stem: 'Traveling by car or bus to school is something….'. The mean of the 12 walking habit items ($\alpha = .94$) and the mean of the 12 car/bus use habit items ($\alpha = .97$) served as the final measures of walking and car/bus habit, respectively.

The Intervention

Travelling Green is a school-based resource developed by West Dunbartonshire Council in collaboration with National Health Service Greater Glasgow. The implementation of the resource has been designed in line with the Scottish 'Curriculum for Excellence'.[41] A previous evaluation of this resource has shown it to successfully increase distance travelled to school by active modes and decrease the distance travelled by inactive modes.[10] The resource is currently funded by the Scottish Government and has been made available to every school in Scotland.

Overall, the resource seeks to promote walking and cycling to school by developing children's knowledge and understanding of the factors surrounding the adoption of healthy lifestyles. Local councils provide training to teachers on how to deliver the resource. The intervention comprises a teacher's handbook and pupil packs for each child. Implementation of the resource in the current study took place over 6 weeks and was implemented by teachers. This was in line with the design of the resource.

Teacher's Handbook

The material included in the resource is designed to support teachers to deliver lessons across a range of topic areas including: health and wellbeing, science, social studies, expressive arts, technologies, and languages. These topics are covered by the resource within a series of 13 lessons. Detailed lesson plans are provided which have been designed to enable the delivery of lessons in an informative and interactive way. These lessons use a variety of delivery methods including individual, class and group discussions, worksheets, practical tasks, and take home activities.

Pupil Pack

This part of the resource contains a set of active travel resources which is designed to be used by children and their families at home in addition to the delivery of the resource within the curriculum. The pack includes: information guides, travel challenges, progress charts (i.e., goal setting activities), guides for parents and fluorescent/reflective stickers.

Data analysis

Data were analysed in SPSS (version 18; IBM Corp., Chicago, IL). Descriptive statistics were calculated for sample characteristics and all primary outcome variables. A series of two-way mixed factorial ANOVAs was used to assess the effect of Travelling Green on TPB variables and habit. Post-hoc analyses using *t*-tests were conducted to explore any interactions. Statistical significance was accepted at $p = .05$. Effect sizes were assessed calculating Cohen's D.[43] The following values were used to interpret Cohen's D: 0.2 = small; 0.5 = medium; and 0.8 = large.

Results

Descriptive statistics

Descriptive statistics are provided in Table 1. These statistics show that children within the sample lived in close proximity to the school: 71% children of lived less than one mile away from the school, 23% lived between one and three miles, and 6% lived more than three miles from the school. More children in the intervention group lived within a one-mile radius of their school than the comparison group (I = 83% and C = 61%) and more children in the comparison group lived within one to three miles from their school (I = 13%; C = 32%). This difference was statistically significant ($\chi^2(2) = 8.47$, $p < .05$) indicating that the distance to school was not significantly different between the intervention and comparison group.

Overall, car ownership was high. 28% of families reported owning one vehicle, 54% reported owning two vehicles, 7% reported three or more and 12% of children came from families reporting no vehicles were owned. The percentage of children who came from households who did not own a vehicle was higher in the comparison group than the intervention group, (I= 8%; C= 15%). However, this difference was not statistically significant ($\chi^2(3) = 8.44$, *p* > .05) indicating that the pattern of vehicle ownership was not significantly different between the intervention and comparison group.

The majority of children in the sample were British (92%). This was the case for both intervention and comparison groups (I= 95%; C= 89%). However, this difference was not statistically significant ($\chi^2(7) = 8.92$, $p > .05$) indicating that ethnicity was not significantly different between the intervention and comparison group. The ethnic diversity within the overall sample was considered to be similar to the national population (http://www.scotland.gov.uk/Publications/2008/07/28100032/20).

In addition to SIMD scores,[37] eligibility for free school meals was used as a proxy measure of deprivation. The eligibility for free school meals is widely used as a proxy for socioeconomic status in UK educational research.[42] Qualification for free school meals is based on a number of criteria including a variety of government benefits (e.g. a variety of Income Support, Income-based Job Seeker's Allowance, income related element of Employment and Support Allowance; and Child Tax Credit). Twenty percent of children in the comparison group qualified for free school meals compared with 17% in the intervention group. This difference was not statistically significant ($\chi^2(1) =.49$, $p > .05$) indicating that the deprivation, as determined through free school meals, was not significantly different between the intervention and comparison group.

*******Insert Table 1 here ******

Descriptive statistics for TPB constructs and habit for pre- and post-intervention measures are displayed in Table 2. Participants, on average, had positive attitudes and intentions towards walking to school, perceived social pressure (subjective norm) to walk to school, and perceived that they had control over their performance of this behavior. This was determined by a sample mean for these constructs above the scale mid-point of 2.5. Participants, on average, reported moderate levels of walking habit. This was determined by a sample mean for these constructs above the scale mid-point of 3. And participants, on average, reported low levels of car/bus habit, determined by a sample mean for these constructs below the scale mid-point of 3.

*******Insert Table 2 here *******

Two-way mixed factorial ANOVAs

Results of the two-way ANOVAs (see Table 3) indicate significant group*time interactions for attitude and subjective norm. There was a greater decline in the control group than the intervention group in both attitude ($F_{1, 165} = 7.92$, $p < .05$, $\eta^2 = .05$) and a greater increase in subjective norm in the control group compared to the intervention group ($F_{1, 165} = 3.98$, $p < .05$, $\eta^2 = .02$). The effect sizes for both variables are regarded as 'small'.[43] Further post hoc examination of these interactions was performed using *t*-tests. These indicated that the intervention group was significantly and meaningfully higher in attitude ($t_{165} = 3.39$, $p < .01$, $d = 0.53$) and subjective norm ($t_{165}= 3.87$, $p < .01$, $d = 0.60$) at baseline but were not significantly different at post measures for attitude ($t_{165} = .30$, $p > .05$, $d =.43$) or subjective norm ($t_{165} = 1.50$, $p > .05$, $d = .24$). Significant main effects for group were observed for attitude ($F_{1, 165} = 4.90$, $p < .05$, $\eta^2 = .03$) and subjective norm ($F_{1, 165} = 8.89$, $p < .01$, $\eta^2 = .05$). Significant main effects for time were observed for attitude ($F_{1, 165} = 123.60$, $p < .05$, $\eta^2 = .43$) and subjective norm ($F_{1, 165} = 23.58$, $p < .01$, $\eta^2 = .13$). Effect sizes ranged from 'small' (i.e., attitude) to 'large' (i.e. subjective norm).[43]

There were no significant group*time interactions in PBC ($F_{1, 165} = .01$, $p > .05$, $\eta^2 = .00$), intention ($F_{1, 165} = .01$, $p > .05$, $\eta^2 = .00$), car/bus use habit ($F_{1, 165} = .01$, $p > .05$, $\eta^2 = .00$) or walking habit ($F_{1, 165} = .98$, $p > .05$, $\eta^2 = .01$).

Significant main effects for time with small to medium effect sizes were observed indicating a decrease from pre to post in PBC ($F_{1, 165} = 23.58$, $p < .01$, $\eta^2 = .13$) and car/bus use habit ($F_{1, 165} = 29.00$, $p < .01$, $\eta^2 = .07$). There was no significant main effect for time in intention or walking habit ($F_{1, 165} = .09$, $p < .01$, $\eta^2 = .00$).

Main effects for group were observed for all variables; attitude ($F_{1, 165} = 4.90$, $p < .05$, $\eta^2 = .03$), subjective norm ($F_{1, 165} = 8.89$, $p < .01$, $\eta^2 = .05$), PBC ($F_{1, 165} = 23.80$, $p < .01$, $\eta^2 = .12$), intention ($F_{1, 165} = 10.05$, $p < .01$, $\eta^2 = .06$), car/bus use habit ($F_{1, 165} = 10.70$, $p < .01$, $\eta^2 = .06$) and walking habit ($F_{1, 165} = 31.03$, $p < .01$, $\eta^2 = .16$). These results indicated that scores in the intervention group were significantly higher (with medium to large effect sizes) than those in the comparison group for attitude ($t_{165} = 3.39$, $p < .01$, $d = 0.53$), subjective norm ($t_{165} = 3.87$, $p < .01$, $d = 0.60$), PBC ($t_{165} = 4.08$, $p < .01$, $d = 0.64$), intention ($t_{165} = 2.85$,$p < .01$, $d = 0.44$), and walking habit ($t_{165} = 4.93$, $p < .01$, $d = 0.77$). A significant difference (with a medium effect size) was observed in scores of car/bus habit scores ($t_{165} = 3.14$, $p < .01$, $d = 0.44$), demonstrating higher levels in the comparison group compared to the intervention group.

*******Insert Table 3 here *******

Discussion

The purpose of this study was to investigate the effect of Travelling Green on children's cognitions and habits. Overall, there appeared to be no beneficial effect of the intervention on these variables. A greater increase in subjective norm was evident in the comparison group compared to the intervention group and a greater decrease in attitudes was evident in the intervention group compared to the comparison group as indicated by the significant interaction. Children's perceptions of behavioral control, and their car/bus use habits decreased while their intentions to walk to school and their walking habits remained stable.

These findings were unexpected given that Travelling Green focuses on providing children with a positive attitude and motivation towards active school travel. Possible explanations for these results include: a) group differences at baseline, b) ceiling effects, and c) seasonal variations. First, large group differences in pre-intervention outcome measures were observed. Differences between the intervention and comparison group ranged from 0.25 to 0.66 on a 4-point scale and 0.60 to 0.77 on a 5-point scale, and more favourable cognitions and habits in the intervention group compared to the comparison group. Such differences may demonstrate selection bias and therefore pose a threat to the internal validity of the study.[44] Additionally, and in combination with these observations, the presence of a ceiling effect should also be considered. For example, given that the mean attitude score in the intervention group at baseline was approaching the scale's limit (i.e. 3.57 on a 4-point scale), the potential for increase in this construct (compared to the comparison group) may have been constrained.[45] This could also explain why measures of subjective norm in the intervention group failed to increase in line with the control group. Furthermore, although significant decreases in attitude, PBC and intention were observed, it may be important to highlight that measures collected post-intervention/control period remained favourable (i.e. above the scale mid-point). Therefore, while a decline in these constructs occurred, children's overall dispositions (i.e. being either positive or negative) were unchanged.

It is also plausible that results were influenced by seasonal variation. Data in the present study were collected from September (pre) to November (post). Over this period changes in weather such as a decrease in temperature and daylight hours, and an increase in rainfall may make the decision to walk less favourable. This could explain the decreases in attitudes and PBC observed in both groups from pre- to post- intervention. This is consistent with previous studies that have demonstrated a decline in children's physical activity levels[46, 47] and active school travel during the winter period.[48, 49]

Further explanation for the findings in this study could relate to aspects of internal validity and test-retest reliability of the TPB measures in this study. Firstly, concerning the internal construct validity of these measures, it is possible that the measurement of the TPB constructs in this study were in fact defined too narrowly in this context. For example, in this study the measurement of attitude focused on the instrumental and affective components of active travel relative to the fun and enjoyment attributes of the behaviour. However, it is possible that children's attitudes are also reflective of wider environmental, social and economic concerns. Furthermore, the validity of the measure is also dependent on the ability of children to fully understand and reflect on the questions being asked. For example, this may be particularly pertinent when measuring perceptions of behavioural control. In this example, the item 'I could walk to school every day if I wanted to' could be interpreted in a literal way (thus prompting the child to reflect on their physical capacity) or in a social context (thus prompting reflections on the constraints a parent may hold over a child). These issues should be addressed in future research. This could be achieved through the use of qualitative research which could ensure that the behavioural, normative and control beliefs are identified in the measurement of the TPB constructs, and through the use of 'think aloud' qualitative research which would help identify how children are interpreting each of the items in the measure.

Secondly, concerning the reliability of the measure of attitude and subjective norm (Chapter 4), it is also possible that the unexpected findings in this study are due to measurement error. For example test-retest reliability for these constructs were reflective of poor (subjective norm; ICC = .33) and moderate agreement (attitude; ICC = .47). Further research investigating the test-retest reliability of the TPB constructs would benefit this area. Particularly, and relevant to research in Chapter 4, this research should be designed to test the TPB constructs over a time frame which is shorter (i.e. less than 6-weeks) and a period which either has more consistent weather (i.e. potentially spring time).

Implications for research and practice

Given the present findings, a number of practical implications should be highlighted. First, with regard to changing children's cognitions towards active travel, future research addressing the methodological issues discussed may enable greater understanding of how to better promote active school travel through a school-based intervention. However, it should also be considered that the implementation of a classroom based intervention may be insufficient to address the complexities of active school travel. For example, it is conceivable that children's behavioral choices (in this instance, travel mode) are in fact, mediated by parental decisions. In this instance, an intervention focusing predominantly on increasing a child's perceived or actual ability to walk to school might be insufficient without adequate parental support. This is congruent with recent findings demonstrating that in 90% of cases, parents were reported as being the primary decision maker for travel to school choices.[50] As a result, altering current strategies to incorporate parent support into the intervention may be necessary. Future research should therefore explore the factors surrounding the decision making process in order to inform and integrate such considerations into future interventions. This could be achieved through qualitative analyses with the key stakeholders (children, parents, teachers, schools), for example, interviewing parents to examine the relationship between themselves and their child with regard to the way in which the family unit arrives at a decision each morning to either walk or drive.

Second, with regard to changes in habit, further research is needed to identify effective strategies to both form pro-behavioral habits (i.e., walking) and break counter-behavioral habits (i.e., car/bus use). Researchers investigating adult travel have suggested that breaking a habit can be achieved through a significant change to the context in which the habit is performed[51] and thus behavior change is likely to be more effective when delivered shortly before, during, or after context change. In the case of active school travel, this could be achieved by implementing the intervention at the beginning of an academic year, or following a change of school (i.e. elementary to high school transition) or introducing a change in school policy (e.g., parking restrictions within the vicinity of the school). From a practical perspective, such an approach could be easily introduced into many existing interventions and therefore be a cost-effective and relatively easy way to increase the effectiveness of an intervention. Future research should therefore explore this concept. Regarding habit formation, only one recent study has investigated this behavioral construct. According to this study, it takes an individual, on average, 66 days to form a habit.[52] However, this time is highly variable between individuals and behaviors (ranging from 18 to 254 days). Therefore, although it may be that the 6-week implementation of Travelling Green in the present study may have been insufficient for children to develop a habit, the ability to draw substantive conclusions is limited given the lack of research examining habit formation in this behavior and age group. Therefore, although extending the delivery time of the intervention may be beneficial, additional research examining the habit formation process in children is needed to inform such practice.

Strengths and limitations

Although there has been much research investigating the construct of habit in relation to adults' travel behavior, this is the first study to evaluate changes in habit in children's school travel. More generally, this contributes to an important, yet under-researched area investigating the concept of children's habits. The evaluation of the TPB constructs addressed several of the main limitations of previous studies by providing a more comprehensive examination of psychological determinants that have been previously demonstrated to underpin children's travel behavior.[36] The identification of the constructs in this study provides both a pragmatic evaluation of a complex school-based intervention and a number of modifiable targets that can be identified in future research and practice. Additionally, this study used a quasi-experimental design and included a relatively large sample size. Further to this, the recruitment of participants from high and low socio-economic backgrounds overcomes the criticism directed at previous studies that have failed to consider socio-economic status as a potential moderating factor in the effectiveness of an intervention.[9]

Despite these strengths, the study is not without limitations. Only schools in urban areas were recruited for the study. Since differences are known to exist in school travel between urban and rural areas in terms of risks[53] and attitudes,[54] the scope to generalise these findings to rural areas is limited. Randomization of children to either the intervention or comparison group was not possible due to the implementation of the intervention being at the school, rather than individual, level. Further to this, the delivery of the intervention had been pre-planned in the schools, and therefore the randomization of schools to either intervention or comparison group was not feasible. Additionally, while measurement of the adherence to and exposure of the interventions was confirmed in all schools, the study did not control for other factors that are known to be significant in implementation fidelity such as quality of program delivery, participant responsiveness, and program differentiation.[55] This may have resulted in variation in the fidelity of implementation between schools. Since the intervention is delivered in its entirety and therefore targets all the TPB components simultaneously, it is not possible to identify the effectiveness of individual strategies within the intervention. Although this is common in school-based research, it means that the efficacy of individual components remains unknown.

Conclusion

In conclusion, the findings from this evaluation suggest that the Travelling Green intervention demonstrated a lack of beneficial effects in relation to changing the TPB constructs or changing habits. The promotion of active travel programs delivered primarily through classroom-based resources, such as Travelling Green, may not be sufficient to change the determinants underlying active school travel. Instead, behavior-change in this setting may require multi-level strategies, such as greater family involvement and additional local/school changes to policy and/or infrastructure. A number of key issues are raised that highlight both the potential limitations (e.g., seasonality) of the present study along with issues inherent in school-based research. Possibilities for future research include: a) experimental research to identify effective methods to break car/bus use habit and form walking habit in children, b) examination of the potential effects of seasonality, and c) investigation of the generalizability of these results, particularly to rural schools.

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Table 1. Sample characteristics of comparison and intervention groups

		Comparison (N = 87)	Intervention (N = 79)	Total (N = 166)
Distance to School	Less than one mile	60.8%	82.8%	71.0%
	One mile +	32.4%	12.5%	23.2%
	Three miles +	6.8%	4.7%	5.8%
Cars/Vans owned	0	15.1%	7.8%	11.7%
	1	20.5%	35.9%	27.7%
	2	56.2%	51.6%	54.0%
	2+	8.3%	4.7%	6.5%
Age	8 years	35.6%	36.7%	36.1%
	9 years	64.4%	63.3%	63.9%
Ethnicity	British	94.5%	89.12%	92.0%
	Indian	2.7%	1.6%	2.2%
	Pakistani	2.7%	0%	1.5%
	White and Asian	0.0%	1.6%	0.7%
	Chinese	0.0%	1.6%	0.7%
	British/Irish	0.0%	1.6%	0.7%
	White American	0.0%	1.6%	0.7%
	Irish	0.0%	3.1%	1.5%
Sex	Male	62.1%	57.0%	59.6%
	Female	37.9%	43.0%	40.4%
Deprivation	Free school meals*	20.07%	16.61%	18.42%

Note:

*Percentage of pupils registered for free meals in 2009/10 (measured at school level; http://www.ltscotland.org.uk/scottishschoolsonline/schools/freemealentitlement.asp)

Table 2. Mean (M) and standard deviation (SD) of all constructs

	Range			Pre		Post	
			N	M	SD	M	SD
Attitude	1-4	Intervention	79	3.57	.42	2.99	.42
		Comparison	87	3.32	.52	2.79	.50
		Total	166	3.44	.49	2.98	.46
Subjective Norm	1-4	Intervention	79	2.91	.59	3.04	.65
		Comparison	87	2.58	.51	2.89	.62
		Total	166	2.74	.57	2.96	.64
PBC	1-4	Intervention	79	3.51	.59	3.24	.68
		Comparison	87	3.10	.69	2.82	.58
		Total	166	3.29	.68	3.02	.62
Intention	1-4	Intervention	79	3.32	.75	3.40	.70
		Comparison	87	2.98	.78	3.07	.83
		Total	166	3.14	.78	3.23	.78
Car/bus use habit	1-5	Intervention	79	2.02	1.39	1.73	1.13
		Comparison	87	2.62	1.32	2.34	1.33
		Total	166	2.34	1.38	2.05	1.27
Walking habit	1-5	Intervention	79	3.97	1.07	3.80	1.27
		Comparison	87	3.10	1.19	3.19	1.27
		Total	166	3.51	1.21	3.48	1.33

Table 3. Results of 2-way mixed factorial ANOVAs for each of the outcome variables.

		F	***P***	**η^2**
Attitude	Main effect (Pre-Post)	123.57	.01	.43
	Main effect (Intervention vs. Comparison)	5.17	.05	.03
	Interaction (Time and group)	7.58	.01	.04
Subjective Norm	Main effect (Pre-Post)	23.58	.01	.13
	Main effect (Intervention vs. Comparison)	8.89	.01	.05
	Interaction (Time and group)	3.592	.05	.02
PBC	Main effect (Pre-Post)	29.00	.01	.15
	Main effect (Intervention vs. Comparison)	23.80	.01	.13
	Interaction (Time and group)	.01	.91	.00
Intention	Main effect (Pre-Post)	2.51	.11	.02
	Main effect (Intervention vs. Comparison)	10.05	.01	.06
	Interaction (Time and group)	.01	.93	.00
Car/bus use habit	Main effect (Pre-Post)	12.66	.01	.07
	Main effect (Intervention vs. Comparison)	10.70	.01	.06
	Interaction (Time and group)	.00	.98	.00
Walking habit	Main effect (Pre-Post)	.09	.76	.01
	Main effect (Intervention vs. Comparison)	31.02	.01	.16
	Interaction (Time and group)	.98	.32	.01

CHAPTER SEVEN

General Discussion

This chapter provides a summary of the research area and the main findings from the four studies that are reported within the thesis. These findings are then discussed within a broader context regarding the overall contribution to a number of key research areas. These areas of discussion include: the application of theory, the conceptualisation of school travel as habit and the utility of the theory of planned behaviour (TPB). This chapter then discusses the practical implications of the findings in relation to the extent to which we are able to change children's travel cognitions and habits. The contribution of the thesis is then contextualised in relation to current research investigating behaviour and behaviour change in order to draw upon the importance of this thesis. Finally, the chapter highlights the implications drawn from the findings of the thesis in terms of research and practice and ends with a general conclusion.

Summary of the Research Area

The TPB (Azjen, 1991) has been used extensively in health psychology to understand and predict a wide range of behaviours (Conner & Sparks, 2005). However, a substantial proportion of the variance in behaviour, beyond the effect of intentions (conscious motivation), remains to be explained (Sheeran, 2002; Webb & Sheeran, 2006). Understanding why intentions do not always translate to actual behaviour is an important step towards improving the effectiveness of behaviour change interventions (Sheeran, 2002). As with many other popular socio-cognitive models of behaviour, the TPB fails to account for behaviour that is performed repetitively and automatically such as those that are habit. Previous attempts to extend traditional models of behaviour through the addition of habit have received criticism due to the way in which the construct of habit has been either conceptualised or operationalised (Somner, 2011). However, the availability of a measure of habit, the Self Report Habit Index (SRHI; Verplanken & Orbell, 2003), has allowed development in this field of research.

Habit has been described as a form of automaticity in responding, which develops as a person repeats a particular behaviour in stable circumstances (Aarts & Dijksterhuis, 2000a; Betsch, Haberstroh, & Hohle, 2002; Ouellette & Wood, 1998; Triandis, 1980; Verplanken, 2006; Verplanken & Aarts, 1999; Verplanken & Orbell, 2003; Wood, Quinn, & Kashy, 2002; Wood, Tam, & Wit, 2005). Travel behaviour is therefore likely to be under habitual control, at least to some extent, because journeys are typically characterised by both repetition (i.e. they are typically made repetitively) and situational stability (i.e. they take place at approximately the same time of day, have the same start and end points and typically constitute the same route; Garling, 1998; Kenyon & Lyons, 2003; Verplanken, Aarts & van Knippenburg, 1997). Researchers have demonstrated that travel behaviour can indeed be predicted through both reasoned and habitual processes (de Bruijn et al., 2009; Gardner, 2009). In the case of the school commute, this is also a journey that occurs frequently (i.e. every weekday) and in a stable context (i.e. same time and route) and may therefore also become habitual. The investigation of both reasoned and habitual processes is therefore important to this area of research. To date, this has not yet been performed. The research in this thesis is therefore the first to investigate this under-researched area.

Summary of Findings

This research presented in this thesis had four aims. Firstly, to explore methodological issues relating to the reliability and validity of a measure of habit and to explore the ambiguity surrounding the conceptualisation of the constructs. Secondly, to explore the reliability and validity of a questionnaire designed to measure the TPB constructs. Thirdly, to test the utility of the TPB and the addition of habit in relation to explaining school travel. And finally, to examine the extent to which these determinants of behaviour can be changed through a school-based intervention. These aims were addressed within four studies. A summary of each study follows:

Study 1. The first study demonstrated the first systematic investigation of habit in travel behaviour among primary school aged children. This was enabled through the development of a habit measure, the SRHI (Veplanken & Orbell, 2003). The SRHI uses 12 items across a number of proposed “features” (Verplanken & Orbell, 2003, p. 1317) including history of repetition, automaticity (lack of control, lack of awareness and efficiency) and expression of one’s identity. Results of the analyses in this study demonstrated the SRHI to have good internal consistency, test-retest reliability and external construct validity (i.e. known-groups validity evidence). Initial examination of the dimensionality of walking habit and car/bus use habit was performed using exploratory factor analysis (EFA). Results indicated that a one factor structure explained 60% of the total item variance in walking habit respectively and a one factor structure explained 74% of total item variance in car/bus use habit. Following these analyses, the dimensionality of walking habit and car/bus use habit was further examined using confirmatory factor analysis (CFA). These analyses made comparisons between a unidimensional and a multidimensional conceptualisation of both walking habit and car/bus use habit. Through these results a unidimensional conceptualisation for walking habit and car/bus use habit was concluded. These conclusions were arrived at through the results of the CFA and the consideration of the following: a) the proposed use as suggested in the development of the measure, b) the initial EFA analyses, and c) the principle of parsimony (Hair et al., 1998)

Findings from this study represent an important contribution not only to the active school travel literature, but to the wider area of habit research. The most prominent contribution is the availability of evidence concerning the dimensionality of habit which has been inconsistently conceptualised in previous research. For example, in the development of the SRHI, Verplanken and Orbell (2003) described habit being characterised by three unique "features". This was somewhat ambiguous and although the authors referred to habit as being defined by separate "features", and therefore potentially separate dimensions, the authors concluded that from the results of a principal component analysis, habit was in fact a one-dimensional construct. Despite this, subsequent applications of the SRHI had subdivided (and removed) scale items pertaining to individual "features". As a result, the use of the SRHI in this form was not supported by reliability and validity evidence. The research in this study has therefore made an important contribution by addressing the ambiguity surrounding the way in which habit has been conceptualisation and operationalised.

Findings from this study support the use of the SRHI to measure habit as a unidimensional construct. The availability of a measure of habit is considered an important development that enables researchers to calculate the extent to which children's school travel behaviour is habitual at a given point in time. Consequently, this means the habituation of a given behaviour can be monitored over time and differences between behaviours and between individuals can be examined.

Study 2. Given that a common focus of interventions lies within strategies designed to change cognitions (e.g. beliefs and goals), the investigation of these constructs is essential in order to examine the effectiveness of interventions and identify the processes by which interventions may work. Despite this, very few studies have examined the effectiveness of interventions at changing children's cognitions (Chillon et al., 2011). The investigation of active travel cognitions requires the availability of a psychometrically sound measure. The second study examined the internal consistency, test-retest reliability and internal construct validity of an adapted TPB questionnaire to measure travel cognitions. The questionnaire consisted of 15 statement items followed by a 4-point Likert scale that assessed attitude, subjective norm, perceived behavioural control (PBC) and intention. The format for the questionnaire was consistent with the guidelines provided by Fishbein and Azjen (2010) concerning standard measures of the TPB constructs. Results from this study demonstrated fair to acceptable reliability, good internal consistency, and supported the fit of a four-factor, correlated model. The questionnaire therefore provided an internally consistent, valid and easy-to-administer tool for assessing cognitions related to travel in 8 to 9 year old children. The availability of a practical and feasible method to assess child travel cognitions provides a valuable contribution to the area.

Study 3. The third study tested the extent to which habit strength augments the predictive validity of the TPB in relation to children's active school travel. The study used a prospective measure of school travel that was measured objectively using an accelerometer. The predictive utility of the TPB and habit strength in relation to both intention and subsequent behaviour were examined through the use of hierarchical multiple regressions. The results of this study found that the TPB significantly predicts children's active school travel and accounted for 41% and 10% of the variance in intention and objectively measured behaviour, respectively. Together, walking habit and car/bus use habit significantly increased the proportion of explained variance in both intention and behaviour by 6%.

The study was an important contribution to the wider evidence base on the TPB and habit because some of the key limitations that characterise previous research in other domains were addressed through the use of an objective measure. Conclusions drawn from these findings were important in highlighting the need to include both intentional and habitual processes when identifying the determinants of school travel behaviour.

Study 4. The fourth study evaluated the effectiveness of a school-based resource, called Travelling Green, in changing attitude, subjective norm, PBC, intention, walking habit and car/bus use habit. The study employed a quasi-experimental design and assessed outcome variables pre-post a 6-week intervention/control period. Findings from this study were somewhat disappointing in that significant group by time interactions were found for attitude and subjective norm in unexpected directions. Specifically, decreases in attitude were evident in both groups; however, this decrease was greater in the intervention than the comparison. Additionally, although both the intervention and comparison increased in subjective norm, the increase was greater in the comparison group than the intervention group. No significant interactions were found for PBC, intention, walking habit or car/bus use habit. However, of these variables, there were significant decreases in PBC and car/bus use habit and no significant changes in intention or walking habit. A number of possible explanations for these results were highlighted such as: a) large group differences in all of the pre-test outcome measures, in combination with b) ceiling effects for the intervention group, and c) potential seasonal effects of the winter intervention period on the efficacy of the intervention. Consequently, although it appeared that there were no beneficial effects of the intervention on outcome variables these results were not conclusive.

Contribution of the Thesis

This section of the general discussion examines the contribution of this thesis to a number of research areas in order to provide a broader perspective to the findings of this thesis. These areas include: the application of theory to understand behaviour, the investigation of habit in relation to children's travel behaviour, the utility of the TPB and the extent to which we are able to change children's travel cognitions and habit.

Application of theory. Broadly speaking, behaviour is complex and models designed to understand behaviour are deliberately simple (Brug, Oenema, & Ferreira, 2005). The use of theoretical models of behaviour allows for a pragmatic approach that can be workable in subsequent studies (Taylor, Bury, Campling et al., 2007). However, while this is true, there is often tension between the completeness of a model against its comprehensibility (Darnton et al., 2008). In this context, the sufficiency of the TPB has received considerable attention with the suggestions of additional constructs that might provide a useful addition (Eagly & Chaiken, 1993). Referring to this point, Azjen (1991) suggested that the model was indeed open to further elaboration stating that "the theory of planned behavior is, in principle, open to the inclusion of additional predictors if it can be shown that they capture a significant proportion of the variance in intention or behavior after the theory's current variables have been taken into account" (p. 199). In this context, it is argued that the extension of the TPB through the addition of habit not only provides an important acknowledgement and demonstration of the dual-processing evident in human cognition (Evans, 20008), but it also provides an increase in the understanding of inherently complex behaviours through an extension that can be empirically tested.

Understanding children's school travel habits. Researchers have been intrigued by habits for a long period of time, but the notion of habituation in children's behaviour has been relatively under-researched. The classic works in ecological psychology by Barker and Wright (1955) provided early evidence in terms of the rigid patterns and routines that exist in children's behaviour that can be observed in daily life. The investigation of habit in children, like that of adults, was however hindered by the methodological difficulties that existed in the measurement of habit (Chaiken & Eagly, 1993). This may have been further confounded in studies of child behaviour due to factors such as comprehension, IQ, and concentration that may have made earlier measures unfeasible. Additionally, prior to the development of the SRHI that enabled the present research, habit measurement relied on either the use of past behavioural frequency as a proxy for habit (Triandis, 1977) or upon script-based methods such as the response-frequency measure (Verplanken et al., 1994). Conceptually, the use of past behaviour as a proxy for habit was considered inaccurate (Verplanken, 2006). However, the use of alternative measures, such as script-based measures, was also considered unsuitable within a child population due to both conceptual and methodological reasons such as large sample size, longitudinal and school-based which make the use of script-based measures unfeasible and problematic. As a result, the examination of habit in children has received relatively less attention compared to that of adults and can only be currently observed in a handful of studies. To date, these have included the investigation of tooth brushing (Wind et al., 2005), physical activity (Kremers et al., 2008), and television viewing

(Kremers et al., 2006). The present thesis has therefore provided an important contribution to habit research in children by provided reliability and validity evidence for a measure of children's travel habit, by investigating the role of habit within the domain of active school travel, and by evaluating the extent to which a school-based intervention can change children's travel habit.

The utility of the TPB. Generally, the application of the TPB (study 3) was consistent with previous demonstrations within the literature. The TPB components accounted for a total of 41% of the variance in intentions, a figure that is slightly higher compared to the meta-analysis of health behaviours that found the TPB components accounted for 39% of the variance in intentions (Armitage & Conner, 2001). This figure is also similar compared to the results of previous studies investigating children's physical activity behaviour (i.e. Martin et al., 2007; Motl et al., 2002). In terms of the prediction of behaviour, a vast distinction in the area has been shown in terms of the prediction of subjective versus objectively-measured behaviour (Armitage & Conner, 2001). The results of study 3 were that 10% of the variance in behaviour could be predicted through the TPB variables. Therefore compared to objectively measured behaviour, this finding was slightly lower than that of the meta-analysis Armitage and Conner (2001) which demonstrated that 21% of the variance in behaviour could be accounted for through intentions. In terms of the prediction of children's physical activity behaviour, this finding was in line with previous research that has demonstrated the explained variance in behaviour to be between 8 and 10% (Martin et al., 2007; Trost, Saunders, & Ward, 2002).

The extension of the TPB with the addition of habit to the model increased the explained variance in both intention and behaviour. Firstly, walking habit and car/bus use habit increased the explained variance in intention by 6% and secondly, car/bus use habit increased the explained variance in behaviour by an additional 6%. With regard to the addition of habit to the model, the findings from study 3 therefore confirmed that school travel is controlled by both intentional and habitual processes. These findings were interesting given that both walking and car/bus use habit were significant predictors within the model but in different stages of the model. Firstly, walking habit (i.e. the target behaviour) and car/bus use habit (i.e. the counter behaviour) was, alongside PBC, evidenced as a direct predictor of walking intention, and secondly, car/bus use habit (i.e. the counter behaviour) was, alongside intention, evidenced as a direct predictor towards behaviour.

In terms of walking behaviour, no researcher investigating adult or child behaviour has incorporated a measure of habit (or even past behaviour as a proxy for habit) into the prediction of intention or behaviour. Therefore, while these findings demonstrate an important empirical contribution to the literature, the ability to contextualise these findings in relation to previous research investigating children's travel behaviour was not possible. However, studies that have applied the TPB to adults' walking behaviour have demonstrated that, like children's travel behaviour, neither subjective norm nor attitude significant predict intention (Eves et al., 2003; Scott, Eves, French, & Hoppé, 2007) and in fact, PBC is the strongest predictor of walking intentions (French et al., *In press*). Research investigating children's physical activity has suggested that, contrary to the prediction of children's travel behaviour, the strongest predictor of children's intention to be physically active is attitude followed by subjective norm (Martin et al., 2007; Motl et al., 2002). The failure of attitude and subjective norm to predict intention in the context of school travel suggested that, in the context of the TPB, walking to school is determined only by the child's perception of the control they have over the behaviour. Despite these findings appearing counter to the predictions of the TPB, Ajzen and Fishbein (2004) have clarified that the relative importance of each of the antecedents of intention are expected to vary from behaviour to behaviour and population to population and as a result, only one or two of the predictors of intention may be necessary in any given situation. Given this interpretation, the present findings were not necessarily unexpected.

In terms of the prediction of behaviour, the findings underscored the importance of habitual decision-making alongside conscious processes as discussed above. These findings therefore challenged the current theme of active travel interventions that focus on changing cognition as a route to changing behaviour. Instead, the findings suggested that behaviour change interventions should include both the establishment of the target behaviour, in this case walking, as a habit whereby the behaviour becomes automatic and no longer requires conscious effort. In addition, interventions should also include strategies that have been designed to break or disrupt counter-behavioural habits such as the use of the car or bus. Such findings represent an important contribution to the knowledge base concerning active travel promotion in children.

Overall, the recommendations for the inclusion of habit change strategies in active travel interventions represents an approach that is consisted with the perspective recently illustrated in the report commissioned by DEFRA and written by Darnton et al. (2011) that outlined strategies and policy considerations for policy makers and practitioners to incorporate effective techniques for bringing about habit change in a range of sustainable behaviours including travel.

Focusing on travel-related research, these findings differ from previous research that has investigated the interaction between reasoned and automatic decision making. For example, researchers investigating adult travel behaviour have demonstrated that the intention-behaviour relationship is moderated by habit (de Bruijn et al., 2009; Gardner, 2009; Verplanken, Aarts, van Knippenberg, & Moonen, 1998; Verplanken et al., 1994). For instance, where transport users display strong travel habits, motivation has no or little effect on behaviour. In contrast, where transport users display weak habits, intention is likely to guide behaviour. These researchers have therefore suggested that the reasoning processes that are outlined in the TPB are expected to occur only in a novel or unfamiliar situation where behaviour is unlikely to be governed by habit. Such findings have been explained by the presence of a "habitual mind-set" which refers to habitual behaviour being accompanied by an enduring cognitive orientation that makes an individual less attentive to new information and courses of action, and consequently contributes to the maintenance of the habitual behaviour (Verplanken & Aarts, 1999). In contrast, the failure to replicate the moderating effect of habit described in adult travel research within a child sample (study 3) suggested that, compared to adults, children's travel behaviour may be governed by both cognition and habit regardless of the habit strength. For example, the findings in study 3 demonstrated that intention was positively associated with walking to school and car/bus use habit was negatively associated with walking to school. Since these two factors were independent predictors of behaviour (i.e. no interaction was evidenced), these findings suggest that in contrast to adult behaviour, change in a child's travel behaviour can, to an extent, be achieved through strategies designed to either increase a child's intention to walk to school or strategies designed to break the habit of using a car or bus. Accordingly, unlike the "habitual mind-set" that has been observed in adults, children's behaviour is governed by both rational deliberation (intentional and conscious thought) and non-conscious automated processes (such as habit). These findings have highlighted the importance of intervention strategies that draw upon the unique role that both cognition and habit play in determining children's behaviour. These findings therefore provide an important contribution to the literature for researchers and practitioners interested in behaviour change.

Changing children's school travel cognitions. Schools are generally considered ideal settings for the promotion of physical activity behaviours such as active travel (Dobbins et al., 2009). This is exemplified by many factors including the ability to target large numbers of children at once, the lack of cost to families, and the controlled nature of the school environment. The promotion of active travel has been identified as a means for helping children to maintain physical activity and establish lifelong health habits (Telama et al., 2005). However, to date, school-based interventions promoting active travel have ranged in their effectiveness from a small to moderate effect size in changing behaviour (Chillon et al., 2011). Given that most active travel interventions rely predominantly on behaviour change achieved through changes in a child's cognition, it is important to understand the effect that interventions have on cognition. However, although a number of researchers have identified changes in parents' cognition, only one researcher has evaluated change in children's cognition (McKee et al., 2007). The study performed by McKee et al. (2007) investigated stage of change pre- and post- the implementation of an active school travel intervention (also Travelling Green). Results from the study of McKee et al. found that 71% of children in the experimental school progressed to a higher behaviour stage or remained in the "action" and "maintenance" stages compared with 52% of the control school, in relation to active travel to school. The movement towards the "action" and "maintenance" stages of change is considered to be a progression of an individual's readiness to adopt a healthy behaviour. Such changes may be bought about through a number of changes that may be either tangible or intangible, or at the cognition level and the behaviour level (Prochaska &

DiClemente, 1983). In theory, the general progression is often illustrative of an increase in behavioural intent. However, despite the positive effects of this previous evaluation of the Travelling Green resource in the McKee et al. (2007) study, the evaluation of Travelling Green in this thesis (study 4) failed to demonstrate any beneficial effects. This was somewhat unexpected given the conceptual overlap between the measures taken in the McKee et al. (2007) study and those taken in this thesis, particularly that of intention. Reasons for these differences could have been due to variations between the implementation of the intervention or sampling differences between studies. For example, these reasons include differences that existed between the implementation of the interventions in the two studies such as the length and timing (seasonality) of delivery. Additionally, differences between the school environments in the selected schools (i.e. urban/rural and/or area-level or individual-level deprivation) may have also contributed to the differences in these findings. Alternatively, these findings could have been a reflection of measurement differences. For example, although children's intention and their readiness to change may be considered to be comparable, the difference in these constructs (i.e. intention and readiness for change) and the way both constructs were operationalised may have attributed to the differences between the studies.

In terms of the research related to children's travel cognitions, the thesis has contributed in two major ways. Firstly, the presentation of the reliability and validity evidence in study 2 for the use of a questionnaire-based measure to assess children's cognition towards walking to school will enable further research that can examine cognitive change associated with active travel. This in turn can help identify the most effective ways of promoting positive attitudes towards active travel. Secondly, the findings from study 4 provided a valuable insight into the extent to which children's cognitions are influenced by a school-based intervention. Although, the findings from this study did not demonstrate the intervention to be effective in changing cognition, the discussion points that were raised in this study provide key considerations that will be insightful for future research and practice.

Changing children's school travel habits. Findings demonstrated that the intervention failed to have any beneficial effect on walking habit or car/bus use habit (study 4). Firstly, no change was found in walking habit. However, a significant decrease in car/bus use habit was found. According to Verplanken & Aarts (1999), intervention strategies designed to change habitual behaviour (i.e. either strengthen or break habits) should be based on techniques that utilise the nature of the construct of habit. For instance, the automaticity that is evident in habitual behaviour can be formed when behaviour is performed repeatedly in a stable context. Interventions aimed at encouraging individuals to develop a behaviour as a habit should therefore seek to ensure that the context in which the behaviour is being performed is sufficiently stable and that the behaviour is being performed sufficiently frequently. However, to date only one study, conducted by Lally et al. (2009), has directly examined the habit formation process. The findings from Lally et al. suggested that it takes, on average, 66 days to form a new habit. However, there was a marked variation in the time taken to form a habit between individuals and behaviours ranging from 18 days to 254 days (Lally et al., 2009). Behaviours that were considered to be more complex, for example exercising every day, took, on average, one and a half times longer to develop as habit than behaviours that were relatively simple such as eating and drinking. The findings of Lally et al. (2009) also provided empirical findings in terms of daily repetition and habit formation in that missing a single day did not reduce the formation of a habit. In total, the findings of Lally et al. (2009) may provide an important base for which to contextualise and understand the findings in this thesis. For example, based on the findings of Lally et al. (2009), it may be that the duration of the intervention in study 4 was insufficient to enable children to form or strengthen their walking habit. Although this is a plausible rationale, the ability to generalise the findings from Lally et al. (2009) are unknown given that the developmental process of habit may be substantially different in children compared to adults, and that the development of school travel as a habit may also represent a behaviour that is somewhat more complex than behaviours such as exercise that were targeted in the study by Lally et al. (2009). Overall, the thesis raises important considerations regarding the implementation of children's active travel interventions and the habit change. Given that little is known regarding the development of children's habit, the presentation of reliability and validity evidence for use of the SRHI in children (study 2) provides an important contribution to the literature that will enable researchers to pursue this area of research.

Concerning the disruption of habits, findings from study 4 suggested that the Travelling Green intervention was not effective in disrupting or breaking children habits. To date, a number of approaches have been identified to break or disrupt habits. Generally, these approaches have been designed to disrupt the flow of the context in which the behaviour is being performed. Such disruption is posited to interrupt the individual's automatic response and instead force the individual to deliberate over the behaviour (Verplanken et al., 2008). These approaches are therefore centred on providing techniques in which to increase the role of conscious deliberation and includes the following techniques: moments of change (Bamberg 2006; Thompson et al., 2011), change theory (Lewin, 1951), and implementations intentions (Gollwitzer, 1993, 1999; Gollwitzer & Sheeran, 2006). However, in terms of the Travelling Green resource, strategies that were included (see Appendix J) were not designed specifically centred on these techniques but were instead designed to meet a wide range of objectives and to be easily implemented in a number of schools. For example, given that the resource was made available for all schools in Scotland and administered through Local Authorities, it was essential that the resource was designed to coincide with the national curriculum, “Curriculum for Excellence” (Scottish Executive, 2004). As a result, the inclusion of strategies that were feasible and pragmatic solutions to active travel promotion was essential to enable the large scale implementation of the resource. Consequently, the findings raise the importance of identifying and including strategies that are designed to incorporate habit change techniques in order to improve the effectiveness of active travel interventions. Since this habit and habit change is a relatively under-researched area in children, further discussion is made later in this chapter concerning the research and practical implications of this issue.

Contextualising the Research

The inclusion of habit in traditional models of behaviour is underpinned by the recent accumulation and convergence of research evidence in psychology, sociology and neuroscience that has demonstrated the reliance of brain functioning on two separate systems thus offering a dual-process model to understand decision making (Vlaev & Dolan, 2009). These two systems consist of “System 1” processes that have been described as automatic, uncontrolled, effortless, associative, fast, unconscious and affective, and “System 2” processes that have been described as reflective, controlled, effortful, rule-based, slow, conscious and rational (Chaiken & Trope, 1999; Evans, 2008; Slovic et al., 2002). System 1, also referred to as the “automatic mind”, governs approximately 95% of our behaviour and oversees our biological functions and most of our daily behaviours (Lakoff & Johnson 1999). The predominance of this system is supported by social psychology research through the use of ecological studies that have provided evidence detailing the prevalence of automatic processes. For example, one such study, performed by Quinn and Wood (2006) using experience sampling diaries, found that approximately 45% of behaviours were undertaken in the same place almost every day and therefore highlights the prevalence of habitual behaviour. However, despite the evidence demonstrating the existence of both conscious and automatic decision-making processes, traditional models of behaviour such as the TPB, have focused narrowly on conscious (or intentional) processes. As a result, researchers within the area have acknowledged the need to extend traditional models of behaviours to include both intentional and automatic processes such as habit in order to increase their predictive explanatory power (Sheeran, 2002). The findings in this thesis therefore support this perspective of behaviour and demonstrate the examination of intentional and automatic processes in children's travel behaviour.

In terms of a broader perspective, the notion of a dual-process model of cognition has become an increasing focus and its significance is evidenced through both developments in the social psychology literature and through the direct influence of the theorisation in this literature on government policy making. This has been evidenced by a number of authors whose work has become increasing mainstream. The work of these authors include textbooks such as "Nudge" (Thaler & Sunstein, 2008), "Predictably irrational" (Ariely, 2008), "Habit: The 95% of the behavior marketers ignore" (Martin, 2008), and "The social animal" (Brooks, 2011). Generally, these authors have drawn upon the reasons why human beings may make non-rational decisions and highlight the limitations of traditional or orthodox models of behaviour. These authors have been highly influential and their perspective has been reflected in recent changes made to government policy making. For instance, in the UK, the coalition government formally recognised in the coalition agreement the need to incorporate the insights from behavioural economics and social psychology into policy making in a way that would ensure that policies adopt “intelligent ways to encourage, support and enable people to make better choices for themselves” (HM Government, 2010). In order to bridge the gap between the developments made in the academic literature and current policy making, and therefore ultimately enable government to incorporate the dual-process model of cognition into policy making, the government developed the Behavioural Insights Team (BIT) in the Cabinet Office. The BIT, anecdotally known as the “Nudge” department after the influential book by Thaler and Sunstein (2008), was established in July, 2010. The team is currently led by Dr David Halpern and comprises of civil servants and external expert advisers including the co-author of “Nudge”, Professor Richard Thaler. The work of the BIT is guided by an evidence-based framework, “MINDSPACE” (Dolan, Hallsworth, Harpen, et al., 2010), which provides a formalised set of guidelines for applying behavioural insights from the academic literature into public policy making. To date, the BIT has published several papers demonstrating the application of behavioural insights in a range of policy areas such as fraud, error and debt, energy efficiency, consumer affairs, health, and test, learn and control (Cabinet Office Behavioural Insights Team, 2010). The first report to apply behavioural insight to health was published in 2010 and included the discussion of public choices on matters such as food, smoking, alcohol, physical activity, travel and organ donation. In terms of children’s travel, the finding that children’s travel is guided by both conscious and habitual processes (study 3) highlights that the application of behavioural insight to travel policy-making may also be beneficial in changing children’s travel behaviour.

While the concept of nudging has stimulated significant debate in both policy and the research community concerning health behaviour change, the evidence to support the effectiveness of nudging as a means to improve population health and reduce health inequalities is weak (Marteau et al., 2011). According to a recent paper written by Marteau and colleagues this is reflective not only of an absence of evidence but also evidence of little or no effect. In this context, the authors highlight the need for further primary research and a synthesis of existing research to examine the effectiveness of nudging interventions. They also highlight that given the diversity of interventions which have been identified, further examination of nudging should seek to identify what works, for whom and in what circumstances. In addition to these issues raised, Marteau et al also discuss the possible harmful effects of nudging. According to these authors, it is possible that harm may arise from the perverse response to nudges. They illustrate this point using an example of the promotion of healthy eating, and suggest that, for example, labelling foods as healthy or making healthier side dishes the default can lead to a ‘halo’ effect which can result in an underestimation of energy content and subsequent excessive consumption.

Given that there is a need to increase the evidence base concerning how nudge may work to change behaviour, the adoption of an appropriate framework to classify and identify the components of behaviour change is needed in order to categorise the evidence and therefore build a strong evidence base for behaviour change. While there are a number of frameworks that exist, there has been little acknowledgement of the mechanisms that rely on the automatic motivation (i.e. ‘nudge’ style components) may work. A more recent method for developing and implementing behaviour change has been described by Michie, van Stralen and West (2011). The significant of this method, described as the Behaviour Change Wheel, in relation to interventions that rely on prompting automatic motivation, is that firstly both automatic and reflective behavioural systems are included and secondly, it recognises that the context is a key component to the effective design and implementation of behaviour change. This latter point is particularly significant given the inherent importance of context in relation to automatic and habitual behaviours. Thus future research that utilises this method can provide evidence to ascertain how interventions that incorporate ‘nudge’ may be designed and implemented in order to achieve effective behaviour change. Such incorporation into future research would therefore enable a stronger evidence base and identify what work, for who and under what conditions, an issue which has been raised in relation to the use of ‘nudge’ in behaviour change interventions.

Implications for Research and Practice

Measurement of children’s active travel cognition. A predominant focus of active travel interventions is the promotion of positive attitudes of the targeted behaviour, which, in turn, are hypothesised to result in behaviour change. To accurately determine the efficacy of such interventions, the potential mediators should be examined using reliable and valid instruments. The provision of a psychometrically sound measure to assess children’s attitude, subjective norm, PBC, and intention towards active travel should be used in future research. This measure will allow researchers to clearly identify the associations between hypothesised mediators and active travel. This will ultimately assist in developing more efficacious interventions by understanding and identifying how interventions work.

Measurement of children’s active travel habits. Future research should continue to investigate the habit strength of walking and car/bus use in relation to children’s school travel. The SRHI is a measure of habit that can be relatively easily incorporated into intervention research. Utilising habit measurement in interventional research could be beneficial to researchers for a number of reasons including: a) to monitor change; b) to identify children who are likely to benefit from active travel interventions; and c) to provide an indication of when an intervention has been successful (i.e. the target behaviour has become habitual and/or the counter-behavioural habit been broken). This latter point may be particularly important in ensuring the long-term effectiveness of an intervention.

Breaking and forming habit. Active travel interventions should go beyond educational and persuasion techniques and instead, include additional strategies that have been designed to develop walking as a habit and break or disrupt the habit of using the car or bus to travel to school. This could be achieved through the modification of existing interventions to accommodate such strategies or through the inclusion of additional strategies or components alongside existing interventions. One such way to modify existing interventions is the inclusion of significant contextual change. For example, since contextual cues triggers habitual behaviour (Aarts et al., 1997), a sufficient manipulation of the contextual cues of the behavioural context can disable the automatic cuing of behaviour and instead allow the role of reasoned decision making to become more dominant. Such manipulation could involve changes to the physical, temporal or social context. For example, physical change might involve changes to the parking legislation or road markings surrounding the school or temporal change might involve changes to the school start time. However, although strategies focusing on contextual change may offer a more effective solution to increasing active travel, such strategies can often be more difficult to implement. For instance, contextual change often requires a broader approach and an involvement at various levels such as the interpersonal, organisational, community or societal (Kok, Gottlieb, Commers, et al., 2008). In relation to school travel, choices and practices of travel as well as the school travel environment are often shaped by parents, school management, and local and national policy makers. Interventions designed to disrupt car/bus use habit may therefore need to consider multi-level factors. However, such an approach is not always possible and can often involve additional funding and require agreement between multiple stakeholders.

In contrast, the Travelling Green resource represents a more pragmatic and relatively cost-effective approach to promoting active school travel in that its implementation requires limited resources, little external funding, little input from external agencies, and is able to fit in with the national curriculum. With these considerations, the next section of this chapter provides a further insight into existing techniques used to either break or form a habit. The techniques discussed offer potential pragmatic and feasible solutions that can increase the effectiveness of existing active travel interventions. These techniques include contextual change, conscious-raising techniques and implementation intentions.

Contextual change. Habit change may be more effective when significant changes occur to the context in which a behaviour is performed (Bamberg, 2006; Thompson et al., 2011). This can be achieved at a moment of change which refers to an occasion where the circumstances of an individual's life change considerably within a relatively short period of time (Verplanken, Walker, Davis & Jurasek 2008). This concept has been outlined within the "habit discontinuity hypothesis" (Verplanken et al., 2008) and within the context of "teachable moments" (McBride et al., 2003; Ogden & Hills, 2008). The central premise is that a moment of change will cause a significant disruption to the context in which a habit is performed which will result in an increase in conscious decision-making (Verplanken et al., 2008). Concerning school travel, examples of moments of change may include the attending of a new school, environmental changes to the road or infrastructure surrounding a school, starting a new academic school year, or changes to parking or legislation in and around schools. In some instances, the implementation of an intervention to coincide with such changes can be achieved with little change to existing interventions and requiring little additional cost. However, although this form of habit change has previously proved successful in adults (Verplanken et al., 2008), no researcher has investigated the concept of moments of change within the context of school travel. As highlighted earlier, although the feasibility of such techniques needs to be considered, future research should include examining the effectiveness of such techniques in children.

Conscious-raising techniques. Another approach to habit change has been outlined in Lewin's three-step change model (Lewin, 1951). The three steps included in this model include "unfreezing", "move", and "re-freezing". The model is based on group values or norms and reflects the perspective that behavioural constancy is needed to maintain the integrity of the group and in doing so, self-identity. The first step in this theory is the "unfreezing", where individuals re-evaluate their behaviour and are motivated to recognise the need to change behaviour. Techniques that can be used in the unfreezing step include motivating individuals by preparing them for change, building trust with individuals and creating recognition for the need to change, and actively allowing individuals to recognise problems and allowing for solutions to be formed by the group. The second step, "move", refers to encouraging individuals to take action and become involved in the change process. The third step, which involves "re-freezing" the behaviour, is to stabilise the new behaviour and make the change permanent. This step is considered crucial in providing long-term behaviour change. According to the model, behaviour change is more effective when these processes are implemented in a group setting, for several reasons. Firstly, introducing a "public" commitment is suggested to increase the likelihood of maintaining the new behaviour. Secondly, working in a group of peers and sharing similar experiences is posited to help strengthen the subjective norm which, in turn, can encourage further change. Thirdly, it is expected that group members are able to support each other in making change and that this creates a greater sense of group success.

Lewin's three-step change model has been widely used to change a range of behaviours including health behaviours. The model has been applied in a commercial setting to change eating behaviour, for example Weight Watchers, and in peer-reviewed research to change travel behaviour (Nye & Burgess, 2008). Regarding school travel, the application of this model may also provide a useful strategy for achieving habit change in children. However, as with previously discussed habit change techniques, the application of this approach is yet to be examined in children. Particularly, given the suitability of this approach to school-based interventions (i.e. use of group work), future research examining the effectiveness of this model to change children's travel behaviour could provide useful findings.

Implementation intentions. Future interventions designed to modify unwanted habits may also consider the use of implementation intentions. Implementation intentions have been described as the "if-then" plans that specify when, where, and how an individual will strive towards a given goal (Gollwitzer, 1993, 1999; Gollwitzer & Sheeran, 2006). Implementation intentions are specific and take the format of "if opportunity Y occurs, then I will perform goal directed response Z!" (Gollwitzer, 1999). These plans have been effective in a wide range of behaviours including health (e.g. Sheeran & Orbell, 2000) and travel (Aarts & Dijksterhuis, 2000b). In a recent meta-analysis by Gollwitzer & Sheeran (2006) the use of implementation intentions demonstrated a positive effect of medium-to large magnitude on goal achievement. Concerning changing school travel behaviour, the inclusion of additional strategies might involve the specification of the exact times needed to wake up, get ready and leave the house in order to walk to school, planning of the walking route and crossing points, and organisation of how the walking will be performed, which might entail organising who is going to walk together, and the clothing and items that are required such as a rain jacket, umbrella, comfortable shoes. The application of implementation intentions provides a particularly attractive solution to school-based interventions given that the incorporation of such a technique could be cost-effective and easy to incorporate into existing interventions. Consequently, the effectiveness of such strategies should be addressed in future research

Conclusion

As with many other popular socio-cognitive models of behaviour, the TPB assumes that behaviour is the result of reasoned and conscious decision making. The TPB therefore fails to account for behaviour that is performed repetitively and automatically such as those that are habit. Previous attempts to extend the TPB to include habit have demonstrated inaccuracies in either the conceptualisation or operationalisation of the construct. The availability of the SRHI overcomes previous limitations (Verplanken & Orbell, 2003). However, although previously applied to examine the role of habit in adult travel behaviour, no researcher has applied the SRHI to understand children's travel habit. The research in this thesis therefore demonstrates the first empirical application of the SRHI to measure children's travel behaviour. The thesis provided reliability and validity evidence for the use of a TPB measure to assess children's travel cognitions. The findings from this research then enabled an investigation of the role of habit and cognition in relation to children's travel behaviour. The findings highlighted that children's travel behaviour is guided by both conscious and automatic decision making processes. As a result, the thesis underscored the need to incorporate strategies into active travel interventions that target change in habit alongside those that target change in cognition.

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LIST OF APPENDICES

Appendix A: Ethics form

UNIVERSITY OF STRATHCLYDE

APPLICATION FORM FOR UNIVERSITY ETHICS COMMITTEE AND DEPARTMENTAL ETHICS COMMITTEES

This form applies to all investigations (other than generic applications) on human subjects undertaken by staff or students of the University that fall within the scope of the University's Code of Practice on Investigations involving Human Beings. Such investigations may fall within the remit of the University Ethics Committee (see Code of Practice Section B1) or the Departmental Ethics Committees (see Code of Practice Section B2). However, this form should NOT be used for generic applications (there is a separate form for this) or any investigation involving clinical trials or the National Health Service (including staff, patients, facilities, data, tissue, blood or organ samples from the NHS). Applications for investigations involving the NHS must be made under the governance arrangements for National Health Service Research Ethics Committees (see Code of Practice Section B9) and where ethical approval is required from the NHS the form to be used is that issued by NRES.

The form should be completed in language that is understandable by a lay person. Please explain any abbreviations or acronyms used in the application. Guidance on completing this application form is attached in order to assist applicants and further information is available in the Code of Practice.

Information sheets for volunteers and consent forms to be used in the investigation must be submitted with the application form for consideration by the Committee. The

application will be judged entirely on the information provided in this form and any accompanying documentation – full grant proposals to funding bodies should NOT be attached. Applications which are not signed and/or do not include the required additional information (e.g. information sheet and consent form) will not be considered by the Ethics Committee and will be referred back to the Chief Investigator.

The form is designed for completion in Word, and should in any case be typed rather than handwritten. The grey-shaded text boxes on the form will expand to allow you to enter as much information as you require. If you have any difficulty filling out the form in Word, please contact Gwen McArthur in the Secretariat (ext 2472).

Please refer to the appended notes for guidance on how to complete the form.

PLEASE COMPLETE THE FORM IN BOLD TYPE FACE

Checklist of enclosed documents

Document	**Enclosed**	**N/A**
Participant information sheet(s)	☒	☐
Consent form(s)	☒	☐
Sample questionnaire(s)	☒	☐
Sample interview format(s)	☐	☒
Sample advertisement(s)	☐	☒
Any other documents (please specify below) **Letter to Head of Education at West**	☒	☐

Dunbartonshire Council	☐ ☐ ☐	☐ ☐ ☐

1. Chief Investigator (Ordinance 16 member of staff only)

Name: **Dr. David A. Rowe**

Status **Reader in Exercise Science**

Department: **Sport, Culture and the Arts.**

Contact details: Telephone: **0141 950 3712** E-mail: **david.rowe@strath.ac.uk**

2. Other Strathclyde Investigator(s)

Name(s): **Dr. Norah M. Nelson[1], Professor Nanette Mutrie[1], David McMinn[2], Katherine Ord[3], Rachel Edwards[3], Stacey Robertson[3], Stephanie Bryson[3], and Andrew Burnside[3].**

Status (e.g. lecturer, post-/undergraduate): **[1]Lecturer. [2]PhD Student, [3]Undergraduate dissertation student.**

Department(s): **Sport, Culture and the Arts.**

If student(s), name of supervisor: **Dr. David A. Rowe (McMinn, Robertson), Dr. Norah M. Nelson (McMinn, Ord, Edwards), and Professor Nanette Mutrie (Bryson, Burnside).**

Contact details: Telephone: **0141 950 3275, 0141 950 3137**

E-mail: **norah.nelson@strath.ac.uk, david.mcminn@strath.ac.uk,**

nanette.mutrie@strath.ac.uk, rachel.edwards@strath.ac.uk,

stacey.robertson@strath.ac.uk, stephanie.bryson@strath.ac.uk,

andrew.burnside@strath.ac.uk.

Details for all investigators involved in the study. No other investigators.

3. Non-Strathclyde collaborating investigator(s)

Name(s): N/A

Status:

Department/Institution:

If student(s), name of supervisor:

Contact details: Telephone: E-mail:

Please provide details for all investigators involved in the study

4. Title of the investigation:

Active commuting for primary school children; Pilot testing for the Travelling Green project.

5. Where will the investigation be conducted?

The data collection will occur at Kilbowie Primary School, Clydebank, West Dunbartonshire and the data analysis and write up will occur at the University of Strathclyde, Glasgow.

6. Duration of the investigation (years/months):

(Expected) start date: **January 2009, or following ethics approval, if this is later than January.**

(Expected) completion date: **April 2009**

7. Sponsor:

University of Strathclyde

8. Funding body (if applicable): N/A

Status of proposal – if seeking funding (please cross as appropriate):

In preparation ☐ **Submitted** ☐ **Accepted** ☐

Date of submission of proposal: **Date of start of funding:**

9. Objectives of investigation:

(including the academic rationale and justification for the investigation)

Regular physical activity contributes to the prevention of several chronic diseases associated with a risk of premature death (US Department for Health and

Human Services, 1996; Warburton, Nicol, & Bredin, 2006). Furthermore, physical activity in youth promotes healthy growth and development of the musculoskeletal and cardio respiratory systems, and provides opportunity for social interaction, achievement and mental well-being (Department of Health, 2004). Sadly, many children are not meeting the current Scottish physical activity recommendations of accumulating 1 hour of moderate intensity physical activity on most days of the week (The Scottish Executive, 2003) and are therefore missing out on the benefits to be reaped from regular physical activity.

Active travel (for example walking and cycling) to school provides an ideal opportunity for children to contribute to the recommended 1 hour of daily physical activity (Boarnet, Anderson, Day, McMillan, & Alfonzo, 2005; Tudor-Locke, Ainsworth, & Popkin, 2001). It has been shown that children who travel actively to school have higher levels of physical activity (Cooper, Page, Foster, & Qahwaji, 2003) and are more likely to meet the physical activity recommendations than those who travel by inactive modes such as the car, bus, or train (Davison, Werder, & Lawson, 2008). Fewer children are walking to school than in the past and there has been a marked increase in the number of children being driven (McKee, Mutrie, Crawford, & Green, 2007). In an attempt to encourage active travel to school, several interventions/ programmes have been designed (McDonald, 2007). Preliminary investigations suggest that these interventions/programmes may increase physical activity levels amongst children (Lee, Orenstein, & Richardson, 2008).

One such intervention is ‘Travelling Green’, a curricular resource aimed at encouraging children to walk to school rather than taking inactive modes of transport. ‘Travelling Green’ was developed by West Dumbartonshire council and NHS Greater Glasgow between 2001 and 2005, and has subsequently been made available to every

school in Scotland. The resource comprises of a teacher pack containing 13 lessons encompassing Health and Wellbeing, Science, Social Studies, Expressive Arts, Technologies and Languages, which fits well with the new 'Curriculum for Excellence'. In addition to the teacher pack, the resource contains various materials for children, including Pupil Information Guides, My Travel Challenges, Chart Your Progress to School, Chart Your Progress Home/Guides for parents, and Fluorescent/Reflective Stickers. The resource also contains activity sheets to be used in the classroom and a Child Questionnaire designed to gather information on children's travel habits, barriers and facilitators to active travel.

An initial evaluation of this resource found a significant increase in the distance walked to school and a significant decrease in the distance driven after receiving the intervention (McKee, Mutrie, Crawford, & Green, 2007). However, this study was limited by the absence of objective measures of physical activity, the absence of 'follow up' measurements to assess the lasting impact (maintenance) of the intervention, and failed to identify the mechanisms by which the intervention changed behaviour. In addition, this evaluation failed to identify determinants of active travel in children. Studies of a similar nature have been limited by a lack of control groups and the use of cross sectional designs, which doesn't allow for the identification of the determinants of active travel in children (Lee, Orenstein, & Richardson, 2008).

The limitations stated above highlight the need for a more comprehensive evaluation of the 'Travelling Green' resource. This evaluation should address the limitations of the initial evaluation and therefore aim to objectively measure children's physical activity, investigate the mechanisms by which the intervention changes behaviour, and be designed in such a way that identifies the determinants of active

travel in children. It is proposed that a study meeting these aims will be carried out using control groups and intervention groups in a 'quasi-experimental' design. The study will be guided by the RE-AIM tool. RE-AIM is an evaluation framework that expands the assessment of interventions beyond efficacy (effectiveness) to include other criteria that may better identify the translatability and public health impact of a given intervention. It has been suggested that the translatability and public health impact of health enhancing interventions is best evaluated by examining all five of the following dimensions; Reach, Efficacy, Adoption, Implementation, and Maintenance (Glasgow, Vogt, & Boles, 1999).

Social Cognitive Theory (SCT) will be used as the overarching psychological framework to understand behaviour in this study. SCT explains human behaviour as a reciprocal interaction of personal, behavioural and environmental factors (Bandura, 1977), therefore acknowledging that personal and environmental factors play a role in shaping physical activity behaviour.

In order to carry out this comprehensive evaluation, methods and measures must first be identified and piloted for two key areas; i) active travel itself, and ii) the determinants of active travel. Both of these areas have been identified in the literature as being important aspects in the study of active travel in children (Mackett, Brown, Gong, Kitazawa, & Paskins, 2006; Panter, Jones, & Van Sluijs, 2008).

The aim of this study is therefore, to identify and pilot appropriate methods and measures for children's active travel to school, and the determinants of active travel in children, with a view to using these methods in a larger scale 'quasi-experimental' evaluation of 'Travelling Green' using intervention and control groups.
(Note: Ethical approval will be sought separately for the larger scale evaluation.)

10. <u>Nature of the participants</u>:

Are any of the categories mentioned in Section B1 (b) (participant considerations) applicable in this investigation?

<u>Yes</u> No

If 'yes' please detail: **Participants will be children under the age of 12, and therefore informed consent must be sought from a parent/guardian.**

Number: ***n* = 39 primary 5 children** Age (range): **9-10 years**

One parent or guardian for each child (*n = 39)*.

The proposed location for the study is within a school in West Dumbartonshire. Before any research can be conducted with schools in this area, permission must first be granted by the Head of Education in West Dumbartonshire Council. A letter seeking permission from the Head of Education can be found in Appendix A. Recruitment will be conducted by means of convenience sampling. A school from West Dumbartonshire (Kilbowie primary) will be contacted and asked if they are willing to participate in the study. Children in two primary 5 classes will have the study explained to them and given information sheets to read (Appendix B) and consent forms to sign (Appendix D). The child information sheet has been written using age appropriate language. Parent information sheets (Appendix C) and consent forms (Appendix D) will also be given to the children to take home. Those participants who return signed consent forms will constitute the sample for this

study; there is a maximum of 39 child participants (this is the total number of primary 5 pupils in Kilbowie School). Parents will be asked to fill in a questionnaire as part of the study, and will therefore be considered study participants. Parents signed consent will be given for both themselves and their child.

With regard to exclusion criteria, the parent questionnaire in this study asks the parents 'Does your child have any illness, health problem or disability that limits their ability to walk to and from school?' If the answer to this question is 'Yes', the child will be allowed to participate but their data will not be used in the study as the determinants of their behaviour may be different or confounded by their condition.

11. <u>What consents will be sought and how</u>?

Permission to conduct the study in West Dunbartonshire will be sought from the Head of Education in West Dunbartonshire council (See appendix A for letter). In addition to this, approval to conduct the study will be sought from the head teacher of the school in which the study will take place. Finally, written parental consent and consent from the participants will be obtained before any data collection takes place (See Appendix D for consent form).

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12. <u>Methodology</u>

Are any of the categories mentioned in the Code of Practice Section B1 applicable in this investigation?

Yes ☐ No ☒

If 'yes' please detail:

Design: what kind of design/research method(s) is/are to be used in the investigation?

The proposed study will use a cross sectional design, with a sample of approximately 39 primary five children and approximately 39 parents/guardians. The sample size in this study has been predetermined by the available number of primary 5 pupils in the selected school. However, it is recognised that the sampling variability of parameter estimates stabilises around a sample size of N = 30, thus the proposed sample size in this study is appropriate to ensure that the data provide trustworthy estimates of the parameters (means, correlations, etc.). Both quantitative and qualitative methods will be used in the data collection process.

Techniques: what specific techniques will be employed and what exactly is required of participants?

Three main forms of data collection will be used in this study.

1. **Objective measures of physical activity consisting of two activity monitors and a Global Positioning System (GPS) tracking device.**
2. **Child and parent questionnaires to assess the personal and environmental correlates of active travel, child self efficacy, and street connectivity.**

3. Focus groups with child participants, to get a better knowledge of their views on active travel.

<u>1. Objective Measures</u>

Participants will be asked to wear an elastic belt containing two physical activity monitors (New Lifestyles NL-1000 and an ActiGraph GT1M accelerometer) and a GPS tracking device (Trackstick Super) on their journey to and from school over 5 days. The New Lifestyles NL-1000 (New Lifestyles, Inc. Lee's Summit, MO.) is an innovative and affordable (≈ £30 per unit) motion sensor, based on a piezoelectric accelerometer mechanism. In addition to the standard function of recording steps, the NL-1000 has a function that has been labeled the MVPA™ Timer. This function records the accumulated time spent in physical activity of at least moderate intensity; it has been suggested that activity of moderate intensity is more beneficial to health than light intensity (American College of Sports Medicine, 2001; US Department for Health and Human Services, 1996). There is little validity evidence available for the use of the NL-1000 MVPA™ Timer in the school setting, and no available evidence for its use as a measurement tool for active travel to school in children.

The Actigraph GT1M (Actigraph, Pensacola, FL) accelerometer is a validated and accurate measure of physical activity (Freedson, Melanson, & Sirard, 1998; Ward, Evenson, Vaughn, Rogers, & Troiano, 2005) and will be used as a criterion reference during this study. One of the aims of this study is to provide validity evidence for the NL-1000 activity monitor for use with primary five children in the school travel setting by comparing its data on physical activity intensity to data from the 'gold standard' GT1M accelerometer. This validation work will be carried out with a view to using the NL-1000 in the final evaluation of 'Travelling Green'.

The GT1M accelerometer will also be used in conjunction with the GPS device, Trackstick Super (Telespial Systems Inc., CA), to identify where activity occurs on children's journey to and from school. Few studies have used GPS in conjunction with accelerometry and it has been suggested that more research regarding how to complement accelerometry with GPS data is necessary (Rodriguez, Brown, & Troped, 2005). GPS data on children's movements gathered in this study will be accessed solely by the researchers named on this form, and will not be available to any other party.

2. Questionnaires

Three questionnaires have been developed for this study, two child questionnaires and one parent questionnaire. The primary aim of the questionnaires is to gather important information on the association between various personal and environmental factors identified by Panter et al. (2008) and children's active commuting to school. Panter et al. (2008) developed a conceptual framework for the determinants of active travel in children; this framework has been used to guide the development of the three questionnaires. Items have been developed and included in the questionnaires that Panter et al. (2008) have identified in their framework. By doing this, no important determinant of active travel should be left out. Both child questionnaires and the parent questionnaire have been compiled using adapted items from the following questionnaires used in previous studies; Child Questionnaire from Travelling Green resource, Traffic and Health in Glasgow Questionnaire (Medical Research Council, 2005), and the 'Active Where' Parent-Child Survey 1 (Forman et al., 2008).

Child Questionnaires (Appendix E and F)

Children will fill in a questionnaire asking them about their travel habits to school, what they feel the barriers and facilitators to active travel to school are for them, what they feel the benefits of active travel to school are, their preferred mode of transport, preferred travel companion, their feelings about the local environment, and questions on their self efficacy to overcome barriers to active travel.

The child questionnaire has been designed in two formats, a 3 point 'Likert' scale response (Appendix E) and a 'Tick' response (Appendix F). The sample of participants will be split into two groups, one group will fill in the 'Likert' response questionnaire, and the other will fill in the 'Tick' response questionnaire. Participants will be observed filling in the questionnaires and the researchers will note any difficulties that the children have filling in the questionnaires. Using two formats will allow for a choice to be made on which one is most suitable for use in the final evaluation of 'Travelling Green'.

Both child questionnaires elicit the same information from the participants, the only difference being that the 'Likert' response questionnaire will indicate the importance of each response, whereas the 'Tick' response will only indicate certain important factors in relation to the participants' journey to school, however, the importance of each factor will not be evident. A 3 point Likert scale has been selected because it has been suggested that children may not have the cognitive ability to understand a 5 point Likert scale (Feltz, Short, & Sullivan, 2008; Saunders et al., 1997).

The test- retest reliability of each questionnaire will be assessed with subgroups of participants. A short time period (1 week) between initial completion of the questionnaires and a second completion will be used so that there isn't time for participant's circumstances to change dramatically, thus effecting reliability results.

Parent Questionnaire (Appendix G)

One parent/guardian for each child participant will be asked to fill in a 'Parent Questionnaire' developed specifically for this study. The parent questionnaire seeks to gain information on their child's demographics, including name, age, and sex. The parent questionnaire also gathers information on the child's health status, decision maker regarding whether child walks to school, child's ethnicity, family socioeconomic situation, distance from school, child's usual mode of transport and who they travel with, parent's perceptions of the barriers and facilitators to their child's active transport, perceived benefits of active transport, and what would make walking to school better for their child. Questions will also be asked regarding how parents would prefer their child travelled to school and who they would prefer them to travel with, parent's feelings about living in the local area, parent's self efficacy of their child's ability to overcome barriers to active travel to school, and questions on street connectivity in the surrounding area.

3. Focus Groups

Finally, two focus groups of child participants will be formed to provide more in depth information on their views of active travel. Group 1 will comprise of 8-10 children who walk to school and group 2 will comprise of 8 -10 children who are driven to school. Once we have established who walks regularly and who is driven regularly, a random sample of 8-10 will be taken from each population using the SPSS random function. Two researchers will be present during the focus groups, one as facilitator and one as note taker, the class teacher will have the opportunity to be present.

13. Data collection, storage and security:

Electronic data e.g. Actigraph GT1M files and GPS files will be collected and stored on a password protected computer at the Jordanhill Campus, University of Strathclyde Glasgow, and will only be accessed by the named investigators. Data in hard copy form e.g. completed questionnaires will be stored in a locked filing cabinet, only able to be accessed by the named investigators. To ensure participant anonymity, each participant will be assigned an identification code. A list of identification codes and corresponding participant names will be kept separate from the data.

Will anyone other than the named investigators have access to the data? If 'yes' please explain. **No**.

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14. <u>Potential risks or hazards:</u> Participants will face no additional risk or hazard to those inherent in their normal journey to school.

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15. Ethical issues

Part of the study will be carried out using participants under the age of 12; therefore parental written consent will be required. Additionally, parental consent will be required for their participation in the study. Any individuals for whom consent is not received will be ineligible to participate in the study.

Parents will be assured that any information from both them and their child will be kept confidential, and that no one will be able to identify them in the final

write up of the results. Each participant will be assigned an identification number that will ensure their anonymity. A list of names and identification numbers will be kept separate from the data in a secure place.

All data will be kept locked in the University of Strathclyde on a password protected computer, managed by the postgraduate student, David McMinn. Only the researchers in this study will have access to this data, and all undergraduate students will return data to David McMinn at the end of their dissertation period.

In keeping with the Data Protection Act 1998, data will be stored for no longer than is necessary for the attainment of the purpose for which it is held; in this case, until the completion of David McMinn's PhD thesis.

GPS systems will track the movements of children to and from school and it is recognised that this may raise concerns amongst some parents, however, there is no obligation for parents to give consent for their child if they have any reservations about the study. It should be noted that similar studies using the same techniques have been conducted (Mackett, Brown, Gong, Kitazawa, & Paskins, 2007; Rodriguez, Brown, & Troped, 2005). Participants will be reassured that the data will not be shared with others, will only be used for this research, and will be anonymised so that individual children's journeys will not be identifiable in any reports.

Participants will have approximately £350 worth of equipment to measure physical activity in their possession, and it should be acknowledged that there is a risk of theft or loss of this equipment. However, the equipment will not put participants at risk of any personal harm. The devices may be concealed under clothing to reduce risk. Other researchers have used similar devices with children in the UK and reported no cases of loss or theft (A. Jones, University of East Anglia. Personal communication).

16. Any payment to be made:

No payments will be made to the participants. However, reflective SUSTRANS armbands will be given to participants as a token of appreciation for their involvement in the study. Participants will be expected to return all equipment at the end of the study.

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17. What debriefing, if any, will be given to participants?

Participants will be given the opportunity to express how they felt about being involved in the study, or ask any questions about any aspect of the study.

18. How will the outcomes of the study be disseminated? Will you seek to publish the results?

The study results will be used in five undergraduate dissertations and will provide the pilot data for David McMinn's PhD thesis. There is the possibility of the results being published in peer reviewed journals and presented at academic conferences in the form of poster presentations and/or oral presentations.

19. Nominated person (and contact details) to whom participants' concerns/questions should be directed before, during or after the investigation.

Dr. David A. Rowe; 0141 950 3712, david.rowe@strath.ac.uk

Dr. Norah M. Nelson; 0141 950 3275, norah.nelson@strath.ac.uk

David McMinn; 0141 950 3137, david.mcminn@strath.ac.uk

20. Previous experience of the investigator(s) with the procedures involved.

Dr. Rowe has considerable experience in the objective measurement of physical activity in children and Dr. Nelson has experience in school based research and active travel behaviour. David McMinn has previously collected data in the school setting using some of the measures proposed in this study.

21. Chief Investigator and Head of Department Declaration

I have read the University's Code of Practice on Investigations involving Human Beings and have completed this application accordingly.

Signature of Chief Investigator

Please also print name below

David Rowe

Signature of Head of Department Please also print name below

……………………………………………

Date:

22. <u>Head of Department statement on Sponsorship</u>

(NB - only for University sponsored projects under the remit of the DEC with no external funding and no NHS involvement)

This application requires the University to sponsor the investigation. I am aware of the implications of University sponsorship of the investigation and have assessed this investigation with respect to sponsorship and management risk. As this particular investigation is within the remit of the DEC and has no external funding and no NHS involvement, I agree on behalf of the University that the University is the appropriate sponsor of the investigation and there are no management risks posed by the investigation.

If not applicable, cross here

Signature of Head of Department   Please also print name below

……………………………………………

Date:

* *

For applications to the University Ethics Committee the completed form should be sent (electronically with signed hard copy to follow) to Louise McKean or Lynda Frew in Research and Innovation in the first instance.

Appendix B: Management Risk Assessment and Sponsorship

UNIVERSITY OF STRATHCLYDE

Research and Innovation

Management Risk Assessment and Sponsorship

The Code of Practice on Investigations involving Human Beings requires that all investigations involving humans as subjects should be subject to management risk assessment as well as ethical scrutiny. For those projects that fall within the remit of the University Ethics Committee, and/or involve the NHS, and/or are externally funded then this form should be completed and returned to Research & Innovation.

1. Chief Investigator: Dr David Rowe

2. Project Title: Active commuting to primary school; pilot testing for the Travelling Green project.

3. Is it proposed the University will sponsor of the project (i.e. have responsibility for overall management of the project)?

   Yes _X___ No ______

   If no, who is the Sponsor? ………………….

4. Are you aware of any issues relevant to the University's insurance cover? For example is this a clinical trial and/or are you offering no-fault compensation to volunteers?

   Yes ______ No __X__

   If yes, what are those issues? ………………

5 Are you aware of any issues relevant to the University's assessment of management risk of this project? Please see attached for examples of possible management risk issues.

   Yes ______ No __X__

   If yes, what are those issues? ………….

Signature of Chief Investigator: D.A. Rowe

Date: 19/01/2009

For projects that fall within the remit of the University Ethics Committee, and/or involve the NHS, and/or are externally funded please send this completed form with the appropriate ethics application form to Anne Muir, Contracts Managers, Research and Innovation.

MANAGEMENT RISK ASSESSMENT ISSUES

When considering management risk Research and Innovation and Senior Officers will consider factors including but not limited to the following.

1. Risk to reputation of University and risk of litigation and/or insurance claims.

This risk maybe caused by

- harm to volunteers and wider community,
- poor research strategy,
- breach of statutory framework or contractual obligations,
- project not being carried out according to protocol,
- inadequate or inappropriate insurance cover.

2. Risk to research completion.

This risk maybe caused by

- failure to properly carry out research,
- failure to proper supervise students,
- inadequate resources and/or facilities,
- inexperienced staff.

3. Risk to dissemination and use of research results.

This risk maybe caused by lack of resources or failure to identify and act upon intellectual property in results.

4. Risk to researchers – career and reputation.

This risk maybe caused by misconduct or non-completion of research.

The management risk assessment will consider the University's context. In particular,

- Research and Development Strategy, including the objective of the University in general, and the objective of University research generally and within the relevant faulty/department.
- Research and Development Structure and Systems. In particular the support provided by the University's structure to reduce the risks posed by research and by this project, and the systems in place to monitor and respond to the risks.

Appendix C: Information sheet for child

University of Strathclyde
Education

Project Information sheet for Child

Study title: Active commuting for primary school children; Pilot testing for the Travelling Green project.

What is the study about?

We want to find out if you walk to school. We also want to know what you think about walking to school.

At the University Of Strathclyde before any project starts it has to be checked by university staff. They make sure that the research is OK to do. The University of Strathclyde Ethics Committee has said that the study is OK to do.

Do you have to take part?

No. It is your choice if you take part in the project or not. We will not be upset if you choose not to take part.

If at any time during the project you feel that you don't want to continue then you can tell the researcher to stop. You do not have to give a reason.

What will you do in the project?

You will be asked to do two things in this project.

- The first thing will be to wear a belt with 2 small gadgets on it and carry another small gadget in your bag. These gadgets will let us know how much walking you do, and if you walk, what route you take. You will be asked to wear the belt and carry the other gadget in your bag on your journey to and from school on 5 days.

- The second thing you will be asked to do is fill in a sheet about your journey to and from school. The sheet will ask about things that might stop you walking to school, and things that would make walking to school better. Students from the University of Strathclyde will be in your classroom to help you fill in the sheet if you find it hard.

- Your parent or guardian will also be asked to fill in a sheet. They will answer questions like the ones you will answer.

Why have you been asked to take part?

You are the age that we are interested in studying. Your school has also been kind enough to let us come in and do the study with you.

What are the possible risks to you in taking part?

There will be no extra risk involved in this study, only the usual risks of going to and from school. The belt with the gadgets on it will be easy to wear.

What happens to the information in the project?

All the information which is collected about you in the project will be kept private. No one will know that the information belongs to you. All the information will be kept at the University Of Strathclyde.

Thank you for reading this sheet. Please ask any questions if you are unsure or confused about what you have read.

What happens next?

- If you are happy to be involved in the project. You will now need to take the consent form and information sheets home to your parent/guardian. There is a sheet for them to read which tells them about the project and a form for both of you to sign and return to the school.
- If you do not want to take part in the project then thank you for your time.

Who can you contact if you have any questions about the project?

Dr. David Rowe

Department of Sport, Culture, and the Arts

University of Strathclyde

Jordanhill Campus

76 Southbrae Drive

Glasgow

G13 1PP

david.rowe@strath.ac.uk 0141 950 3712

Who can you contact if you have a complaint about the project?

University of Strathclyde Ethics secretary: ethics@strath.ac.uk 0141 548 2752

Appendix D: Information sheet for parents/guardians

Department of Sport, Culture and the Arts/Creative and Aesthetic Studies

University of Strathclyde Education

Project Information sheet for Parents/Guardians

PLEASE READ THE FOLLOWING CAREFULLY

Study title Measuring physical activity levels of children on their journey to and from school.

What is the study about?

Regular physical activity can help children be healthier. One way for children to take part in physical activity is for them to walk to and from school. Your child has been asked to take part in this study because we are interested to find out how active primary 5 children are when travelling to and from school. We are also interested in finding out what factors might stop them from or encourage them to walk to school. We are hoping that two primary 5 classes will be involved in this study, approximately 60 children.

Does your child have to take part?

No. Participation in this project is entirely voluntary and it is up to you and your child to decide whether or not they take part. You are both free to withdraw from the research at *any time and without giving a reason. Whatever decision you make will not affect your child's education.*

What will your child be expected to do?

Your child will be asked to take part in two main activities.

- The first of these is to wear an elastic belt around their waist which will contain 3 small pieces of equipment, two pedometer like activity monitors, and one GPS tracking device. These pieces of equipment will tell researchers how active your child is when travelling to and from school and where their activity occurs. The pieces of equipment will cause no discomfort to your child. Your child will be asked to wear the elastic belt with the pieces of equipment on their way to and from school on 5 days.

- The second activity that your child will be asked to do is to fill in a questionnaire about their journey to and from school. The questionnaire will ask them about things that stop them walking to school and things that would make walking to school better. The questionnaire will take approximately 30 minutes to fill in and researchers from the University of Strathclyde will be in the classroom to help them.

- In addition, one of the child's parents or guardian will be asked to fill in a similar questionnaire that will ask about their child's journey to and from school. The questionnaire will ask similar questions to the questionnaire filled in by the child. If you need any help filling in the questionnaire, a researcher can be made available at the school to help.

After the study has finished, your child and their school will be thanked for taking part. The results from the study will be used for a PhD project and 5 undergraduate dissertations.

What has your child been told about the study?

Your child has been given a description of the study and what it involves. They have had the opportunity to ask questions about the study directly to the researcher.

What are the potential risks to your child by taking part?

Other than the risks your child usually encounters whilst travelling to and from school, there will be no added risk.

Who can you contact if you have any questions about the project?

Dr. David Rowe

Department of Sport, Culture, and the Arts

University of Strathclyde

Jordanhill Campus

76 Southbrae Drive

Glasgow

G13 1PP

david.rowe@strath.ac.uk

0141 950 3712

Will your child's participation in the research project be kept confidential?

Yes. The information collected from your child in connection with this project will remain confidential during the duration of the study and after its completion. All records will be stored at the University Of Strathclyde with signed consent forms stored separately. The publication of the results will not result in your child being identified with particular responses.

Who can you contact if you have a complaint about the project?

If you have any complaint about the way you or your child have been treated during the project or any harm that your child has encountered as a result of involvement in the project the please contact Dr. David Rowe, Department of Sport, Culture and the Arts, University of Strathclyde, 76 Southbrae Drive, Glasgow G13 1PP. tel: 0141 950 3712. Email: david.rowe@strath.ac.uk

What happens next?

- If you are happy for your child to be involved in the process we would ask you to countersign the consent form with your child and return it to the research team.
- If after reading this information you do not wish your child to take part you do not have to do anything – Thank you for your time

This study was granted ethical approval by the Departmental ethics Committee on the [fill in the date]

Appendix E: Teacher Information Sheet

Travelling Green: 6 and 12 months Data collection

Teacher Information Sheet

What is the Travelling Green?

Travelling Green is a 6 week curricular resource that aims to encourage children to walk to school. We are interested to find out how children's activity levels change after taking part in Travelling Green. We are also interested in finding out what factors might stop them from or encourage them to walk to school. We are particularly interested in the long term (6 and 12 months) changes in behaviour and attitudes following Travelling Green.

Where are we now?

The Travelling Green resource was delivered to you class in the last academic year in June. We now require two weeks of data collection at 6 and 12 months following the delivery of Travelling Green. The data collection is relatively simple and the activities involved are outlined below.

What will your class be asked to do?

Your class will be asked to take part in three activities.

The first of these is to wear an elastic belt around their waist which will contain 2 small devices called activity monitors. These devices will tell researchers how much each child walks. The devices will cause no discomfort to the child. The children have already worn the elastic belt with the devices one week before and after taking part in Travelling Green, and are now required to wear one for the 6 months follow up (Oct/Nov 2010) and the 1 year follow up (June 2011).

The second activity that the class will be asked to do is to fill in a questionnaire about their journey to and from school. The questionnaire will ask them about things that stop them walking to school and things that would make walking to school better. The questionnaire will take approximately 30 minutes to fill in and researchers from the University of Strathclyde will be in the classroom to help them. The children have already filled in the questionnaires one week before and after taking part in Travelling Green, and are also needed to fill one for the 6 months follow up (Oct/Nov 2010) and the 1 year follow up (June 2011).

The third activity that the class will be asked to do is to complete a travel diary every morning on arrival at school. This is an easy task and should only take a couple of minutes. We will provide the diaries and each child must record the time they arrived at school and the mode of travel they used.

In addition, we will ask each child’s parents to fill in a similar questionnaire that will ask about the child’s journey to and from school. The questionnaire will ask similar questions to the questionnaire filled in by the child.

What has the class been told about the study?

All the classes involved in the study have been given a description of the study and what it involves. They have had the opportunity to ask questions about the study directly to the researcher.

We have received parental consent from all children in the study prior to the initial data collection. All parents are therefore aware of the requirements of the study in terms of the questionnaires, travel diaries and the devices which the children are required to wear.

What will be involved in the testing week?

On the Monday the team of researchers including myself, my co-manager (David McMinn) and researchers from the university will visit the class for approximately an hour. We will take a few moments to introduce the team to the class and remind the children what is involved in the project and what we require from them. They will also have a chance to ask questions at this point. We will then supervise the class while they complete the questionnaire. Once they have completed the questionnaires each child will then receive their activity belts. They will also receive the parent questionnaire and the travel diary.

On the Tuesday, Wednesday, Thursday and Friday morning we will be in the playground recording information from one of the device on the activity belt on the arrival of each child. On each of these mornings, we ask you that you remind the children to fill in their travel diaries first thing in the morning.

Finally, on the Friday, we will arrange a time with you to come and visit the class and collect in all the travel diaries, parent questionnaires, and the activity belts.

Appendix F: Child and Parent Consent Form.

University of Strathclyde Education

Department of Sport, Culture and the Arts

<u>Child and Parent Consent Form</u>

Project Title: Active commuting for primary school children; Pilot testing for the Travelling Green project.

Child's Consent

We will now ask if you would like to take part in the project. Please read these sentences.

The project has been explained to me to me [or I have read about the project on the information sheet]. I understand what the project is about and what I would be asked to do. I have been given time to ask questions. If I had any questions they have been answered in a way I understand. I know that I don't have to take part if I don't want to and that it is OK to stop taking part at any time.

Do you agree? And are you happy to take part?

I (write your name)	(today's date)
would like to be involved in the project	

If you **don't** want to take part, **don't** sign your name!

Parental Consent

I confirm that I have read and understand the parent information sheet for the above project and have been given the researcher's name and contact details if I require further information. I understand that my child and I are participating voluntarily and that my child and I are free to withdraw from the project at any time, without having to give a reason and without any effect on my child's education. I understand that any information recorded about my child and I will remain confidential and no information that identifies me or my child will be made publicly available.

I (PRINT NAME)	hereby agree to my child and I taking part in the above study
Signature of Parent:	Date

Child Questionnaire ID ____

About you

1. What is your full name? ____________________________

2. What is the name of your school? ___________________

3. How old are you?

8 ☐

9 ☐

10 ☐

11 ☐

4. What primary year are you in?

Primary 4 ☐

Primary 5 ☐

Primary 6 ☐

Primary 7 ☐

5. Are you a boy or a girl?

Boy ☐

Girl ☐

Mode of Travel

6. On a normal day, how do you usually travel TO school?

On foot---------------------- ☐ By school bus------------- ☐

By public transport------- ☐ By Car (given a lift)------ ☐

Bicycle---------------------- ☐ Other ....

A mixture of .... and ....

7. On a normal day, how do you usually travel FROM school?

On foot---------------------- ☐ By school bus------------- ☐

By public transport------- ☐ By Car (given a lift)------ ☐

Bicycle---------------------- ☐ Other ....

A mixture of .... and ....

8. On a normal day, who do you usually travel TO school with?

An adult--------------------- ☐ An adult and other------- ☐ Children

On my own --------------- ☐ Friends---------------------- ☐

Brother/sister-------------- ☐

9. On a normal day, who do you usually travel FROM school with?

An adult--------------------- ☐ An adult and other------- ☐ Children

On my own --------------- ☐ Friends---------------------- ☐

Brother/sister-------------- ☐

Walking to School

10. **Please tick ONE sentence which best describes how you feel about walking to school.**

- I do not walk any part of my journey to school and I do not plan to-- ☐
- I do not walk any part of my journey to school but I am thinking about it.--- ☐
- I sometimes walk part or all of my journey to school but no more than once a week.---------------------------- ☐

Go to Q11.

- I walk part or all of my journey to school on most days but I have only started recently.----------------------- ☐
- I walk part or all of my journey to school on most days and have been doing this for 6 months or more.--- ☐

Go to Q13.

- I used to walk part or all of my journey to school on most days but I don't any longer.---------------------- ☐

Go to Q11.

11. I don't walk to school because......

Please circle the most appropriate response.

An adult drives me all the way.	Agree	Undecided	Disagree
I live too far away.	Agree	Undecided	Disagree
I don't want to.	Agree	Undecided	Disagree
I don't have enough time.	Agree	Undecided	Disagree
I am not allowed to.	Agree	Undecided	Disagree
The weather is too bad.	Agree	Undecided	Disagree
My friends don't walk.	Agree	Undecided	Disagree
No one from my family walks with me.	Agree	Undecided	Disagree
I am frightened of meeting strangers	Agree	Undecided	Disagree
I am frightened of being bullied	Agree	Undecided	Disagree
The roads are too difficult to cross.	Agree	Undecided	Disagree
I don't know what walking route to take.	Agree	Undecided	Disagree
There are not enough lollipop people.	Agree	Undecided	Disagree
The traffic is too busy/ traffic is too fast.	Agree	Undecided	Disagree
There are too many cars near the school entrance.	Agree	Undecided	Disagree
The route does not have good lighting along the way.	Agree	Undecided	Disagree
I don't feel safe walking to school.	Agree	Undecided	Disagree

Are there any other barriers you feel stop you walking part or all of the journey to school?

____

____

____

____

12. I would be encouraged to walk part or all of the way to school if.....
Please circle the most appropriate response.

I was driven some of the way and dropped off within walking distance.	Agree	Undecided	Disagree
I lived closer to the school.	Agree	Undecided	Disagree
I had more time.	Agree	Undecided	Disagree
I was allowed to.	Agree	Undecided	Disagree
The weather was better.	Agree	Undecided	Disagree
My friends walked.	Agree	Undecided	Disagree
Someone from my family walked with me.	Agree	Undecided	Disagree
There was good lighting along the way.	Agree	Undecided	Disagree
I was less frightened of meeting strangers.	Agree	Undecided	Disagree
I was less frightened of being bullied.	Agree	Undecided	Disagree
There were more safe places to cross the road.	Agree	Undecided	Disagree
I knew what walking route to take.	Agree	Undecided	Disagree
There were more lollipop people.	Agree	Undecided	Disagree
There was less traffic/slower traffic.	Agree	Undecided	Disagree
Cars kept away from the school entrance.	Agree	Undecided	Disagree
I felt safer.	Agree	Undecided	Disagree

Is there anything else that you feel would encourage you to walk part or all of your journey to school?

____

____

____

NOW GO TO QUESTION 14

13. **Which of the following would make walking to and from school better?**

Please tick the most appropriate boxes.

Better weather--- ☐

If my friends walked-- ☐

If I was less frightened of meeting strangers--------------- ☐

If I was less frightened of being bullied---------------------- ☐

More safer places to cross------------------------------------- ☐

More school lollipop people---------------------------------- ☐

Less/ slower traffic-- ☐

Cars kept away from the school entrance----------------- ☐

If my parents walked with me-------------------------------- ☐

If my older brother(s) or sister(s) walked with me--------- ☐

Nothing, I feel fine about walking to school---------------- ☐

Is there anything else that you think would make walking to school better?

____

____

14. If you walked part or all of the way to school on most days, what benefits would there be? *Please tick those that apply to you.*

My heart and lungs would be healthier---------------------- ☐

I would be alert and awake for school---------------------- ☐

I would be able to talk to my friends on the way----------- ☐

My body would become healthier---------------------------- ☐

It would be fun--- ☐

I would be helping the environment------------------------- ☐

I would hear and see things that I wouldn't usually------- ☐

I would save money on fares-------------------------------- ☐

I would get lots of fresh air------------------------------------ ☐

I would be able to talk to my parents on the way---------- ☐

I would be able to talk to my brother(s) or sister (s)

on the way--- ☐

Is there anything else that you feel would benefit you if you walked part or all of the way to school on most days?

____

____

____

____

____

Preferred journey to school

15. **If you could choose how you travelled to and from school, how would you like to travel?**

On foot---------------------- ☐

By school bus------------- ☐

By public transport------- ☐

By Car (given a lift)------ ☐

Bicycle---------------------- ☐

Other ....

A mixture of .... and ....

16. **If you could choose who you travelled to and from school with, who would you travel with?**

An adult--------------------- ☐

An adult and other------- Children ☐

On my own --------------- ☐

Friends--------------------- ☐

Brother/sister-------------- ☐

17. **How sure are you that you can?**

Please circle the most appropriate response.

Walk to school	Very Sure	Kind of sure	Not Sure
Ask a parent or other adult to walk to school with you.	Very Sure	Kind of sure	Not Sure
Walk to school even if your friends don't walk.	Very Sure	Kind of sure	Not Sure
Ask your friends to walk to school with you.	Very Sure	Kind of sure	Not Sure
Walk to school in bad weather.	Very Sure	Kind of sure	Not Sure

Cross difficult roads when walking to school.	Very Sure	Kind of sure	Not Sure
Walk to school even if there are not enough lollipop people.	Very Sure	Kind of sure	Not Sure
Walk to school even if there are many cars near the school entrance.	Very Sure	Kind of sure	Not Sure
Cope with busy traffic when walking to school.	Very Sure	Kind of sure	Not Sure
Walk to school even if I am frightened of meeting strangers.	Very Sure	Kind of sure	Not Sure
Find a route to walk to school.	Very Sure	Kind of sure	Not Sure
Walk to school even if there is poor lighting.	Very Sure	Kind of sure	Not Sure
Walk to school even if it takes a long time.	Very Sure	Kind of sure	Not Sure
Walk to school even if I am frightened of being bullied.	Very Sure	Kind of sure	Not Sure

18. Looking at the faces scale, which face shows best how you feel about living in your local area?

Circle only one

19. Please circle the most appropriate response…

Walking to school every day would be fun	Disagree in a big way	Disagree	Agree	Agree in a big way
Walking to school every day would be enjoyable	Disagree in a big way	Disagree	Agree	Agree in a big way
Walking to school every day would be good for me	Disagree in a big way	Disagree	Agree	Agree in a big way
Walking to school every day would be important for me	Disagree in a big way	Disagree	Agree	Agree in a big way

My family wants me to walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
My friends want me to be walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
My teachers want me to be walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
My family will walk to school or to work every day	Disagree in a big way	Disagree	Agree	Agree in a big way
My friends will walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
My teachers will walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
I could walk to school every day if I really wanted to	Disagree in a big way	Disagree	Agree	Agree in a big way
I have the time to walk to school every day if I really wanted to	Disagree in a big way	Disagree	Agree	Agree in a big way
I live in a place which allows me to walk to school every day if I wanted to	Disagree in a big way	Disagree	Agree	Agree in a big way
I plan to walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way
I intend to walk to school every day	Disagree in a big way	Disagree	Agree	Agree in a big way

20. 'Walking to school is something….' *(Circle one number)*

	Totally disagree				Totally agree
1. I do a lot	0	1	2	3	4
2. I do automatically	0	1	2	3	4
3. I do without having to remember.	0	1	2	3	4
4. That makes me feel weird if I do not do it.	0	1	2	3	4
5. I do without thinking.	0	1	2	3	4

6. That would require effort not to do it.	0	1	2	3	4
7. That belongs to my daily routine.	0	1	2	3	4
8. I start doing before I realize I'm doing it.	0	1	2	3	4
9. I would find hard not to do.	0	1	2	3	4
10. I have no need to think about doing.	0	1	2	3	4
11. That's typically 'me'.	0	1	2	3	4
12. I have been doing for a long time.	0	1	2	3	4

21. 'Travelling by car or bus to school is something….' *(Circle one number)*

	Totally disagree				Totally agree
1. I do a lot	0	1	2	3	4
2. I do automatically	0	1	2	3	4
3. I do without having to remember.	0	1	2	3	4
4. That makes me feel weird if I do not do it.	0	1	2	3	4
5. I do without thinking.	0	1	2	3	4
6. That would require effort not to do it.	0	1	2	3	4
7. That belongs to my daily routine.	0	1	2	3	4
8. I start doing before I realize I'm doing it.	0	1	2	3	4
9. I would find hard not to do.	0	1	2	3	4
10. I have no need to think about doing.	0	1	2	3	4
11. That's typically 'me'.	0	1	2	3	4
12. I have been doing for a long time.	0	1	2	3	4

You're finished!

Thank you for your time and effort.

Parent Questionnaire

About your child

1. What is your child's full name? ___________________________

2. What is the name of your child's school? _________________

3. Does your child have any illness, health problem or disability that limits their ability to walk to and from school?

Tick only one Yes ☐ No ☐

4. Who decides whether your child walks to school or not?

Parent/guardian ☐

Child ☐

5. **To which of these groups do you consider your child belongs to?**

White	British	☐
	Any other White background (Please describe)	
Mixed	White and Black Caribbean	☐
	White and Black African	☐
	White and Asian	☐
	Any other Mixed background (Please describe)	
Asian or Asian British	Indian	☐
	Pakistani	☐
	Bangladeshi	☐
	Any other Asian background (Please describe)	
Black or Black British	Caribbean	☐
	African	☐
	Any other Black background (Please describe)	
Chinese or other ethnic group	Chinese	☐
	Any other (Please describe)	

Questions about you and your household

6. **Are you male or female?** *Tick one only* Male ☐ Female ☐

7. **What is your age?** *Write in* years ....

8. **How far does your child have to travel to get to school?**

Tick one only

Less than one mile ☐

One mile or more ☐ *Write in number of miles*................

9. **What is your postcode?** ....

10. **Does your household own or rent its accommodation?**

Tick one only

Rents it from the council, a housing association, or a charity ☐

Rents it from a private landlord or letting agency ☐

Partly owns it and partly rents it (shared ownership) ☐

Owns it (including buying with a mortgage) ☐

Other ☐

11. **How many cars or vans are owned or available for use, by members of your household?**

Do not include motorcycles, scooters or mopeds.

Write in number
If none, write "0" ....

12. **Thinking about the work you do, which of these best describes your situation at present?**

Please answer for yourself and for your spouse or partner if you have one who lives with you.

	Yourself *Tick one only*	Your spouse/partner *Tick one only*
Doing paid work full time	☐	☐
Doing paid work part time	☐	☐
On a government training scheme	☐	☐
Retired	☐	☐
Full time student	☐	☐
Unemployed	☐	☐
Disabled, invalid or permanently sick	☐	☐
Caring for home and family or dependants	☐	☐
Other	☐	☐
Not living with a spouse or partner	☐	☐

Your Child's Mode of Travel

13. **On a normal day, how does your child usually travel TO school?**

On foot-------------------- ☐ By school bus----------- ☐

By public transport------- ☐ By Car (given a lift)----- ☐

Bicycle--------------------- ☐ Other................................

A mixture of .... and ....

14. **On a normal day, how does your child usually travel FROM school?**

On foot-------------------- ☐ By school bus----------- ☐

By public transport----- ☐ By Car (given a lift)----- ☐

Bicycle--------------------- ☐ Other................................

A mixture of .... and ....

15. **On a normal day, who does your child usually travel TO school with?**

An adult--------------------- ☐ An adult and other------ children ☐

On their own--------------- ☐ Friends-------------------- ☐

Brother/sister-------------- ☐

16. **On a normal day, who does your child usually travel FROM school with?**

An adult--------------------- ☐ An adult and other------ children ☐

On their own--------------- ☐ Friends-------------------- ☐

Brother/sister-------------- ☐

Walking to School

17. Do you agree or disagree with the following statements:
It is difficult for my child to walk or bike to school (alone or with someone) because…

1. There are too many hills along the way	Agree	Undecided	Disagree
2. There are no pavements or cycle paths	Agree	Undecided	Disagree
3. The route is boring	Agree	Undecided	Disagree
4. The route does not have good lighting	Agree	Undecided	Disagree
5. There is too much traffic along the route	Agree	Undecided	Disagree
6. There is one or more dangerous crossings	Agree	Undecided	Disagree
7. My child gets too hot and sweaty	Agree	Undecided	Disagree
8. No other children walk or bike to school	Agree	Undecided	Disagree
9. It's not considered cool to walk or bike	Agree	Undecided	Disagree
10. My child has too much stuff to carry	Agree	Undecided	Disagree
11. It is easier for me to drive my child to school on the way to something else	Agree	Undecided	Disagree
12. It involves too much planning ahead	Agree	Undecided	Disagree
13. It is unsafe because of crime (strangers, gangs, drugs)	Agree	Undecided	Disagree
14. My child gets bullied, teased, harassed	Agree	Undecided	Disagree
15. There is nowhere to leave a bike safely	Agree	Undecided	Disagree
16. There are stray dogs	Agree	Undecided	Disagree
17. It is too far	Agree	Undecided	Disagree

Only answer question 18 if your child <u>does not</u> walk part or all of the way to school.

18. What do you feel would encourage your child to walk part, or all of the journey to school?

Please tick the appropriate responses.

If they were driven some of the way and dropped off within walking distance-- ☐

If they lived closer to the school--------------------------------------- ☐

If they had more time-- ☐

If they were allowed to-- ☐

If the weather was better-- ☐

If their friends walked-- ☐

If someone from their family walked with them----------------------- ☐

If there was good lighting along the way---------------------------- ☐

If they were less frightened of meeting strangers--------------------- ☐

If they were less frightened of being bullied-------------------------- ☐

If there were more safer places to cross the road--------------------- ☐

If they knew what walking route to take------------------------------ ☐

If there were more lollipop people------------------------------------ ☐

If there was less traffic/ slower traffic---------------------------------- ☐

If cars kept away from the school entrance--------------------------- ☐

If they felt safer--- ☐

Is there anything else that you feel would encourage your child to walk part or all of their journey to school?____

____

Go to Question 20
Only answer question 19 if your child walks part or all of the way to school.

19. Which of the following would make walking to and from school better for your child?
Please tick the most appropriate boxes.

Better weather-- ☐

If their friends walked-------------------------------------- ☐

If they were less frightened of meeting strangers---------- ☐

If they were less frightened of being bullied--------------- ☐

More safer places to cross-------------------------------- ☐

More school lollipop people------------------------------- ☐

Less/ slower traffic--- ☐

Cars kept away from the school entrance----------------- ☐

If one of their parents walked with them------------------ ☐

If their older brother(s) or sister(s) walked with them------ ☐

Nothing, they feel fine about walking to school------------ ☐

Is there anything else that you think would make walking to school better for your child?

____

____

____

20. If your child walked part or all of the way to school on most days, what benefits would there be? *Please tick the most appropriate answers.*

My child's heart and lungs would be healthier------------------ ☐

My child would be alert and awake for school------------------ ☐

My child would be able to talk to his/her friends on the way----- ☐

My child's body would become healthier----------------------- ☐

It would be fun-- ☐

My child would be helping the environment--------------------- ☐

My child hear and see things that he/she wouldn't usually------ ☐

My child would save money on fares-------------------------- ☐

My child would get lots of fresh air----------------------------- ☐

They would be able to talk to me on the way------------------ ☐

They would be able to talk to their brother(s) or sister (s)

on the way--- ☐

Is there anything else that you feel would benefit your child if he/she walked part or all of the way to school on most days?

____

____

____

____

____

Preferred journey to school

21. How would you prefer your child travelled to school?

On foot------------------ ☐
By school bus--------- ☐
By public transport------ ☐
By Car (given a lift)---- ☐
Bicycle------------------ ☐
Other.................................
A mixture of .... and ....

22. Who would you prefer your child to travel to school with?

An adult------------------ ☐
An adult and other children----- ☐
On their own------------ ☐
Friends---------------- ☐
Brother/sister----------- ☐

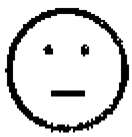
23. How confident are you that your child can…
Please circle the most appropriate response.

(1) Walk to school.............	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(2) Ask a parent or other adult to walk to school with them…	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(3) Ask a friend to walk to school with them................	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(4) Walk to school even if their friends don't walk……...	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(5) Walk to school in bad weather..........................	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(6) Cross difficult roads when walking to school................	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident

(7) Cope with busy traffic when walking to school……...	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(8) Walk to school even if there are many cars near the school entrance…………	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(9) Walk to school even if there are not enough lollipop people……………………	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(10) Walk to school even if they are frightened of meeting strangers………	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(11) Walk to school even if they are frightened of being bullied………………………...	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(12) Walk to school even if there is poor lighting……	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(13) Walk to school even if it takes a long time………	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident
(14) Find a route to walk to school………………………...	Very Confident	Quite Confident	Somewhat Confident	Not Particularly Confident	Not at all confident

24. Looking at the faces scale, which face shows best how you feel about living in your local area?

Circle only one



Streets in my neighbourhood

Please circle the answer that best applies to the neighborhood where you and your child live.

25. The streets in our neighborhood <u>do not</u> have many cul-de-sacs (dead-end streets).

1	2	3	4
Completely true	somewhat true	somewhat untrue	completely untrue

26. The distance between intersections (where streets cross) in our neighborhood is usually short. (100 yards or less; the length of a football field or less).

1	2	3	4
Completely true	somewhat true	somewhat untrue	completely untrue

27. There are many different routes for getting from place to place in our neighborhood. (My child doesn't have to go the same way every time.)

1	2	3	4
Completely true	somewhat true	somewhat untrue	completely untrue

You're finished!

Thank you for your time and effort.

Please give this questionnaire to your child to take back to school.

Appendix I: Data replacement information.

Measurement type	Measure	Variable	Action Taken
Activity belts	Actigraph	PA data counts/Steps/MVPA	Firstly, if individual days are missing then use an individually centred technique to replace (being careful that Mon/Fri are not full days - this is for total daily steps/MVPA). Secondly, if all the data is missing then replace with pre/post – assume no change. Note: For the two Actigraph data sets which didn't download–treat as missing data – assume no change and replace with pre or post.
	NL 1000	Morning arrival time	If NL 1000 groups are missing then leave completely (because the majority of stats analysis will use the Actigraph data with the NL1000 being used to validate the use of pedometers as feasible and cheaper alternative in measuring active transport in a child population.
		Morning Steps	See decision for 'Morning arrival time'.

		Morning MVPA	See decision for ’Morning arrival time’.
		Daily steps	See decision for ’Morning arrival time’.
		Daily MPVA	See decision for ’Morning arrival time’.
Questionnaires	Child	Age (1 item)	n/a
		Primary (1 item)	n/a
		Sex (1 item)	n/a
		Mode to school(1 item)	Add new variable determined through mode to school and where not available use the stage of change i.e. walkers or non walkers and combine this into a new variable column 0=non walker, 1= walker, 2 = mixed mode (e.g. where walking forms part of the journey)
		Mode from school (1 item)	Add new variable determined through mode from school. If missing assume this is the same as mode to school.
		Companion to school (1 item)	Leave missing
		Companion from school (1 item)	Leave missing
		Stage of change(1 item)	Assume no change and replace with pre or post’.

		Barriers to walking (18 item) LIKERT	If the whole scale missing replace with the pre or post (both intervention and control) If a single item is missing item use IIC (any number of items)
		Facilitators to walking (17 item) LIKERT	*See above*
		What would make walking better (12 item) TICK RESPONSE	If the whole scale missing replace with the pre or post (both intervention and control) Single items cannot be missing on a tick box response
		Benefits (12 item) TICK RESPONSE	See decision for 'What would make walking better'.
		Preferred mode (1 item)	Leave as missing (because of the type of statistics to be performed)
		Preferred companion (1 item)	Leave as missing (because of the type of statistics to be performed)
		Self efficacy for walking (14 item)	If the whole scale missing replace with the pre or post (both intervention and control) If a single item is missing item use IIC (any number of items)

		Local area(1 item)	Leave missing
		TPB (15 item)	If the whole scale missing replace with the pre or post (both intervention and control) If a single item is missing use IIC calculated from the sub scale (i.e. attitude, subjective norm, PBC, or intention)
		Walking habit (12 item	If the whole scale missing replace with the pre or post (both intervention and control) If a single item is missing item use IIC (any number of items)
		Car/bus use habit (12 item	See decision for ‘walking habit.
	Parent	Illness/disability	Check to see pre or post response (analysis will be run to determine if these individuals are outliers).
		Who decides	n/a
		Ethnicity	Check to see pre or post response
		Sex	Check to see pre or post response
		Age	Check to see pre or post response

		Distance from school	Check distance using postcode and Google maps
		Postcode	Use Pre or Post response
		House status	Use Pre or Post response
		Car ownership	Leave for now as we will be using this in descriptive statistics
		A)employment b) partner employment	Leave for now as we will be using this in descriptive statistics Leave for now as we will be using this in descriptive statistics (Adapted questionnaire to overcome this problem)
		Mode to school	Leave as missing But add new variable determined through mode to school i.e. walkers or non walkers and combine this into a new variable column 0 = non walker, 1 = walker, 2 = mixed mode (e.g. where walking forms part of the journey)
		Mode from school	Leave as missing But Add new variable determined through mode to school i.e. walkers or non walkers and combine this into a new variable column 0 =non walker, 1 = walker, 2 = mixed mode (e.g. where walking forms part of the journey)

		Companion to school	Leave as missing (same technique used for the child questionnaire)
		Companion from school	Leave as missing (same technique used for the child questionnaire)
		Foreman “barriers” items	If they are missing the whole subscale then leave If they are missing individual items then replace using IIC
		Potential facilitators (non walkers) TICK RESPONSE	If the whole scale missing replace with the pre or post (both intervention and control) Single items cannot be missing on a tick box response
		Barriers/facilitators (walkers) TICK RESPONSE	See decision for ‘Potential facilitators’.
		Benefits TICK RESPONSE	See decision for ‘Potential facilitators’.
		Preferred mode	Leave as missing (because of the type of statistics to be performed)- same as child questionnaire
		Preferred companion	Leave as missing (because of the type of statistics to be performed). This is the same as child questionnaire
		Parent self efficacy	If they are missing the whole subscale then leave

			If they are missing individual items then replace using IIC
		Neighbourhood Perception	*See 'Parent self efficacy'.* (I have in my notes as above, which will keep it consistent with all of the replacement techniques, which means even if we have two of the three missing we can use IIC)
Travel Diaries		Home Arrival time	Create new variable and Label as the following : 0= inactive 1= active (including those who walk at least some of the way) 999= missing For those who are inactive: analyse the 15minutes after school For those who are active : analyses the time until they arrive home (if this value is <15 mins then ignore home arrival time and analyse the 15minutes after school) If individual days are missing don't process the Actigraph data and treat the resulting Actigraph data as missing data (replace using ICC)

			If whole travel diary is missing then replace using pre or post scores – Actigraph data. If both Pre and Post travel diaries are missing then use group mean replacement of the Actigraph data. Further notes available.
		Travel mode	See above for replacement decision
		Anywhere on way home?	See above replacement decision

Appendix J: Travelling Green Lessons.

Table. Summary of the experiences and outcomes of the Travelling Green resource.

Capacity	Objective	Leaning outcomes
Successful learners	Help children develop an understanding of the physical, social and emotional factors that influence a healthy lifestyle. Travelling Green will enable children to set personal foals for achieving a healthy lifestyle.	Enable them to become successful learners with: • Enthusiasm and motivation for learning about a healthy lifestyle • Openness to new thinking and ideas about active and sustainable transport And able to: • Use literacy, communication and numeric skills • Use technology for leaning • Think creatively and independently • Learn independently and as part of a group
Confident individuals	Provide individuals with a sense of well being through health and fitness. It	Enable them to become confident individuals with: • Self respect

	should equip them with skills such as pedestrian skills which will enable them to live as independently as they can and to live a healthy and full life.	• A sense of physical, mental and emotional wellbeing gained through habitual physical activity • Secure values and beliefs And able to: • Relate to others and manage themselves • Pursue an active and healthy lifestyle that includes active travel • Be self aware • Live as independently as they can by becoming a confident road user • Assess risk and take informed decisions about routes and modes of travel
Responsible citizens	Help children develop an awareness of healthy, diet, physical activity, positive a relationships and risks to health, laying important foundations for their physical life, including parenting. TG will also	This will enable them to become responsible citizens with: • Respect for others • Commitment to participate responsibly in political, economic, social, and cultural life And able to:

	help children develop and understanding of how their actions and decisions are affected by and affect others, helping them to recognise the importance of t behaving in ways that can have a positive effect on other people and the environment.	• Make informed choices and decisions about healthy lifestyle including active travel • Evaluate environmental, scientific and technological issues related to sustainable travel • Develop informed, ethical views of complex issues concerning the environmental impact of travel choices
Effective contributors	TG can provide children with the opportunities to engage positively in experiences that are fun, enjoyable and challenging in a variety of settings including the outdoors. They can make positive contributions to the wider life and health of the schools and community through their involvement in Travelling	This will enable them to become effective contributors with: • Resilience • Self resilience gained through independent travel And Able to: • Work in partnership and in teams to raise awareness of travel modes and their impact of the school and wider community • Take the initiative and lead by setting a good example of healthy living • Solve problems through using pedestrian strategies to keep safe.

	Green activities.

Appendix K: Measurement of Active Travel Behaviour

Active travel to school was measured using the Actigraph GT1M physical activity monitor. The Actigraph GTIM contains a uni-axial accelerometer measuring 3.8 × 3.7 × 1.8 cm which were attached to an elastic belt and worn on each participant's right hip. The device measures vertical bodily accelerations which are converted into activity counts and steps. Data from the GT1Ms were downloaded using Actilife data analysis software (version 3.2.2; ActiGraph, Pensacola, Florida, USA). In this study, 5-sec epochs were used. The use of 5-sec epochs corresponds was the shortest epoch length that allowed data storage over 5 days and was therefore considered most appropriate. GT1Ms were also synchronised with a digital watch to allow for accurate recording of participants' morning arrival times at school. The synchronisation of time allowed for the subsequent data processing.

On the Monday of each data collection week members of the research team, which consisted of between four or five research assistants depending on class size, went to the relevant school to administer the travel measures. The research team distributed the child school questionnaires, which were designed specifically for this study, and travel diaries to all participants. The child school questionnaire gathered information about children's usual mode of travel to and from school. Participants sat in small groups to complete their questionnaire, and each group was supervised by a member of the research team. Travel diaries, which were also specifically designed for this study, were used to gather information about the trip home from school regarding the home arrival time of the child, the mode of travel and information concerning any places visited on the route home from school. Participants were asked to store their travel diary in a safe place in the classroom and complete each morning.

On completion of the child school questionnaire, participants were given their belt (with attached activity monitors). The time that the activity monitors were distributed was recorded for GT1M data processing purposes. Participants were asked to wear their activity monitors during waking hours, and only to remove them during sleep, swimming, bathing, and contact sports. Participants were also asked to approach one of the research team in the school playground each morning on arrival at school to have their arrival time.

GT1Ms and travel diaries were collected on the Friday of the data collection week. This was done after the time of day that the activity monitors had been handed out on the Monday to allow Monday afternoon data to be combined with Friday morning data in order to create a composite day. GT1M data were downloaded on Friday evening. Questionnaire and travel diary data were entered into the master data sheet.

Non-wear GT1M data were deleted. These non-wear time included: (a) data before the activity monitors were distributed on the Monday, and after collection on the Friday; (b) data between the hours of 2330 and 0530 (i.e. sleeping time); and (c) data on days when the participant was absent or had forgotten to wear their belt (according to written records). Monday afternoon data were then merged with Friday morning data to create a composite day, resulting in 4 full days of data.

Steps counts were then calculated for the journey to school and the journey home. The journey to school was defined as being from 0530 to the time the child arrived at school (as recorded by the study team). The journey home was processed differently depending on mode of travel reported on the travel diary. If the participant reported walking home, data were analysed from 1500 (end of school day) to the self-reported home time. If the reported home time was before 1515 then data were analysed up to 1515. Data for participants who travelled home inactively were analysed from 1500 to 1515. Therefore each participant was credited with a home commute time of at least 15 minutes. The individualised approach used to calculate afternoon commute time for walkers and non-walkers was taken to avoid unfairly biasing walkers, who often take longer to commute than children who travel by car. If travel diary data were unavailable, then afternoon commute activity was deemed as missing and later replaced. Full day was defined as being between 0530 and 2330. Steps were calculated using the 'sum' function in Excel. Following data processing, active travel data were pasted into a master Excel file ready for missing data replacement. No wear time criterion was used in this study. It was assumed that if participants arrived at school wearing their GT1M there would be at least 8 hours of data collected (6 school-day hours and approximately 1 hour before and 1 hour after school).

Appendix L: Data checking and replacement techniques

An initial check of the data was performed to screen for inputting errors. Following this check, a random selection of questionnaires and travel diaries were read aloud by one of the research team while another member of the team visually inspected the data sheet for agreement. 10% of data were checked. Data inputting errors were <5%. Range checks on each variable were also performed during and after data entry to identify and correct errors that may have affected the final results and conclusions.

Missing data analyses were then carried out to establish type and percentage of missing data. Written records from a data collection diary were consulted to identify days on which participants had forgotten to wear their belts or had been absent from school. Participants with missing questionnaire and travel diary data were also identified.

Missing data were replaced before any statistical analyses were performed. Missing data were diverse in nature due to the multiple outcome variables being measured. Various data replacement techniques were therefore used. Team meetings were held to identify and discuss available data replacement techniques. These discussions led to the most appropriate replacement techniques being selected for the different types of missing data.

Individual missing step data were replaced using an individual information centred (IIC) technique. This technique involved replacing a missing data point with the mean value of remaining data points for a given individual. Previous research has shown that this technique to be more accurate than group information based approaches (i.e. using a group mean to replace data for an individual) (Kang et al., 2009).

Concerning questionnaire data, if a single item within a scale was missing, IIC was used. If a whole scale was missing, data were replaced using the participant's corresponding data from the other data collection week. For example, if a participant was missing a whole scale from the post intervention questionnaire then these data were replaced using their data from the pre intervention questionnaire. This replacement technique was also used for participants missing a whole week of data (either all of their activity monitor data or questionnaire data). Given that this technique assumed no change from pre to post intervention it therefore protected against type 1 error which is particularly important concerning the evaluation of individuals receiving the intervention.

Three participants were missing both pre and post intervention/comparison GT1M data. In this instance, missing data was due to a combination of lost devices and device malfunction. For these individuals, a group mean replacement technique which was based on the school and gender of the participant was used to replace data.

Once the data replacement had been completed, data were exported from the Excel spreadsheet into an SPSS 17.0 data file ready for analysis.