Investigating the Role of Past Behaviour and Habits in Health Behaviour

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Abstract

Globally, there is a significant burden of disease due to unhealthy patterns of behaviours. Poor quality nutrition, over-exposure to the sun, insufficient oral hygiene practices, and excessive alcohol consumption are but a few examples of health-related behaviours that affect mortality and quality of life. To effectively modify people's health behaviour, mechanisms of change must be isolated and tested. Previous research has often used theories of social cognition to understand, explain, and predict health behaviour. More recently, however, researchers are attempting to overcome the notable criticisms of such theories; for example, the tendency to focus on conscious, deliberative processes. To this end, understanding the role of non-conscious, automatic processes have come under the spotlight. The current thesis attempts to contribute to this literature by addressing three main aims. First, this thesis aimed to understand the effect of past behaviour in an integrated, dual-phase model of health behaviour that focuses on multiple deliberative processes. Second, this thesis aimed to explain the effects of past behaviour on future behaviour, with a focus on the role of habit. The final aim was to explore lay representations of habit. As a thesis presented by a series of publications, the four papers that comprise this program of research are presented as journal manuscripts.

Paper 1 aimed to understand the effect of past behaviour in an integrated, multi-theory, dual phase model of health behaviour, exploring fruit and vegetable consumption of Australian heavy goods vehicle drivers (n = 212). The model integrated and tested constructs from self-determination theory (i.e., autonomous motivation), the theory of planned behaviour (i.e., attitudes, subjective norms, perceived behavioural control, and intention), and the health action process approach (i.e., action planning and coping planning), with the addition of past behaviour. Structural equation modelling

identified the relative contributions of motivation, social cognition, and volition to the prediction of fruit and vegetable consumption, one week later. Importantly, past behaviour was shown to attenuate model effects, particularly to the intention-behaviour relationship. This study explicitly demonstrated the effect of past on future behaviour and found significant residual variance unexplained by the conscious, deliberative processes.

To address the second aim of the thesis by seeking to understand which elements of past behaviour exert influence on future behaviour, Paper 2 tested a dual-process model that incorporated constructs that underpinned reasoned action and automatic constructs across three distinct health behaviours and populations: binge drinking in university students (*n* = 319), dental flossing in adults (*n* = 251), and parental sun safety behaviour of children 2 – 5 years of age (*n* = 184). Furthermore, Paper 2 sought to use a measure of past behaviour that combined long-term, recent, and routine patterns of behaviour. This was used to best model potentially distinct patterns of past behaviour; but, to also overcome criticisms that argue past-future behaviour effects are inflated by shared-method variance. The study adopted a prospective design with two waves of data collection, spaced six weeks apart. Structural equation modelling found that the automatic, but not reasoned action constructs, mediated the past-to-future behaviour relationship across all three behaviours.

In further addressing the second aim of the thesis, Paper 3 aimed to explore the role of two different types of habits (i.e., goal-directed and counter-intentional) simultaneously with a reasoned action measure (i.e., intention) in two health-promoting nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables and restricting sugar sweetened beverages) in two populations (i.e., middle school students aged 11 – 14 years (*n* = 266) and university students aged 17 – 24 years (*n* = 340)).

Results revealed different patterns of effects whereby intentions predicted both behaviours in both samples and goal-directed habits and counter-intentional habits only predicted fruit and vegetable consumption in the middle-school sample. This study highlighted how automatic processes may play a significant role in explaining and predicting health behaviours. Of note, in Paper 3, the habit for each behaviour that was measured using an avoidance-orientation (i.e., the habit to restrict or avoid) did not produce a significant effect. The non-significant effects could indicate that such habits do not play a role in health behaviour or, alternatively, demonstrate the participants had difficulty understanding and interpreting such questions. Understanding how the general population interprets the meaning of habit is therefore useful; yet, has rarely been explored.

Paper 4, in addressing the last aim of the thesis, sought to understand lay representations of habit using qualitative methodology across two studies. The first study used an online, open-ended questionnaire to elicit the most salient features of habit. The second study used interviews and focus groups to explore a more in-depth understanding of lay representations of habit by exploring what lay people identify as the important features of habit and which behaviours they identify as habitual. Paper 4 found that, overall, there were many consistencies with a lay and scientific representation of habit (e.g., automatic, frequently engaged). However, despite being able to identify specific features of habit, lay people, at times, identified habitual behaviours that were inconsistent with their definition. In particular, lay people often used the word habit to mean clustered, repetitive patterns of behaviour, synonymous with routine, or as something that is characteristic or typical of them. This highlights potential problems with how lay people may answer self-reported measures of habit and how they evaluate interventions seeking to modify habits. Furthermore, as researchers continue to explore other automatic and implicit processes (e.g., counter-intentional habits or implicit attitudes and motivations) there must be a coherent and consistent definition to distinguish between them.

Overall, the findings of this thesis make an important contribution to the health and behavioural medicine literature by contributing to understanding the role of past behaviour and habit in explaining and predicting health behaviour. The research first corroborated the attenuation effects of past behaviour on future behaviour in an integrated model of health behaviour. It was demonstrated that a significant portion of variance was left unexplained when only reasoned, deliberative processes are used in models of behaviour. The research then demonstrated that the residual variance of past-to-future behaviour was accounted for by automatic constructs (i.e., habit) in three distinct behaviours and populations. This was further expanded by exploring the role of two constructs representing automatic processes, goal-directed and counter-intentional habits, alongside intention. The inconsistent effects across behaviours and samples highlighted that little is known about how lay people represent habits, which likely influences how they interpret measures of habit. Therefore, the final paper qualitatively explored lay representations of habit, demonstrating that while there are some consistencies with a scientific understanding of habit, there remains a number of discrepancies. The findings of this thesis contribute to understanding the effects of past behaviour and habit on health behaviour. These findings highlight that further research is needed in enhancing the scientific conceptualisation of habit and in further understanding the conditions in which constructs representing non-conscious and automatic processes mediate the past-to-future behaviour relationship compared with constructs representing reasoned-action processes.

Keywords: Habit, automaticity, dual-process theories, integrated models

Statement of Originality

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

(Signed)______________________________

Daniel Brown

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Included in this thesis are papers in *Chapters 3, 4, 5 and 6* which are co-authored with other researchers. My contribution to each co-authored paper is outlined at the front of the relevant chapter. The bibliographic details (if published or accepted for publication)/status (if prepared or submitted for publication) for these papers including all authors, are:

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Conference Presentations Related to this Thesis

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Chapter 1: Literature Review

Lifestyles, Chronic Disease, and Modifiable Health Behaviours

Across the globe, citizens of industrialised nations, such as Australia, are living longer and have some of the highest life expectancies (Australian Institute of Health and Welfare; AIHW, 2018). Yet, many are also increasingly living with lifestyle-related ongoing or ‘chronic’ diseases such as cardiovascular disease, diabetes, and cancer (AIHW, 2018; World Health Organisation; WHO, 2019). Chronic diseases are the leading cause of illness, disability, and mortality in industrialised nations, contributing to 87% of all deaths in some countries (AIHW, 2018; WHO, 2019). These diseases are generally the result of living an unhealthy lifestyle and associated with risk factors that can largely be modified. For example, poor diet is a leading factor contributing to many of the chronic conditions (AIHW, 2018). Much of the burden of disease associated with poor nutrition is associated with energy-dense food, high in saturated fats, refined sugar, and salt but which lack sufficient nutrients. This energy-rich but nutritionally hollow diet is a major factor contributing to overweight and obesity in individuals, and, worryingly, there continues to be a rise in obesity rates globally. In Australia, for example, 56% of the population were classified as overweight or obese in 1995, increasing to 61% in 2007-08, further rising to 63% in 2011-2012 (AIHW, 2014), and with current rates sitting at 67% of adults in 2017-2018 (AIHW, 2019). Similar trends have been found in the UK (Baker, 2019) and the USA (Hales, Carroll, Fryar, & Ogden, 2017). Understanding the behaviours which promote health and wellbeing is, therefore, important to investigate. Equally important, however, is investigating the modifiable psychosocial determinants underpinning health behaviour.

Examples of Modifiable Health Behaviours. Many of the noncommunicable diseases affecting industrialised nations and that contribute to the burden of disease are underpinned by modifiable behaviours. For example, engagement in regular physical activity is well-documented as being implicated in improvements to people's health and wellbeing and reducing the risks associated with a range of chronic health conditions and disease risk factors (e.g., cardiovascular disease, obesity) (AIHW, 2017). Although guidelines exist on optimum amounts of physical activity that need to be performed to gain health benefits (e.g., for adults aged 18 to 64 years engagement in 150 minutes of moderate intensity physical activity, or 75 minutes of vigorous intensity physical activity, across 5 or more session a week, is recommended; Department of Health, 2019; WHO, 2011), many adults do not meet these guidelines. For example, in Australia, approximately 52% of adults did not meet the minimum amounts of physical activity recommended in the guidelines (ABS, 2016).

Diet has also been shown to be an important modifiable behaviour which can improve health (Barker, 2012; Ezzati & Riboli, 2013; Rayner & Scarborough, 2005; Scarborough et al., 2011). Having a nutritionally balanced and varied diet is essential for the healthy development of infants and children (WHO, 2013). Moreover, having a nutrient rich diet is a significant contributor to a healthy lifestyle and acts as a guard against ill-health and disease (Boeing et al., 2012). While nutrition guidelines vary somewhat among health organisations, it is widely accepted that adults should consume between 5–7 servings of fruits and vegetables daily (NHMRC, 2013; U.S Department of Agriculture, & U.S. Department of Health and Human Services, 2010; WHO, 2003). A meta-analysis concluded that every serving of fruit or vegetable reduced the risk of mortality by 5% up to a threshold of 5 serves a day (Wang et al., 2014). Increasing fruit and vegetable consumption is specifically associated with a reduced risk of cardiovascular diseases such as heart attacks. Thus, consuming a diet that contains sufficient fruit and vegetable intake is essential for good health, especially in specific developmental stages, such as middle school, when children began to exert more independent food choices (Van Der Horst et al., 2006), or in high-risk populations such as long-haul transport drivers (Birdsey et al., 2015).

Oral health is another modifiable health behaviour that plays a significant role in the burden of disease globally. Broadly, oral health refers to conditions relating to an individual's teeth, gums, and mouth (National Advisory Council on Dental Health, 2012). Oral ill-health is the most prevalent disease, worldwide, of adults. The 2003 World Oral Health Report found that up to 90% of school aged children and almost all adults are affected by dental caries (Petersen, 2003). It is believed that 10 to 15% of global adult populations suffer from severe forms of oral disease (Petersen & Ogawa, 2012). This is a particularly important issue given oral health and periodontal disease can affect many areas of well-being and functioning (National Advisory Council on Dental Health, 2012; Petersen & Ogawa, 2012). Gum pain, for example, can reduce an individual's ability to eat a varied diet; similarly, missing teeth can negatively impact an individual's self-esteem or result in communication difficulties (Petersen & Ogawa, 2012).

Also important to individuals' health is overexposure to medium-to-high levels of ultra-violet (UV) radiation, associated with extended periods in the sun, and which is shown to increase the risk of melanoma and nonmelanoma skin cancer (Cancer Council Australia, 2014). Overexposure to the sun is more problematic in specific global regions. For example, Queensland, Australia has the highest rate of skin cancer in the world and 32.6% of all Australians living with cancer, specifically have skin cancer (ABS, 2013). It is expected that two-thirds of all Australian's will be diagnosed with skin cancer before the age of 70 (Staples et al., 2006). Addressing the factors which increase lifetime risk of skin cancer is therefore of great importance. For example, childhood sun exposure and sunburns directly increase the lifetime risk of skin cancer and, worryingly, most children in Australia (69%) have sustained at least one sunburn (Green, Wallingford, & McBride, 2011). While overall rates of skin cancer have continued to increase over the last two decades (AIHW, 2016), population statistics show the start of a downward trend for those 45 years of age and younger, likely the result from long-standing public health campaigns (Erdmann et al., 2013). These changes highlight the importance of limited overexposure to the sun as early as possible (Hornung, 2000) and instilling habitual use of sun safety behaviours from childhood (Erdmann et al., 2013).

Excessive alcohol consumption, such as consuming more than four standard drinks in any one occasion (i.e., binge drinking; NHMRC, 2009), is another major modifiable health behaviour implicated to ill-health and the cause of preventable illness (NHMRC, 2009). In Australia, one standard drink contains 10 grams of alcohol (Department of Health, 2019), which is largely consistent with many other countries (e.g., France, New Zealand, Spain), despite some variations in other industrialised nations(e.g., one standard drink is 14 grams in America and 8 grams in the UK) (Kalinowski & Humphreys, 2016). Binge drinking is particularly problematic as it has both significant short-term and long-term health consequences. Short-term consequences relate to higher risk of injury to the drinker or those that could be affected by the drinker’s behaviour (Laslett et al., 2011). Under the influence of alcohol individuals are, for example, more likely to engage in risky sexual behaviours, exposing themselves to sexually transmitted infections and unwanted pregnancies (Brown, Gause, & Northern, 2016; Leigh et al., 2008). Similarly, people who have engaged in binge drinking are more likely to engage in violent behaviour (Crane, Godleski, Przybyla, Schlauch, & Testa, 2016; Leonard & Quigley, 2017) including intimate partner violence that is often directed towards women (Devries et al., 2014; Foran & O'Leary, 2008). Furthermore, alcohol misuse can have a serious impact on physical health including the liver, cardiovascular system, and other detrimental central nervous system problems (Barclay, Barbour, Stewart, Day, & Gilvarry, 2008).

In summary, there are a range of modifiable health behaviours that, if engaged in, can contribute to reducing the global burden of noncommunicable diseases. These include, but are not limited to, engaging in regular physical activity, consuming a healthy diet, improving oral hygiene practices, limiting sun exposure, and reducing excessive alcohol consumption. However, to modify these health behaviours, the mechanisms and processes that govern their engagement need to first be identified. Using theoretical models to understand behaviour may offer insight into the conditions that contribute to individuals' engagement in health behaviours and provide the necessary formative evidence of the mechanisms of behaviour change.

Behavioural Theories in Health Psychology and Behavioural Medicine

Despite the increase in life expectancy, the majority of Australians still suffer with one or more non-communicable, lifestyle related illnesses. Health promotion and illness prevention is a critical component of reducing the burden of disease. To date, very little money is spent on health prevention. For example, the Australian government spends approximately 2% of its health budget on preventive measures, focusing spending instead on primary healthcare and treatment (AIHW, 2015; Australian Government Productivity Commission, 2015). It has been estimated, however, that by reducing the rates of many of the health behaviours discussed above, the annual health care budget could save an additional AUD$1.9 billion (Cadilhac et al., 2011). It has been argued that little is invested in preventive health because of the poor evidence of what works, how it works, and who it works for (Australian Government Productivity

Commission, 2015; Hagger & Weed, 2019). While the outcomes of health promotion and preventive medicine may be clear (i.e., a healthier population), health conditions are innately complex, creating barriers for governments to know where to invest resources.

To reduce the burden of disease and concurrently build the evidence regarding how to do this, behavioural scientists seek to develop interventions that lead to specific changes in health promoting or health debilitating behaviours. Behavioural scientists propose that interventions based on theories in psychology and behavioural medicine can best serve to change behaviour (Davis, Campbell, Hildon, Hobbs, & Michie, 2015; Glanz & Bishop, 2010; Michie & Abraham, 2004; Michie, Johnston, Francis, Hardeman, & Eccles, 2008). Behavioural theories provide a systematic way of understanding behaviours by combining interrelated processes and constructs. Theories will often integrate relevant factors in a way that illustrates the causal mechanisms that lead to the behaviour (Glanz & Bishop, 2010). Theories are, therefore, often used to guide the search for why people do or do not perform certain behaviours in specific circumstances and helps to identity the relevant information that may translate to the construction of efficacious interventions (Glanz & Bishop, 2010; Glanz, Rimer, & Viswanath, 2008).

To date, there is a large body of research that demonstrates that theory-based interventions are more effective than a-theoretical interventions (Knittle et al., 2018; Michie & Abraham, 2004; Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016). By targeting key mechanisms of change, theory-based interventions may result in simpler, cheaper, and more effective population level behaviour change (Michie et al., 2017). There is evidence that some theory-based interventions are only as-good as a-theoretical interventions and that some of these cannot be applied to “the real world” (Hagger & Weed, 2019). Prestwich, Webb, and Conner (2015) argue that this is likely due to theory translation. While these interventions appear to be “theoretically inspired” they fail to adequately link intervention components to the determinant specified in the theory (Abraham, 2015; Hagger & Weed, 2019; Michie et al., 2017; Prestwich et al., 2015). Researchers must, therefore, become more adept at mapping theoretical determinants of behaviour to their interventions to provide greater confidence in the findings. Ultimately, interventions based on theory, can only be as good as the validity of the theory it is based on. To this end, it is of great importance to understand and test the constructs and proposed mechanisms within theories to determine the utility of the theory (Glanz & Bishop, 2010). Similarly, the process of theory validation may include the addition of variables that can improve the predictive or explanatory power of the theory (Ajzen, 2011; Sniehotta, Presseau, & Araújo-Soares, 2014). Furthermore, other variables may be identified that may moderate or mediate the associations between the theory constructs. Each of these processes should be thoroughly examined to provide the best likelihood of successful behaviour change when such variables or mechanisms of action are manipulated in interventions.

An overview of the current landscape of global health and the identification of relevant modifiable health behaviours has been the focus of the current section. The literature shows that, overall, industrialised nations have access to high quality healthcare and are rarely affected by serious communicable diseases. Many industrialised nations do, however, experience a high burden of disease related to non-communicable, lifestyle related issues. The most prevalent chronic diseases such as cardiovascular disease and many forms of cancer are, in part, the result of modifiable behaviours. For example, eating the recommended serves of fruits and vegetables, limiting exposure to high-level of UV radiation, brushing and flossing teeth twice daily, and reducing heavy episodic binge drinking can each promote longevity and well-being.

To effectively intervene to change these behaviours, theoretically based interventions should be constructed. For this to happen, relevant determinants should be identified, integrated, and tested in models of health behaviour change. Given the importance of behavioural theories in predicting and explaining behaviour, the next section will review the dominant theoretical approach to health behaviour change, reviewing their strengths and limitations, and proposing the addition of other relevant constructs.

Theoretical Overview

As reviewed in the previous section, there is a significant burden of disease, particularly in industrialized nations, that can be attributed to patterns of behaviour. While there are broader socio-cultural, environmental, political, or structural factors which influence population health, there are clear psychological and behavioural factors which individuals can adopt to promote well-being. Engaging in behaviours such as healthy eating (e.g., eating the recommended number of fruits and vegetables or restricting sugar-sweetened beverages) and sun-safety behaviours (e.g., wearing sunglasses or a hat when outside in daylight) can increase longevity and promote quality of life. Identifying the factors which predict and explain these health behaviours has, therefore, been at the forefront of interest in health psychology and behavioural medicine. To this end, using relevant theories, models, or frameworks has been central to identifying and systematically testing the relevant antecedents of behaviour (Michie & Abraham, 2004; Prestwich et al., 2015). Identifying the key psychological factors that relate to behaviour and the associated processes in psychological theories of behaviour can be useful to inform the development of interventions by identifying the targets for that need to be changed in order to modify the behaviour of interest (Bartholomew, Parcel, & Kok, 1998; Kok et al., 2016; Michie et al., 2008). There is some evidence that theory-based interventions can be more effective in changing behaviour (Avery, Donovan, Horwood, & Lane, 2013; Glanz & Bishop, 2010; Knittle et al., 2018) and provide more consistent effects (McEwan et al., 2019), while interventions that are not based on theory have limited capabilities to specify change mechanisms and do not contribute to knowledge on how interventions work and how they may be replicated and generalized.

To date, a considerable amount of the research on theory-based behaviour change interventions has been based on theories of social cognition (Conner & Norman, 2005; McEwan et al., 2019; Prestwich et al., 2014). Traditionally, theories of social cognition in health psychology have been applied to either explaining and predicting behaviour or to understand how people respond to interventions/treatment (Conner, 1993; Cooke, Dahdah, Norman, & French, 2016; Hagger, Chan, Protogerou, & Chatzisarantis, 2016; Jones, Smith, & Llewellyn, 2016; Rich, Brandes, Mullan, & Hagger, 2015). Theories such as the health belief model (Rosenstock, 1966, 1974), protection motivation theory (Rogers, 1975), social cognitive theory (Bandura, 1982), and the theory of planned behaviour (Ajzen, 1991) fall into the former category. These theories are based on individuals' beliefs about the behaviours, their outcomes, and their processing of information about those behaviours and outcomes.

The theory of planned behaviour is a social cognitive theory that has been particularly influential in the prediction of health behaviour across multiple contexts, behavioural domains, and populations (Ajzen, 2011; McDermott et al., 2015; Riebl et al., 2015). Yet, despite the consistent use and support for the theory of planned behaviour (Hagger, Polet, & Lintunen, 2018; McEachan, Conner, Taylor, & Lawton, 2011), there have been a number of well-documented criticisms that have called into question its utility in explaining behaviour (Armitage, 2015; Armitage & Conner, 2000; Sniehotta et al., 2014). In particular, the theory of planned behaviour and other social cognition theories focus on conscious, reflective processes at the exclusion of other non-conscious processes. The next section will introduce the theory of planned behaviour and discuss some of the notable criticisms. Additionally, the next section will describe ways the criticisms may be overcome, such as integrating other theory-driven determinants of behaviour.

Reasoned, Deliberative Approaches to Health Behaviours

The theory of planned behaviour. The Theory of Planned Behaviour (TPB; Ajzen, 1991) is a social cognition theory which seeks to predict people's intention and behaviour. The TPB has been extensively applied to health-related behaviour research and is regularly cited as a well-validated model of decision making (Davis et al., 2015; Nutbeam, Harris, & Wise, 2010). The TPB proposes that behaviour is predicted by individuals' intention to perform the behaviour in future. Intention is proposed to be determined by three constructs: attitudes, subjective norms, and perceived behavioural control. Attitudes are the positive or negative evaluations of performing the behaviour, whereas subjective norms are the perceived social expectations to perform the behaviour. Perceived behavioural control is the amount of control an individual believes they have in performing the behaviour, which is similar in conceptualization to self-efficacy or an individual's perceived capability in engaging in a behaviour (Ajzen, 1991; Johnston et al., 2014; Williams & Rhodes, 2016). Perceived behavioural control is also expected to directly influence behaviour when it closely reflects a person's actual control over the behaviour (Ajzen, 1991). Ajzen (1991) also hypothesised that the antecedents of attitudes, subjective norms, and perceived behavioural control are corresponding behavioural, normative, and control beliefs, respectively. Behavioural beliefs relate to the positive or negative outcomes which underpin an individual's behaviour. Normative beliefs refer to whether important groups or individuals, such as family and peers, approve or disprove of the behaviour. Control beliefs refer to beliefs which either facilitate or hinder the undertaking of the behaviour. These beliefs are expected to directly inform their associated construct within the TPB.

There are a number of predictions made in the TPB: attitudes and subjective norms are hypothesised to indirectly predict behaviour through intention while perceived behavioural control is thought to directly predict both intention and behaviour. In turn, behavioural, normative, and control beliefs predict attitudes, subjective norms, and perceived behavioural control, respectively. In addition, the influence of other factors such as traits, demographic variables, and environmental determinants on behaviour are argued to be mediated by constructs from the TPB (Ajzen, 1991).

The TPB has been shown to successfully predict intention and behaviour in a number of health behaviours including a range of physical activity behaviours, dietary behaviours, sun safety behaviours, alcohol related behaviours, and oral hygiene related behaviours (Arnautovska, 2017; Buunk-Werkhoven, Dijkstra, & van der Schans, 2011; Collins & Mullan, 2011; Cooke et al., 2016; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017; Starfelt Sutton & White, 2016). A meta-analysis that examined the prospective prediction of the theory found support for its utility in predicting health behaviours (McEachan et al., 2016). The meta-analysis revealed that attitudes, subjective norms, and the capacity subcomponent of perceived behavioural control to all be significant independent predictors of intention, explaining 58.7% of the variance. Intention, in turn, significantly predicted engagement in health behaviours. Interestingly, there were significantly different effect sizes between health promoting behaviours compared to health risk behaviours (i.e., attitudes and subjective norms were significant stronger predictors of health risk behaviours), suggesting that different variables made need to be targeted when attempting to change protective compared to risk behaviours (McEachan et al., 2016). In extending this research, Hagger et al., (2018) found that the inclusion of past behaviour led to a substantial attenuation of the effects of the theory constructs on intention and behaviour, although the effects were not extinguished.

The TPB has also been used to inform the development of health promotion interventions. The model has been applied to interventions seeking to change behaviours such as condom use, oral hygiene, dietary behaviours, and physical exercise (Hardeman et al., 2002; McEachan et al., 2011; Sheeran et al., 2016; Steinmetz et al., 2016). While many of these interventions have been successful in modifying behaviour, some have been criticised for poorly linking the theoretical determinants with relevant behaviour change techniques (Hardeman et al., 2005; Prestwich et al., 2015). When an intervention is accurately mapped to the TPB constructs with empirically supported strategies, there has been success in changing behaviours. For example, in a meta-analysis of behaviour change interventions based on the TPB (Steinmetz et al., 2016), the investigators found effect sizes between .14 and .68 for changes in the antecedents of behaviour (e.g., attitude, intention) and an average effect size of .50 across the interventions that measured behaviour. However, in the health related behaviours, only interventions focused on nutrition and physical activity had, on average, significant effect sizes associated with change in behaviour, while interventions based on drug and alcohol or adherence to medical regimens had negligible or negative average effects (Steinmetz et al., 2016). While the authors of the study did not provide insight into why there may be such differences in effect sizes between behaviours, one reason may be the nature of the behaviours. For example, alcohol/drug related behaviours may have an impulsive or addictive component, which would mean it is harder to change. Furthermore, the adherence to medical regime studies will, by the nature of the behaviour, include a disproportionately higher number of unhealthy, ill, or injured participants compared to healthy participants who take part in physical activity or nutrition interventions. Research has demonstrated that being ill or injured creates barriers for engagement in interventions, therefore reducing the perceived efficacy of those interventions (Kelly et al., 2016). Despite the widespread application of the TPB to predict health behaviours, there has been a number of criticisms levelled at it. One criticism includes the lack of clarity around belief-based antecedents of intention (Deci & Ryan, 1985, 2002; Hagger & Chatzisarantis, 2009). For example, there is no clear distinction between beliefs about outcomes individuals choose to seek (self-determined outcomes) compared to beliefs about outcomes they feel compelled to engage in (controlled outcomes) (Hagger & Chatzisarantis, 2009; Sheeran, Norman, & Orbell, 1999). Another criticism is that a number of people fail to engage in their desired health behaviour despite having the intention to do so. This drop off of motivated abstainers has been coined the intention-behaviour gap (Sheeran, 2002) and has been central to much commentary regarding theory development and utility in health psychology (Head & Noar, 2014; Schwarzer, 2014; Sniehotta et al., 2014). The TPB, as with many other theories of social cognition, has also been criticised for its sole focus on deliberative, conscious processes, to the exclusion of other important implicit, non-conscious, and automatic processes.

Research has shown that individuals' previous behaviour predicts future behaviour, over and above the variance that can be explained by theories of social cognition alone (Conner & Armitage, 1998; Hagger et al., 2018; Mullen, Hersey, & Iverson, 1987). Past behaviour has been hypothesised to reflect implicit or non-conscious processes that influence future behaviour in social cognition theories, outside of an individual's awareness (Evans, 2008; Ouellette & Wood, 1998). Past behaviour's effects could model multiple types of non-conscious processes. Often, past behaviour has been presumed to reflect habit and measures of past behavioural frequency have been used as a proxy of habit (Bagozzi, 1981; Bamberg, Ajzen, & Schmidt, 2003; Ouellette & Wood, 1998; Triandis, 1977). Past behaviour is not, however, a psychological construct that has any psychological content or meaning and is not a construct that can be modified directly. Thus, while past behaviour can be seen to provide substantive, non-zero residual effects on behaviour, attenuating the effects of social cognitive and other variables on future behaviour, understanding the potential mediators that offer meaning to its effect on behaviour is important.

This section has reviewed the application of TPB in health behaviour. The theory has been found to be effective in predicting behaviours, and as a basis for interventions to modify health behaviours. Critics of the theory suggest that the underpinnings of the belief-based antecedents of intentions are poorly specified, the intention-behaviour 'gap', and the sole focus on constructs that reflect conscious, deliberative processes. Given Ajzen (1991) specifically made provision for the inclusion of additional variables if they were theoretically relevant and captured significant variance to provide more utility in any given population, the following section will describe ways researchers have aimed to resolve these criticisms using complementary theoretical approaches.

Limitations of Reasoned Action Approaches and Complementary Theoretical Approaches

Self-determination theory. The TPB postulates that decision-making is guided by underlying beliefs (Ajzen, 1991), but does not outline in detail how individuals' form their beliefs and the determining factors. Self-determination theory (SDT), an organismic, macrotheory of human motivation which focuses on types of motivation rather than the intensity of motivation (Deci & Ryan, 2008a), has been proposed to provide potential determinants of the beliefs from the TPB. SDT is different from other motivational theories because of its focus on motivational quality rather than quantity alone. The theory outlines that humans, in pursuit of their basic psychological needs for autonomy, competence, and relatedness, have three types of motivation: autonomous motivation, controlled motivation, and amotivation. Autonomous motivation refers to engagement in activities and behaviours for self-endorsed reasons that are consistent with the genuine sense of self. Controlled motivation refers to engagement in activities and behaviours for reasons that are perceived to originate outside of the individual. Amotivation represents acting without a sense of motivation or intention (Deci & Ryan, 2008a, 2008b). Autonomous forms of motivation are expected to lead to persistent goal pursuit and are adaptive. Controlled motivation, on the other hand, is thought to provide persistence in goal pursuit only insofar as the reinforcer is present. Controlled motivation is not, therefore, thought to be linked with adaptive outcomes. The theory suggests that individuals motivation lies on a continuum ranging from controlled to autonomous forms of motivation (Deci & Ryan, 2002). The theory also proposes that activities and behaviours that are controlled motivated can be assimilated to be autonomous through an internalization process. A meta-analysis of SDT applied to health contexts provides evidence of the efficacy of the theory, with findings showing that the theory constructs are related to positive health outcomes (Ng et al., 2012).

Hagger and Chatzisarantis (2007) provide two premises for the integration of the TPB and SDT. First, they suggest that constructs from each theory may provide explanations of important processes leading to behavioural engagement. For example, an individual experiencing a behaviour as self-determined is more likely to seek out behaviours that are self-determined, because such behaviours are likely to satisfy their psychological needs for autonomy, competence, and relatedness. They will therefore align their beliefs with their motives, a strategic tendency which sets in motion the process leading to future action (positive attitudes, intentions etc.). A large body of research has tested the effects of models that integrate constructs of the TPB and SDT (see for example: Hamilton, Cox, & White, 2012; Jacobs, Hagger, Streukens, De Bourdeaudhuij, & Claes, 2011). Synthesizing this literature, a meta-analysis found support for the processes proposed in the integration of these theories to health-related behaviours (Hagger & Chatzisarantis, 2009). Despite the evidence regarding the successful integration of the SDT and the TPB, these motivational based theories of health behaviour do not provide sufficient explanations regarding why some people fail to implement their positive intentions or regarding the effects of other non-conscious processes. The next section will, therefore, continue to explore other complementary theoretical approaches to overcome the limitations of the TPB and integrated models based on it.

Dual-phase models. A further criticism of the TPB is the identified shortfall in the relationship between intention and behaviour. Researchers have observed across many samples that individuals report having an intention to perform a behaviour yet subsequently fail to do so. This intention–behaviour ‘gap’ has been found across many health behaviours (Head & Noar, 2014; Orbell & Sheeran, 1998; Rhodes & de Bruijn, 2013; Sheeran, 2002). Some researchers have proposed to differentiate between intention formation in a *motivation* phase and action initiation and maintenance in a *volitional* phase (Heckhausen & Gollwitzer, 1987; Schwarzer, 1992). Heckhausen and Gollwitzer (1987) noted that many people, after forming an intention, forget to carry out the intention or miss cues to initiate the action. They identified that after intention is formed, individuals need a plan which links a cue to action-initiation. Similarly, in the

Health Action Process Approach (HAPA), Schwarzer (1992) hypothesised that a volitional phase would include action plans and action control as means to promote better intention enactment.

Action planning has been identified as an important volitional factor which bridges the intention-behaviour gap. Action planning is a process of predetermining strategies and parameters of when, where, and how a behaviour will be carried out (Hagger & Luszczynska, 2014; Sniehotta, 2009). For example, an oral-hygiene plan could be ‘when I have finished watching the morning news at 7-am, I will brush my teeth for two minutes, in the bathroom’. The aim of an action plan is to form an association between a cue and an action, consistent with the individual’s intention to perform desired behaviour. Furthermore, as an action plan includes parameters for the behaviour (when, where, how) it is more likely to be enacted efficiently when the situational cue is encountered, similar to a habit (Sniehotta, Scholz, & Schwarzer, 2005), and is less easy to forget (Armitage, 2004). Not only has planning been found to aid in transforming an intention to action, but it has also been found to benefit behavioural maintenance by increasing persistence and decreasing potential for the individual to attend to distractions. Importantly, the action plan technique requires a low response burden, which is important to many individuals who may feel they have little time to engage in health behaviour change interventions, as well having the flexibility to be delivered in many formats (e.g., face-to-face, email, SMS) and being low cost to implement (Hagger & Luszczynska, 2014).

Not only has research demonstrated the efficacy of planning strategies, there are many examples of researchers testing integrated, dual-phase models that have typically found support for proposed effects and explained additional variance in health behaviours, over individual theories (Hagger & Chatzisarantis, 2014; Hamilton et al., 2011; Schwarzer, 1992; Schwarzer & Luszczynska, 2008). While these dual-phase models explain further variance in behaviour and identify relevant determinants of behaviour change, they still focus on factors that represent conscious, deliberative processes. To further develop theory to encompass constructs that represent processes other than the motivational and volitional stages of behaviour change, theorists have proposed integrating other non-conscious and implicit factors (Hagger & Chatzisarantis, 2014). Such non-conscious processes hypothesise that individuals engage in health behaviours more spontaneously or *automatically*, with little deliberation. The extent to which individuals' behaviour is determined by deliberative processes (i.e., represented by constructs from theories like the TPB), and constructs that reflect more automatic processes, likely differ according to context and behaviour, necessitating that both processes are taken into consideration in health behaviour change models. There is, however, a dearth of data that has tested such integrated theories, taking into consideration the limitations of theories that focus on factors representing deliberative processes such as the TPB, SDT, and the HAPA, with other non-conscious processes (Hagger, Trost, Keech, Chan, & Hamilton, 2017; Hamilton et al., 2017). The next section will outline current theory on non-conscious and implicit processes, demonstrating how their integration may facilitate understanding of the processes that lead to behavioural participation. In particular, the following sections will explore how research has typically used past behaviour to reflect non-conscious processes. As past behaviour is not a modifiable construct, the role habit as a construct may play in explaining the effects of past behaviour on subsequent behaviour in theories of health behaviour will be outlined.

Non-conscious and implicit processes. Many theories applied to predict health behaviour such as the TPB, SDT, and HAPA assume that behaviour is determined through a reflective, deliberative process (Ajzen, 1991; Deci & Ryan, 1985). However, accumulating evidence demonstrates that factors representing non-conscious and implicit factors play an important role in predicting health behaviour (Hagger et al., 2018; Phipps, Hagger, & Hamilton, 2019; Strack & Deutsch, 2004). Research suggests that health behaviour engagement can occur automatically, with little deliberation, or totally outside of conscious awareness. The premise of having two systems that act in parallel to determine behaviour; a rapid, nonconscious system and a slow, deliberate system, is known as a dual-system approach (Evans, 2008).

Dual-system or dual-process theories differentiate between *System 1* (impulsive) and *System 2* (reflective) processes (Kahneman, 2011; Kahneman & Frederick, 2002). For example, Strack and Deutsch (2004) proposed the Reflective-Impulsive Model (RIM). The RIM proposes that the two systems work concurrently, utilising stored knowledge about the behaviour and non-conscious schema formed through previous experiences in decision making. Dual-process theories typically expect the impulsive system to be triggered when a perceptual stimulus input is associated with a cluster of affective, behavioural, and physiological memories (i.e. there is a cued habitual response from a triggered stimulus) (Hofmann, Friese, & Wiers, 2008). The cue-response is typically established and strengthened through repetitive experience of the behaviour with associated affective, behavioural, and physiological experiences. For example, eating a hamburger regularly from a particular fast-food restaurant may lead to associated experiences and memories of relaxation and satiation. The cluster of cued-responses then may be quickly reactivated by seeing a sign for the fast-food restaurant or smelling the burger. These associated clusters of affective, behavioural, and physiological experiences form gradually over time and are thought to be outside an individual's awareness. Therefore, impulsive processes of behaviour can operate with minimal effort (Hofmann et al., 2008; Strack & Deutsch, 2004). The reflective system includes the use of high-ordered mental operations associated with executive functions such as evaluations, reasoned judgement, and action plans. The reflective, deliberative system is expected to be synonymous with the factors represented in theories of social cognition such as the positive or negative attitudes towards a behaviour or an individual's plan to engage in a behaviour.

Dual-process theories separate conscious, deliberative processes and non-conscious, impulsive processes; however, enactment of health behaviours is often not a function of one process alone, but an interplay of both. For example, an individual might attempt to purposely inhibit or disengage from an automatic behaviour, such as a dieter who chooses a nutritious salad (i.e., a reflective, conscious decision) over their usual burger and fries (i.e., an impulsive, habitual choice). Perugini (2005) found support for an interactive and exclusive model. When individuals make decisions regarding health behaviour, they sometimes use both systems (in an interactive way) or make use of only one system (in a mutually exclusive way). Hofmann et al. (2008) suggest there are situational and dispositional boundaries which increase the likelihood of either a reflective or impulsive decision is made in relation to a health behaviour. These conditions include habitualness (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007), ego depletion (Baumeister, Gailliot, DeWall, & Oaten, 2006), mood (Holland, de Vries, Hermsen, & van Knippenberg, 2012), and cognitive load (Friese, Hofmann, & Wänke, 2008).

The current section has focused on exploring dual-process theories and their capacity to overcome one of the criticisms of social cognition theories by accounting for factors representing both reasoned, deliberative processes and non-conscious, implicit, and automatic processes. In attempting to account for non-conscious processes, past behaviour has, at times, been included as an additional determinant of behaviour in theories of social cognition. While past behaviour can explain additional variance in future behaviour, it is not a modifiable construct. The next section will, therefore, describe the role of past behaviour in health behaviour theories, before introducing habit as a construct and how it can assist in advancing knowledge of past behaviour effects in these theories.

The Role of Past Behaviour

The effects of non-conscious, implicit or automatic factors have not typically been the focus of the dominant theories that have been applied to predict health behaviour. Some of these theories, such as the TPB, are viewed as sufficiently flexible to accommodate inclusion of other variables and constructs that account for additional variance in the outcomes (e.g., intention and behaviour) (Ajzen, 2011). In an effort to augment the role of non-conscious processes into existing theory, some researchers have included past behaviour frequency as an independent predictor of intentions and behaviour (Hagger et al., 2018; Norman & Conner, 2006; Norman & Cooper, 2011). While the addition of past behaviour has led to significantly more explained variance in future behaviour, it has limited theoretical value as it is not a modifiable construct. However, some researchers suggest that the observed pattern of effects of past behaviour may imply effects of other unmeasured constructs, like habit (Ouellette & Wood, 1998). Therefore, it is important to understand both what role past behaviour has in predicting and explaining behaviour, as well as what modifiable constructs account for the effects of past behaviour on future behaviour.

Past behaviour has been shown to independently predict future behaviour when included alongside other theory variables (Conner & Armitage, 1998; Hagger et al., 2018; Mullen et al., 1987). Some have argued that this is a mere statistical artefact that provides no meaning in causal models of human behaviour (Ajzen, 1987). It is said that past behaviour represents many psychological processes that generate consistent self-reporting in questionnaires and demonstrates temporal stability without providing insight into how or why this stability occurs (Ajzen, 2002). The lack of meaningful explanatory power has led some researchers to exclude past behaviour from theory development which is problematic for many reasons. If past behaviour is not included in such theories, researchers cannot understand the unique contribution of theory constructs on behaviour (Ajzen, 2002; Hagger et al., 2018). Similarly, it limits identification of the mechanisms that maintain behavioural consistency over time that many health practitioners, desiring to promote health behaviour change and maintenance, need to understand (Ajzen, 2002; Ouellette & Wood, 1998).

Research has shown that when past behaviour is included in social cognition theories like the TPB as an independent predictor of behaviour it frequently exhibits substantive residual effects on behaviour, and also attenuates the effects of social cognitive and other variables on future behaviour (Hagger et al., 2018; Norman & Conner, 2006; Norman & Cooper, 2011). In seeking to explain the residual effects of past behaviour, Ajzen (1992, 2002) argues that the residual effects are an artefact of assessing past behaviour and future behaviour using the same measure, leading to shared method variance. While this proposition may be true, other research, using differing measures of past and future behaviour have also found residual effects (Verplanken, 2006). Ajzen (1991) does, however, regard the role of past behaviour as a test of sufficiency of the TPB as he argues that the effects of past behaviour should be mediated through the model constructs (i.e., attitudes, subjective norms, and perceived behavioural control). In particular, Ajzen argues that the effects should be mediated through perceived behavioural control given the repeated experience of an action should enhance the perceptions of control over in engaging in it. Research, however, does not fully support this notion, with past behaviour having equally strong correlations with attitude and stronger correlations with intention (Conner & Armitage, 1998).

The proposal that the constructs in the TPB mediate (i.e., explain) the effect of past behaviour on future behaviour is consistent with the arguments made by Ouellette and Wood (1998). Specifically, the authors describe how behaviours that are novel or are not able to be repeated often are likely governed by conscious, intentional processes. Conversely, Ouellette and Wood (1998) hypothesized that well-practiced and repeated behaviours likely reflect habitual patterns that are expected to be repeated in the future. They suggest that these automatic behaviours can be in-line with a person's intention and goal or be perceived as non-volitional and counter-intentional (i.e., outside of an individual's awareness/control or in opposition to an individual's intention) (Gardner, Corbridge, & McGowan, 2015; Ji & Wood, 2007). Similarly, the theory of interpersonal behaviour explicates behaviour as a function of both intention and habit, both of which should be moderated by facilitating conditions (Triandis, 1977). Again, similar to the arguments of Ouellette and Wood (1998), Triandis proposes that new behaviours are likely a function of intention and other deliberative processes, whereby behaviours that can be repeated often are a function of automatic processes, such as habit.

Measures of past behaviour may reflect habit, but as past behaviour is not a construct, current measures of past behaviour do not provide the content or substance of what the effect represents. To date, past behaviour is often measured using arbitrary timeframes, which do not necessarily reflect the typical performance of a behaviour. For example, measures of health behaviours have been assessed over brief (e.g., one or two weeks: Gardner & Lally, 2013; Hagger et al., 2017; Kothe, Mullan, & Butow, 2012;

Mullan, Allom, Sainsbury, & Monds, 2015) and longer (e.g., one to six months: Caudwell, Keech, Hamilton, Mullan, & Hagger, 2019; Luszczynska & Cieslak, 2009; Phillips & Gardner, 2016; Scheerman, Hamilton, Sharif, Lindmark, & Pakpour, 2019) periods. Measuring past behaviour by arbitrary timeframes may miss important patterns of behavioural engagement that may occur across other extended timeframes. For example, there is often fluctuations to diet (Costa et al., 2013; Sturm, Patel, Alexander, & Paramanund, 2016), physical activity (Fowke et al., 2004), and sun safety behaviour (Sun et al., 2014; Xiang et al., 2015) across the seasons. Asking participants to reflect on their physical activity, over the last week in winter (when they are likely to be more sedentary), for example, may not adequately capture their typical performance of the behaviour across the rest of the year. As Ouellette and Wood (1998) predicted different patterns of effects would likely occur for behaviour that occurs more frequently compared to less often, it would seem reasonable for measures of past behaviour to account for recent and long-term enactments of behaviour. Similarly, Perugini and Bagozzi (2001) proposed differentiating long-term and frequent behaviours (i.e., up to one year) from more recent behaviours (within the last month). Yet, while changing measures of past behaviour may better represent different patterns of behavioural engagement, it would still only provide an observation of behaviour that does not provide relevant information on the conditions or processes that determine the behaviour. For example, observing a colleague eating vegetable snacks each day at lunch does not provide the relevant information to know the processes that determines the behaviour. The colleague may have their lunch packed for them, be intentionally adhering to a meal plan, or automatically preparing the snacks. Identifying a relevant psychological construct that reflects the stability of behaviour is, therefore, of great importance.

One construct that likely offers utility in explaining the effects of past behaviour on future behaviour is habit. Habit is defined as an automated action generated in response to well-learned situational cues or specific contexts (Mazar & Wood, 2018; Ouellette & Wood, 1998). It is believed that the cue-response associations are built up via instrumental learning, as people repeated behaviours in stable contexts (Gardner, 2015; Wood & Rünger, 2016). While habit includes repeated performance of a behaviour, it includes the conditions of cue/context stability and experience of automaticity that are missing from past behaviour frequency alone (Verplanken & Orbell, 2003). Habit may, therefore, provide a viable explanation to explain the significant effects past behaviour has on future behaviour.

The Role of Habit

Habit has been defined as a cue-response association, developed over-time through the repetition of an action in a stable context (Gardner, 2015; Mazar & Wood, 2018; Wood & Rünger, 2016). The features of automaticity and context-dependency, in particular, represent the habit impulse. Automaticity has the properties of being outside of awareness, goal-independent and, therefore, at times contrary to desires or intentions, as well as being efficient and fast (Gardner, 2012; Orbell & Verplanken, 2010; Wood & Rünger, 2016). Habits are expected to be cued by a stable internal (e.g., mood) or external (physical location) context (Ji & Wood, 2007). In turn, changes to the context attenuate habitual behaviours, leading to habit discontinuity (Haggar, Whitmarsh, & Skippon, 2019; Verplanken & Roy, 2016; Verplanken, Walker, Davis, & Jurasek, 2008). Habitual behaviours are inextricably linked to their associated contexts and the construct specifies its own development and subjective experience, providing important information regarding how it influences behaviour. Habits, however, are believed to differ from other forms of automatic processes, such as classical conditioning or nonassociated learning (Evans & Stanovich, 2013; Hagger, 2019). Habits are expected to directly relate to a specific behaviour or action that are enacted independent of goals (Wood, 2017; Wood & Rünger, 2016).

There is evidence to suggest many health behaviours are influenced by habits (Brug, de Vet, de Nooijer, & Verplanken, 2006; Gardner, 2015; Gardner, Rebar, & Lally, 2019). In turn, habits can directly predict a range of health behaviours such as fruit intake (Brug et al., 2006), snacking behaviours (De Vet, Stok, De Wit, & De Ridder, 2015), physical activity behaviours (Rebar, Elavsky, Maher, Doerksen, & Conroy, 2014; Rhodes & Rebar, 2017), and food-hygiene practices (Mullan, Allom, Fayn, & Johnston, 2014). There is also evidence that habit plays a role in predicting health behaviour across the lifespan (Gardner, Sheals, Wardle, & McGowan, 2014; Reinaerts, de Nooijer, Candel, & de Vries, 2007). At times, measures of behavioural frequency have been used as a proxy for habit. There have been concerns raised over the validity of the habit-by-proxy approach given repeated or frequent performance of a behaviour alone is not enough in developing the automatic quality of habit. Furthermore, measuring habit, past behaviour, and future behaviour by frequency reduces the clarity and distinction between these factors. It also likely inflates the true effect of behaviour and habit because of the shared method variance problem. Some research (van Bree et al., 2015; Verplanken, 2006) has been able to overcome this issue by using the Self-Report Habit Index (SRHI) (Verplanken & Orbell, 2003). The SRHI is a well-used, validated tool that captures three components of habit; repetition, automaticity, and self-identity. While the SRHI overcomes the frequency-only measurement of habit by adding other important elements, it has been argued to still add unnecessary items of frequency, which similarly risks biasing and inflating the true relationship between behaviour and habit (Gardner, 2012). Researchers are increasingly, therefore, using the automaticity items of the SRHI, now called the Self-Report Behavioural Automaticity Index (SRBAI; Gardner et al., 2012). The SRBAI has been praised both because it does not include the items of frequency which may inflate the true effect of habit, but also because the 4-item scale is short, easy to administer, and maintains similar validity to the SRHI (Gardner, 2015; Gardner et al., 2012). Still, the SRBAI has been criticised as merely measuring automaticity, which is only one of multiple facets of habit, as well as limited in that is reflects the "symptoms" of habit, as opposed to the actual psychological mechanism (Sniehotta & Presseau, 2012).

There is increasing research aimed at identifying the nonconscious and automatic factors that influence behaviour such as habit. This is particularly important in behaviour change and intervention research as clinicians often want to be able to change individuals' maladaptive habits that compromise health (i.e. fast-food consumption, excessive alcohol intake, or overexposure to the sun) and promote healthy habits (i.e., eating fruits and vegetables, engagement in flossing). This requires the understanding of both impulsive and reflective systems and the inclusion of both systems in health behaviour models (Rothman, Sheeran, & Wood, 2009; Strack & Deutsch, 2004). Understanding the role of habit, as a non-conscious, automatic factor, in conjunction with reflective, conscious determinants, is important to further advance theory applied to health behaviour (Gardner, 2014; Hagger & Chatzisarantis, 2014; Orbell & Verplanken, 2015). In particular, identifying the effects of habit on behaviour within the context of social cognitive models, and the associated processes, may provide some guidance on how to intervene to change 'bad' habits or promote 'good' habits. Numerous strategies have been proposed as means to break bad habits such as altering the environment and disrupting the cues-to-action that evoke the habitual behaviour (Haggar et al., 2019; Verplanken & Roy, 2016). In addition, research has suggested strategies that could help develop good habits such as using action plans that specify appropriate cues and, again, changing the physical environment to allow for frequent exposure to relevant cues (Beeken et al., 2012; Gardner, Lally, & Wardle, 2012; Lally & Gardner, 2013).

However, there is still a dearth of empirical data that have tested these mechanisms in a naturalistic setting (Gardner et al., 2014; Lally, Van Jaarsveld, Potts, & Wardle, 2010; Mullan, Allom, Fayn, & Johnston, 2014). Of the studies that have applied habit formation principles, overall, the strategies were able to be successfully promote health behaviours. For example, Gardner et al. (2014) found that simple habit-based techniques (e.g., identifying cues, establishing routines, planning actions and performance contexts) were acceptable to participants. It was also found that even poorly specified habit goals had little negative impact on habit strength after the intervention finished; in some cases, habit strength continued to increase at follow-up. Another study that used a novel behaviour (microwaving a kitchen sponge) was able to control for the effects of variability in previous behaviour as none of the participants had previously engaged in the behaviour (Mullan et al., 2014). The authors found that habit and behavioural frequency increased by using habit-formation techniques such as visual reminders and regular prompts.

In this section, research has been explored that has found the addition of measures of past behaviour explains significantly more variance in health behaviours than social cognitive constructs alone, which likely reflect non-conscious processes. As past behaviour is not a modifiable construct, identifying meaningful constructs that explains its influence on future behaviour is important. Measures that reflect habit, a cued automatic response, may offer a viable solution to understanding the past-to-future behaviour relationship.

Chapter Summary

Many of the documented health problems in Australia, and indeed globally, such as obesity and cancer, can be prevented or reduced by promoting modifiable health behaviours. The development of interventions that are effective in promoting these behaviours necessitates the need for a good understanding of the determinants of those behaviours, and the mechanisms and processes involved. Behavioural theories offer much in terms of identifying these determinants and may help identify potential modifiable targets for behaviour change interventions (Glanz & Bishop, 2010). In doing so, behavioural theory must incorporate contemporary research regarding the roles of psychological determinants of health. The purpose of this chapter was to introduce some of the dominant theories that have been applied to predict health behaviour, particularly theories adopting a social cognition approach (Armitage & Conner, 2000; Conner & Norman, 2005). While meta-analyses have indicated that theories of social cognition such as the TPB have been effective in explaining substantive variance in health behaviours, a key limitation is that they tend to focus on constructs that represent reflective, deliberative processes (Evans, 2008). In addition, the introduction of past behaviour as an additional predictor of behaviour in social cognition models has increased the explained variance in behaviour and attenuated the influence of theory constructs on behaviour. Researchers have suggested that past behaviour may reflect effects attributable to habits or non-conscious processes. Accounting for past behaviour also provides information on the extent to which behaviour is under the control of deliberative or non-conscious processes. However, such explanations are only inferred because past behaviour is not a construct and, therefore, residual effects provides little direct verification of the processes involved. There has therefore been increasing efforts to identify means to capture the effect of past behaviour on future behaviour using constructs such as habit, using alternative measures that reflect key features of habits such as its automaticity. However, there is still a dearth of studies that explicitly investigate effects of habit constructs alongside past behaviour (Bamberg et al., 2003; van Bree et al., 2015; Verplanken, 2006), and specifically the effects of habits in relation to past behaviour effects in existing social cognition theories. By further examining the role of past behaviour and habit, a better understanding of the determinants that predict and explain behaviour can be identified. Given the current gaps in the literature, Chapter 2 will provide an overview of the current program of research.

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Chapter 2: Thesis Overview

The preceding chapter demonstrated the importance of understanding the role of non-conscious, automatic processes, in addition to conscious, deliberative processes, in individuals' engagement in health behaviours. This understanding provides necessary formative evidence that may guide the development of efficacious, theory-driven interventions aimed at promoting healthy and breaking unhealthy behaviour, and rests on several key gaps in the literature being addressed. Specifically, a sizeable portion of previous research has focused solely on reasoned-action or deliberative, conscious processes at the expense of other relevant factors (Conner & Norman, 2005; Hagger, Chatzisarantis, & Biddle, 2002; Hagger, Polet, & Lintunen, 2018; McEachan, Conner, Taylor, & Lawton, 2011). For example, there is evidence that past behaviour affects future behaviour, and this is suggested to represent automatic processes such as habit (Bamberg, Ajzen, & Schmidt, 2003; Norman & Conner, 2006; Ouellette & Wood, 1998). The overarching aim of the current program of research was to investigate the role of past behaviour and habit in health behaviours. To achieve this aim, this program of research used mixed methods to quantitatively model constructs that underpin non-conscious, automatic processes and conscious, deliberative processes; and, qualitatively explore lay representations of habit. Three specific aims of the program of research are detailed below and are addressed in a series of four papers presented in Chapters 3, 4, 5, and 6. See Figure 2.1 for a visual overview of the research conducted in this thesis.

Research Aim 1

The first aim of the thesis was to understand the effect of past behaviour in an integrated, dual-phase model of health behaviour that focuses on multiple deliberative processes.

While there is considerable research testing the effects of individual theories of health behaviour (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Armitage & Conner, 2000; Ng et al., 2012), which often focus on specific processes (e.g., motivation or volition), there still remains a paucity of research integrating and testing these processes together to understand the combined effects on future health behaviour. Similarly, while there has been research investigating the effect of past behaviour on future behaviour (Ajzen, 2002; Bamberg et al., 2003; Norman & Cooper, 2011), there has been little research understanding past behaviour effects in integrated models. Furthermore, there are similarly few studies that explicitly demonstrate the attenuating effects of past behaviour on both deliberative processes and future behaviour. Therefore, Paper 1 tested an integrated, multi-theory, dual phase model of health behaviour, further exploring the contribution of past behaviour. The model was tested by investigating fruit and vegetable consumption of Australian long-haul heavy goods vehicle (HGV) drivers (n = 212), a population group with reported high levels of overweight and obesity and at risk of poor eating habits. Structural equation modelling was used to identify the relative contributions of motivation, social cognition, and volition to the prediction of fruit and vegetable consumption, one week later. Importantly, the contribution of past behaviour was explored by reporting all the effects of the model with and without the addition of past behaviour.

Research Aim 2

The second aim of the thesis was to explain the effects of past behaviour on future behaviour, with a focus on the role of habit.

While the current literature has demonstrated that past behaviour predicts future behaviour, few studies have tested the mechanisms which explain the relationship. Dual-process models hypothesise that behavioural engagement is composed of both conscious and non-conscious processes (Evans, 2008). Similarly, past behaviour has been proposed to affect future behaviour by both deliberative constructs underpinning conscious processes such as intention, as well as automatic constructs underpinning non-conscious processes such as habit (Ouellette & Wood, 1998). However, to date, there has been little evidence that has demonstrated mediation effects of constructs that reflect both deliberative and automatic processes (Bamberg et al., 2003; van Bree et al., 2015; Verplanken, 2006). Paper 2, therefore, sought to test a model that included constructs that represent reasoned action and automatic processes across three distinct health behaviours and populations: binge drinking in university students (*n* = 321), flossing in adults (*n* = 253), and parental sun safety behavior of children 2 – 5 years of age (*n* = 192).

In further exploring the second aim of the thesis, Paper 3 investigated two types of habit (i.e., goal-directed and counter-intentional) with intention whilst accounting for the effects of past behaviour. Structural equation modelling was employed to explore the pattern of effects across the two health-promoting nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables and restricting sugar sweetened beverages) and two populations (i.e., middle school students ages 11 – 14 (*n* = 266) and university students aged 17 – 24 (*n* = 340)).

Research Aim 3

The third aim of the thesis was to gain a rich understanding of lay representations of habit.

The preceding studies addressed the role of past behaviour and habit in models of health behaviour. However, there remains a knowledge gap regarding lay beliefs and representations of habit. To date, limited studies have qualitatively investigated the construct of habit, habit measurement, habit formation, and the role of habit in health behaviours (Gardner & Tang, 2014; Lally, Wardle, & Gardner, 2011). This understanding is important and may further inform scientific discourse, measures, and interventions on habit. To address this gap, Paper 4 used two studies, an online-questionnaire using an open-ended question format to elicit how participants define habit (*n* = 158), followed by interviews and focus-groups (10 participants interviewed individually, and 17 participants who were interviewed in seven focus groups) to triangulate the data and further explore lay representations of habits.

Chapter Summary

This chapter provided an overview of existing gaps in knowledge regarding the role of past behaviour and habit in health behaviour, and how the current research aimed to fill those knowledge gaps. First, research testing integrated models that include constructs that underpin multiple deliberative processes (i.e., motivation, volition) in heath behaviour while also accounting for the effects of past behaviour is currently limited. Paper 1 tested such an integrated model and found that past behaviour attenuated model effects, particularly the intention-behaviour relationship, signalling other important processes are likely being missed. To account for this, automatic and deliberative variables were tested in Paper 2, finding that automatic but not deliberative constructs significantly mediated (i.e., accounted for) the past-to-future behaviour relationship. Further, given Paper 2 highlighted the important role of habit, Paper 3 wanted to overcome the paucity of data exploring multiple automatic constructs simultaneously with deliberative constructs. The mixed effects found in Paper 3 highlighted that there could be issues in the conceptualisation and measurement of habit, particularly from a lay-person perspective. Paper 4, therefore, qualitatively explored lay representations of habit, in a first step to addressing this gap in the literature.

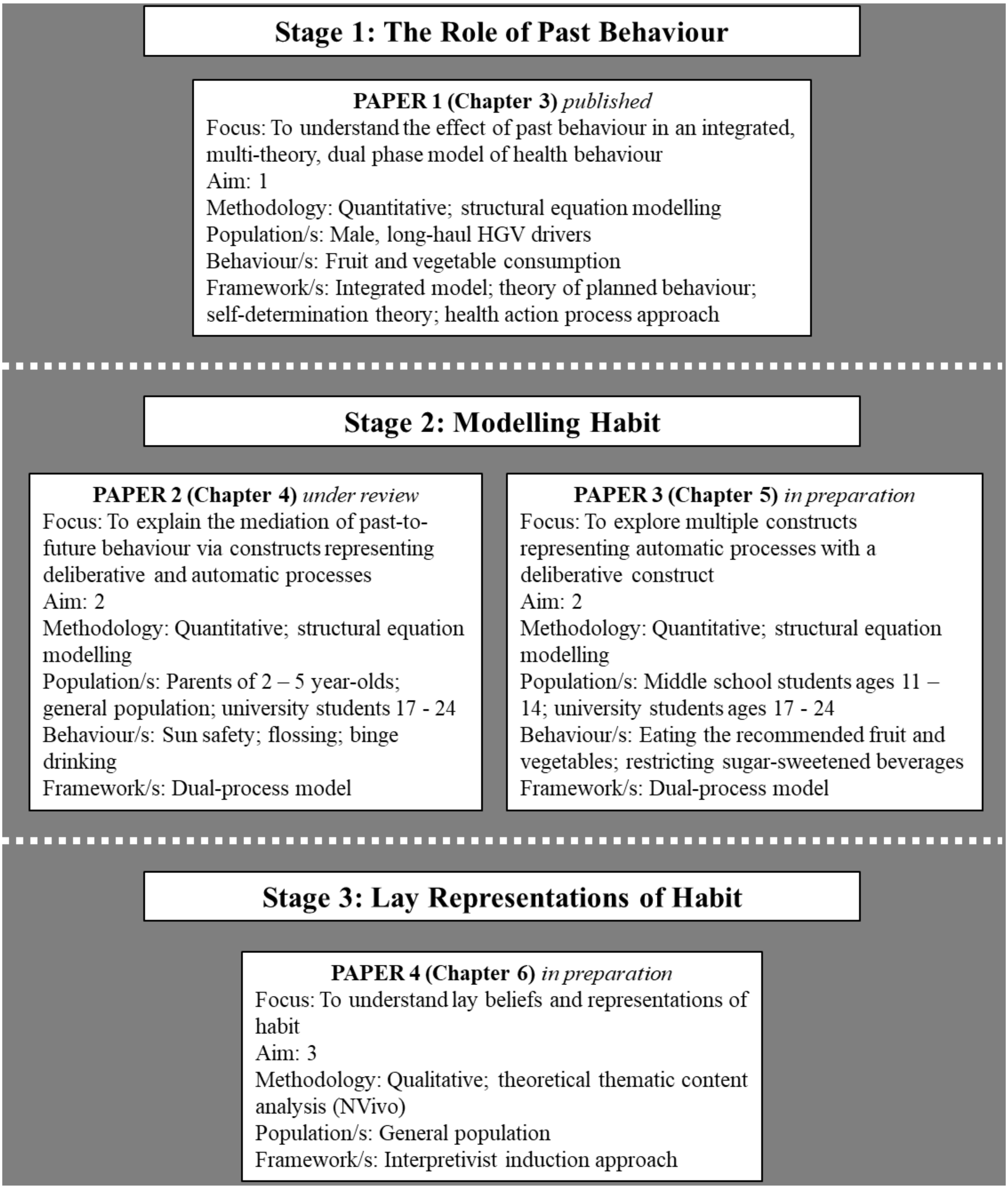

Figure 2.1. Visual overview of the research aims and respective studies and papers adressing the aims in this thesis

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Chapter 3: Predicting Fruit and Vegetable Consumption in Long-Haul Heavy Goods Vehicle Drivers: Application of a Multi-Theory, Dual-Phase Model and The Contribution of Past Behaviour (Paper 1)

This chapter contains a paper based on Aim 1 of the thesis that has been accepted and published in the journal *Appetite* (Impact Factor 3.174; SCImago ranking Q1). The PhD Candidate is the first author of the paper and co-authors are the supervisory team. The PhD Candidate takes overall responsibility for the publication and all co-authors meet criteria for authorship. Electronic supplementary material to the paper are attached at the end of the chapter.

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

Brown, D. J., Hagger, M. S., Morrissey, S., & Hamilton, K. (2018). Predicting fruit and vegetable consumption in long-haul heavy goods vehicle drivers: Application of a multi-theory, dual-phase model and the contribution of past behaviour. *Appetite*, *121*, 326–336. https://doi.org/10.1016/j.appet.2017.11.106

The PhD Candidate’s contribution to the paper involved collection of the data, analysis and interpretation of the data, writing the manuscript, and revising the manuscript in the publication process. The PhD Candidate's supervisors provided supervision and advice at all stages and provided comments on the manuscript drafts.

(Signed) ________________________________ (Date)__29/12/19____________

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(Countersigned) __________________________ (Date)__ 29/12/19____________

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(Countersigned) __________________________ (Date)___ 29/12/19___________

Principal Supervisor: A/Prof Kyra Hamilton

Predicting fruit and vegetable consumption in long-haul heavy goods vehicle drivers: Application of a multi-theory, dual-phase model and the contribution of past behaviour

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Abstract

Fruit and vegetable intake is insufficient in industrialized nations and long-haul heavy goods vehicle (HGV) drivers are considered a particularly at-risk group. The aim of the current study was to test the effectiveness of a multi-theory, dual-phase model to predict fruit and vegetable consumption in Australian long-haul HGV drivers. A secondary aim was to examine the effect of past fruit and vegetable consumption on model paths. A prospective design with two waves of data collection spaced one week apart was adopted. Long-haul HGV drivers (*N* = 212) completed an initial survey containing theory-based measures of motivation (autonomous motivation, intention), social cognition (attitudes, subjective norms, perceived behavioural control), and volition (action planning, coping planning) for fruit and vegetable consumption. One week later, participants (*n* = 84) completed a self-report measure of fruit and vegetable intake over the previous week. A structural equation model revealed that autonomous motivation predicted intentions, mediated through attitudes and perceived behavioural control. It further revealed that perceived behavioural control, action planning, and intentions predicted fruit and vegetable intake, whereby the intention-behaviour relationship was moderated by coping planning. Inclusion of past behaviour attenuated the effects of these variables. The model identified the relative contribution of motivation, social cognition, and volitional components in predicting fruit and vegetable intake of HGV drivers. Consistent with previous research, inclusion of past fruit and vegetable consumption led to an attenuation of model effects, particularly the intention-behaviour relationship. Further investigation is needed to determine which elements of past behaviour exert most influence on future action.

Introduction

Professional long-haul heavy goods vehicle (HGV) drivers are a population that is particularly at risk of chronic disease. Drivers spend long hours in a single, sedentary body posture, have poor sleep hygiene, and lack adequate nutrition (Apostolopolous, Sonmez, Shattell, Gonzales, & Fehrenbacher, 2013; Birdsey et al., 2015; Sieber et al., 2014). It is, therefore, not surprising that long-haul HGV drivers have been documented to have obesity rates three times higher than the average population (Birdsey et al., 2015), with other studies reporting over 80% of the sample of HGV drivers being overweight or obese (Body Mass Index ≥ 25) (Hamilton, Vayro, & Schwarzer, 2015). In an attempt to address the health risks associated with long-haul driving and to understand the poor health habits of this at-risk group, studies have investigated the social and psychological beliefs that may guide long-haul drivers' eating decisions. For example, Vayro and Hamilton (2016) identified a number of salient behavioural, normative, and control beliefs that relate to HGV drivers' dietary decisions, which is consistent with previous research in other health behaviour contexts (Chan et al., 2015; Cowie & Hamilton, 2014; Hamilton, Kirkpatrick, Rebar, White, & Hagger, 2017; Hamilton, Peden, Pearson, & Hagger, 2016; Hamilton, White, et al., 2012; Rowe et al., 2016; Tanna, Arbour-Nicitopoulos, Rhodes, Leo, & Bassett-Gunter, 2015), and eating behaviours in the general population (Sainsbury & Mullan, 2011; Spinks & Hamilton, 2015).

The elicitation of the salient beliefs provides a starting point for examining the multiple social psychological factors that likely underpin drivers' decisions to consume fruit and vegetables. The beliefs are components of broader behavioural theories derived from social psychology that may provide a framework for identifying the salient factors that relate to fruit and vegetable consumption, and the processes by which they affect behaviour. The purpose of the current study was to apply a behavioural model comprising constructs from multiple social cognitive and motivational theories to predict fruit and vegetable consumption in long-haul HGV drivers. The model incorporates multiple processes purported to underpin behaviour, including the factors that determine intentions to act, the mechanism by which the intentions are enacted, and how past participation in the behaviour may affect the determinants of subsequent behavioural enactment.

Multi-theory, dual phase model of fruit and vegetable consumption

Many theories applied to predict and understand health-promoting dietary behaviours have adopted a social cognitive perspective. According to the theories, engaging in dietary behaviours is a deliberative and intentional process (Ajzen, 1991, 2011) and intention is assumed to be the most proximal antecedent of behavioural engagement (Armitage & Conner, 2000; Conner & Norman, 2015). Prominent among intentional theories applied to dietary behaviour is the theory of planned behaviour (TPB; Ajzen, 1991; Emanuel, McCully, Gallagher, & Updegraff, 2012; Guillaumie, Godin, & Vézina-Im, 2010; Kothe, Mullan, & Butow, 2012). According to the TPB, intentions to perform a given behaviour in the future is a function of attitudes (i.e., the positive or negative evaluations of performing the behaviour), subjective norms (i.e., the perceived social expectations to perform the behaviour), and perceived behavioural control (i.e., the amount of control an individual believes he/she have over performing the behaviour). The TPB has been shown to account for up to 41% of the variance in intention and 35% of the variance in behaviour across a number of health related behaviours (Conner & Armitage, 1998; Godin & Kok, 1996; McDermott et al., 2015; Riebl et al., 2015; Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008) including up to 41% of the variance in intention and 45% of the variance in dietary behaviours (Collins

& Mullan, 2011; Fila & Smith, 2006; Guillaumie et al., 2010; Hamilton, Daniels, White, Murray, & Walsh, 2011; Mullan, Wong, & Kothe, 2013; Mullan, Wong, Kothe, & Maccann, 2013; Spinks & Hamilton, 2016; White, Terry, Troup, Rempel, & Norman, 2010). The TPB will therefore form the basis of the current hypothesised model. However, research applying the TPB in health behaviour has identified substantive limitations (Sniehotta, Presseau, & Araújo-Soares, 2014). Sniehotta et al. (2014) has been particularly critical of the future use of the TPB as a sole behavioural change framework. Prominent limitations of the TPB include the lack of explicit detail on why certain beliefs are pursued (Hagger & Chatzisarantis, 2009), and the imperfect link between intentions and behaviour suggesting that while many individuals tend to make intentions to perform health behaviours, many do not act on them (Orbell & Sheeran, 1998). Integrating other theoretical perspectives has been recommended as a possibility to address these limitations and provide a more effective explanation of the determinants of dietary behaviour (Sniehotta et al., 2014). A number of theoreticians and researchers have proposed and tested ‘extended’ or integrated models of behaviour change such as the integrated behaviour change model (Hagger & Chatzisarantis, 2014), the integrated model of behavioural prediction (Fishbein & Yzer, 2003), and the trans-contextual model (Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003).

One perspective that may assist in explaining the origins of people’s beliefs regarding health behaviours is self-determination theory (SDT). The theory is an organismic, macrotheory of human motivation which focuses on motivation quality rather than intensity (Deci & Ryan, 1985, 2008b). SDT identifies two broad types of motivation: autonomous and controlled. Autonomous motivation refers to the engagement in an activity because it is perceived to be self-endorsed, freely chosen, and absent from any external contingency. In contrast, controlled motivation reflects acting due to externally-referenced pressure or contingency, or to attain a reward or avoid punishment (Deci & Ryan, 2008a, 2008b). According to SDT, it is autonomous motivation that is the most likely form of motivation to be related to persistence on tasks and attainment of adaptive outcomes (e.g., positive affect, enjoyment, interest, well-being) because the reasons for participating are consistent with an individual's true autonomous self. In contrast, controlled motivation is related to persistence only as long as the controlling contingencies are present, and is not related to adaptive outcomes. Deci and Ryan (1985) explicitly align motivational forms from SDT with social cognitive factors that underpin behaviour. They suggest that individuals perceiving a given behaviour to be autonomously motivated are likely to strategically align their beliefs about performing the behaviour in future (e.g., attitudes, perceived behavioural control) with their motives. Research has shown that individuals classify their beliefs accordingly (Chatzisarantis, Hagger, Wang, & Thøgersen-Ntoumani, 2009; Hamilton, Cox, & White, 2012; McLachlan & Hagger, 2011; Wilson & Rodgers, 2004) and formed the basis of an integrated model in which autonomous beliefs served as an antecedent of the belief-based constructs from the TPB (Hagger & Chatzisarantis, 2009). The integrated TPB and SDT model provides a basis for the antecedent beliefs from the TPB and demonstrates the process by which generalized motives are enacted.

Research applying the model that integrate the TPB and SDT in health behaviour contexts has demonstrated significant effects of autonomous motivation on the belief-based constructs from the TPB (attitudes, subjective norms, and perceived behavioural control), significant effects of belief-based constructs on intentions, and a significant intention-behaviour relationship (Girelli, Hagger, Mallia, & Lucidi, 2016; Hagger, Trost, Keech, Chan, & Hamilton, 2017; Hamilton, Cox, et al., 2012; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017). Importantly, significant effects of autonomous motivation on behaviour were found mediated by the belief-based constructs from the TPB and intentions. An earlier meta-analysis examining the cumulative findings of research on the integrated TPB and SDT model in health-related behaviour context supported its predictions (Hagger & Chatzisarantis, 2009). Specifically, attitudes, subjective norms, and perceived behavioural control were able to mediate the relationship between autonomous motivation and intentions. These effects have been predominantly tested using prospective studies with follow-up periods ranging from one to five weeks (Hagger & Chatzisarantis, 2009). One study investigated the integration of SDT variables with the TPB in a three-wave prospective design in two university samples; one for diet and one for exercise behaviours (Hagger, Chatzisarantis, & Harris, 2006). Structural equation modelling supported the sequence of indirect effects in exercise behaviours and both the direct and indirect effects of the sequence in dieting behaviours. Given the effectiveness of the model in accounting for variance in the antecedents of intentions and health behaviour, the current investigation adopted a model that integrated constructs from the TPB and SDT to explain fruit and vegetable consumption in long-haul HGV drivers. Specifically, we included autonomous motivation as a direct predictor of attitudes, subjective norms, and perceived behavioural control. We did not include controlled motivation for three reasons. First, controlled motivation has a limited role relative to autonomous motivation as a determinant of adaptive behavioural outcomes (Chatzisarantis, Hagger, Biddle, Smith, & Wang, 2003). Second, meta-analytic research (Chatzisarantis et al., 2003; Howard, Gagné, & Bureau, 2017) supports the notion that autonomous and controlled motivation can be conceptualised as operating on a continuum. For example, graduated indexes of motivation based on weighted composites of autonomous and controlled forms of motivation tend to correlate well with single measures of autonomous motivation

(Pelletier & Sarrazin, 2007). Finally, the single construct of autonomous motivation reduces the number of constructs in an already complex model.

This model alone, however, does not provide sufficient explanation for people's failure to implement their intentions. Sheeran (2002) identified an intention–behaviour 'gap' in social cognitive models, noting that a substantial proportion of individuals who stated having an intention to act often failed to do so, an effect noted in many studies of health behaviour (Orbell & Sheeran, 1998; Rhodes & Bruijn, 2013). One perspective on the shortfall in the prediction of health behaviour by intentions comes from dual-phase models of behaviour, such as Heckhausen and Gollwitzer's (1987) model of action phases and Schwarzer's (1992) health action process approach (HAPA). The model of action phases differentiates between a motivational phase, in which intentions are formed, and a volitional phase, in which action is initiated (Heckhausen & Gollwitzer, 1987). Heckhausen and Gollwitzer (1987) noted that many people, after forming an intention, forget to carry the intention out or miss cues to initiate the action. They identified that after an intention is formed, individuals need to engage in planning to provide an explicit link between relevant cues in the environment or social context and action initiation.

Planning is a key self-regulatory strategy in the volitional phase which has been shown to 'bridge' the intention-behaviour 'gap' (Gollwitzer, 1999; Gollwitzer & Sheeran, 2006; Hamilton, Bonham, Bishara, Kroon, & Schwarzer, 2017; Hamilton, Kothe, Mullan, & Spinks, 2017). Planning is conceptualised as comprising both action planning and coping planning. Action planning is a task-facilitating self-regulation strategy where individuals specify relevant cues to an intended behaviour (Guillaumie, Godin, Manderscheid, Spitz, & Muller, 2012). This is usually achieved by prompting individuals to state when, where, and how the behaviour will be carried out (Hagger &

Luszczynska, 2014; Sniehotta, 2009). Coping planning is a self-regulation strategy where individuals anticipate barriers that may hinder performance and mentally link an appropriate response (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). Action planning variables have been hypothesised to act as a mediator (Schwarzer, 2008) and moderator (Heckhausen & Gollwitzer, 1987; Hagger and Chatzisarantis, 2009) of the effect of intentions on behaviour. The moderating relationship is consistent with the prediction of the model of action phases (Heckhausen & Gollwitzer, 1987), suggesting that introducing plans lead to stronger effects of intentions on behaviour. Empirical literature has shown support for this effect (de Bruijn, Rhodes, & van Osch, 2012; Norman & Conner, 2005; Wiedemann et al., 2009). The mediation account suggests that intentions are enacted because individuals engage in planning, consistent with hypotheses from the HAPA and recently referred to as a *dual mediation model* (Carraro & Gaudreau, 2013). Empirical literature has also provided support for this effect (Schwarzer et al., 2010; Schwarzer et al., 2007; Zhou et al., 2015). In the current study, we aim to augment the integrated TPB and SDT model to incorporate volitional components from dual phase models in an integrated multi-theory, dual-phase model to predict long-haul HGV drivers' fruit and vegetable consumption. Specifically, we propose that action and coping planning will mediate and moderate the intention–behaviour relationship, consistent with the model of action phases and HAPA, respectively.

Our proposed multi-theory, dual-phase model reflects the hypotheses derived from motivational and social-cognitive theories which assume behaviour is enacted through a deliberative process (Ajzen, 1991; Deci & Ryan, 1985). Evidence, however, also indicates that implicit and automatic processes may play an important role in health behaviour decision making (Hagger & Chatzisarantis, 2014; Strack & Deutsch, 2004).

Individuals' past actions therefore, may be important to consider. There is consistent evidence that including past behaviour as a predictor of behaviour in tests of social cognitive models increases the amount of explained variance in intentions and, particularly, future behaviour (Aarts, Verplanken, & Knippenberg, 1998; Ouellette & Wood, 1998; Verplanken & Orbell, 2003). Researchers suggest two functions for past behaviour. First, it likely models habitual processes, that is, the aspects of behaviour that are unaccounted for by the social cognitive components that reflect deliberative, reasoned decision-making in advance of acting. This is modelled by the unique effects of past behaviour on future behaviour that bypass intentions and its antecedents in social cognitive models. Second, past behaviour may reflect effects of unmeasured constructs on behaviour. It is possible that these may be deliberative but not accounted for by the specified social cognitive variables, or implicit, which may reflect non-conscious beliefs related to automatic, non-conscious processes. Despite the importance of past behaviour on future behaviour, research has rarely explicitly tested the impact of past behaviour on individual or integrated health behaviour models. Importantly, for the current investigation, long-haul HGV drivers often follow a relatively fixed driving schedule and route which determines where and when they can eat. It is therefore likely that long-haul drivers' dietary decisions may be guided by routine and, thus, strongly affected by past behaviour. We aimed to test the impact of past behaviour on the multi-theory, dual-phase model's ability to predict and explain fruit and vegetable consumption for long-haul HGV drivers.

The Current Study

The aim of the current study was to test a multi-theory, dual-phase model to predict fruit and vegetable consumption in a sample of long-distance HGV drivers in Australia. The proposed model is presented in Figure 1 and hypothesized relations among model constructs are summarised in Table 1. The motivation phase comprised hypotheses derived from research integrating the TPB (Ajzen, 1991) and SDT (Ryan & Deci, 2000). Given that research has shown that autonomous motivation acts as a distal predictor to the belief-based antecedents of action from the TPB (Hagger & Chatzisarantis, 2009), autonomous motivation was expected to predict attitudes (H_1), subjective norms (H_2), and perceived behavioural control (H_3). Consistent with the TPB, attitudes (H_4), subjective norms (H_5), and perceived behavioural control (H_6) was expected to predict intention, intention was expected to predict behaviour (H_7) and perceived behaviour control (H_8) was also expected to directly predict behaviour to the extent that it acts as a proxy for actual control (Ajzen, 1991). The volitional phase of the hypothesised model integrates hypotheses from the model of action phases (Heckhausen & Gollwitzer, 1987) and the HAPA (Schwarzer, 2008). It was expected that intention would predict action planning (H_9) and coping planning (H_{10}), and action planning (H_{11}) and coping planning (H_{12}) were hypothesized to predict behaviour. It was expected that there would be no direct relationship between autonomous motivation and behaviour (H_{13}). We also expected action planning (H_{14}) and coping planning (H_{15}) to moderate the intention on behaviour relationship. A number of indirect relationships were also expected. We predicted that attitudes (H_{17}), subjective norms (H_{18}), and perceived behavioural control (H_{19}) would have indirect effects on behaviour mediated by intention. Autonomous motivation was hypothesised to predict intention (H_{20}) and behaviour (H_{21}) indirectly, mediated by the social cognitive variables in the model. The effects of intentions on behaviour were expected to be mediated by action planning (H_{22}) and coping planning (H_{23}), respectively, consistent with hypotheses from the HAPA. Collectively, these hypotheses replicate the explicit components of reflective and deliberative processes. We also predicted that past behaviour would significantly and directly predict all constructs in the hypothesised model (H_{16}). However, consistent with theory and findings from the literature on past behaviour frequency and habit (Ouellette & Wood, 1998; Perugini & Bagozzi, 2001; Rothman, Sheeran, & Wood, 2009) we expected that effects in the model would be attenuated with the inclusion of past behaviour. The attenuation notwithstanding, we predicted that the pattern of effects proposed in the theory would remain statistically significant. We expected results would demonstrate the relative contribution of constructs from the two phases (motivational and volitional) on fruit and vegetable consumption as well as the effect of past behaviour on motivational and social-cognitive constructs.

Table 1.

Summary of hypothesised direct and indirect effects in the multi-theory, dual phase model of fruit and vegetable consumption

Hypothesis	Independent Variable	Dependent Variable	Mediator	Prediction[a]
Direct effects				
H_1	Autonomous motivation	Attitude	-	Effect (+)
H_2	Autonomous motivation	Subjective norm	-	Effect (+)
H_3	Autonomous motivation	Perceived behavioural control	-	Effect (+)
H_4	Attitude	Intention	-	Effect (+)
H_5	Subjective norm	Intention	-	Effect (+)
H_6	Perceived behavioural control	Intention	-	Effect (+)
H_7	Intention	Behaviour	-	Effect (+)
H_8	Perceived behavioural control	Behaviour	-	Effect (+)
H_9	Intention	Action planning	-	Effect (+)
H_{10}	Intention	Coping planning	-	Effect (+)
H_{11}	Action planning	Behaviour	-	Effect (+)
H_{12}	Coping planning	Behaviour	-	Effect (+)
H_{13}	Autonomous motivation	Behaviour	-	No effect
H_{14}	Action planning x Intention	Behaviour	-	Effect (+)
H_{15}	Coping planning x Intention	Behaviour	-	Effect (+)
H_{16}	Past behaviour	Autonomous motivation Attitude Subjective norms Perceived behavioural control Intention Action planning Coping planning Behaviour	-	Effect (+)
Indirect effects				
H_{17}	Attitude	Behaviour	Intention	Effect (+)
H_{18}	Subject norm	Behaviour	Intention	Effect (+)
H_{19}	Perceived behavioural control	Behaviour	Intention	Effect (+)
H_{20}	Autonomous motivation	Intention	Attitude Subjective norm Perceived behavioural control	Effect (+)
H_{21}	Autonomous motivation	Behaviour	Attitude Subjective norm Perceived behavioural control Intention	Effect (+)
H_{22}	Intention	Behaviour	Action planning	Effect (+)
H_{23}	Intention	Behaviour	Coping planning	Effect (+)

Note. [a]Denotes whether the hypothesis specifies a positive (+) effect, or no effect.

Method

Participants and procedure

Participants (N = 212; M_{age}= 45.18, SD_{age} = 11.90) were male, long-haul heavy HGV drivers, who drove a ≥ 12-tonne HGV, travelled at least 200km in one work period, and spent most of their work time driving (weekly driving hours, M = 67.20, SD = 15.08). Drivers were recruited face-to-face at HGV events/locations (e.g. HGV stops, HGV charity events) and through social media (e.g. Facebook groups) and offered the opportunity to enter into a draw to win one of three AUD100 gift vouchers as an incentive to participate. The study received approval from the Institution Human Research Ethics Committee. A prospective-correlational design was used. At Time 1 (T1), participants completed a survey either face-to-face (N = 132) or online (N = 80) assessing social cognitive and motivational measures as well as demographic factors. One week later (Time 2; T2), participants completed a follow-up survey assessing their FV intake over the previous week. Participant data across the time points was anonymized and matched using a unique code identifier created by the participant.

Measures

Social cognitive and motivational constructs (i.e., attitudes, subjective norms, perceived behavioural control, and intention) were measured on previously-validated multi-item psychometric instruments developed using standardised guidelines (Ajzen, 1991; Ryan & Connell, 1989; Sniehotta et al., 2005) adapted to make reference to the target behaviour in the current study. These guidelines are consistently used in research on dietary behaviours (Fila & Smith, 2006; Hagger et al., 2017; Spinks & Hamilton, 2016; White et al., 2010). Brief details of the measures are provided below, and a full set of items are available in Appendix A (supplemental materials). Items from each instrument were used as indicators of latent variables representing each model construct in a structural equation model. We referred to the target behaviours in each measure as: "eat fruit and vegetables following the recommended serves each day in the next week". The definition is in accordance with health-promotion guidelines (i.e., five serves of vegetables and two serves of fruit) and time frame (i.e. per day) derived from Australian dietary guidelines for adult males (National Health and Medical Research Council, 2013). The health-promotion guidelines including examples of portion sizes for one serving of fruit and vegetable were provided to participants at the beginning of the survey.

Behavioural intention was measured by three items (e.g., "I intend to eat fruit and vegetables following the recommended serves every day…") on 7-point scales with 1 (*strongly disagree*) and 7 (*strongly agree*) as endpoints. Attitude was measured on four items with responses provided on 7-point semantic differential scales (e.g., "For me to eat fruit and vegetables following the recommended serves every day in the next week would be…,") from 1 (*unfavourable*) to 7 (*favourable*). Subjective norm was measured on three items (e.g., "Most people who are important to me would approve of me eating fruit and vegetables following the recommended serves every day…,") with responses made on a 7-point scale with 1 (*strongly disagree*) and 7 (*strongly agree*) as end points. Perceived behavioural control was measured using two items on a 7-point scale (e.g. "I have complete control over whether I eat fruit and vegetables following the recommended serves every day…,") with 1 (*strongly disagree*) and 7 (*strongly agree*) as endpoints. Autonomous motivation was measured using an adapted version of Ryan and Connell's (1989) measure. Participants were presented with a common stem: "The reason I would eat the recommended serves of fruit and vegetables each day …" followed by four reasons relating to autonomous motives on a 7-point scale (e.g., "Because I personally believe it is the best thing for my health…,") with 1 (*not at all* *true*) and 7 (*extremely true*) as end points. A measure of action planning and coping planning for the target behaviour was developed based on Sniehotta et al.'s (2005) recommendations. Action planning was measured starting with the stem "I have made a plan regarding…" followed by four items (e.g., "when to eat fruit and vegetables") on a 7-point scale from 1 (*not at all true*) to 7 (*extremely true*) as endpoints. Coping planning was measured using four items on the same 7-point scale and stem as action planning (e.g., "What to do if something interferes with my plan). Behaviour at T2 was measured consistent with Australian Dietary Guidelines using three self-report questions (e.g., "In the previous week, to what extent did you eat fruit and vegetables following the recommended serves every day?"). Two of the items used a 7-point scale including from 1 (*not at all*) to 7 (*a large extent*) as end points and one item (i.e., "In the previous week, on how many days did you eat fruit and vegetables following the recommended serves every day…") used an 8-point scale from 0 days to 7 days as endpoints.

Data Analysis

Variance-based structural equation modelling (VB-SEM) was used to test our hypothesised model. VB-SEM is similar to covariance-based SEM, but is based on ranked rather than ordinal data and is therefore distribution-free and less affected by model complexity, sample size, or departures from normality (Henseler, Ringle, & Sinkovics, 2009). Models were estimated using the Warp PLS v5.0 software (Kock, 2015). Missing data (total missing data = 4.24%) were treated using hierarchical regression imputation. All paths among constructs detailed in Figure 1 and the hypotheses listed in Table 1 were specified as free parameters in the model. In addition, we statistically controlled for the effects of age and past behaviour by setting these variables as predictors of all other variables in the model. Moderator effects were modelled using the product-indicator procedure described and validated by Chin, Marcolin, and Newsted (2003).

Validity of the proposed measures was assessed by observing the measurement aspects of the SEM. The loading of each indicator on its respective latent factor were expected to exceed .700. Composite reliability coefficients (ρ) and average variance extracted (AVE) statistics, which test the sufficiency of scale items as indicators of the latent variables and whether the items account for sufficient variance in the factor, respectively, were expected to exceed .700 and .500. Discriminant validity was assessed by observing that the square-root of the AVE for each latent variable exceeds its correlation coefficient with other latent variables. Overall model fit was evaluated using multiple criteria: the goodness-of-fit (GoF) index with values of .100, .250, and .360 corresponding to small, medium, and large effect sizes, respectively, the average path coefficient (APC) and the average R^2 (ARS), both of which should be significantly different from zero for an adequate model, and the average variance inflation factor for model parameters (AVIF) statistic, with values less than 5.000 indicating a well-fitting model (Kock, 2015).

Results

Participants and attrition analysis

One hundred and thirty participants dropped out of the study after completing the initial T1 survey resulting in a final sample of 84 participants[1]. Demographic

[1] The large attrition rate raises concerns over statistical power. To ensure we had adequate power, we computed reproduced statistical power of the key dependent variables in our model using current findings. Power analyses with multiple regression analyses (path analysis is an extension of this kind of analysis) presents some challenges in identifying the appropriate statistical power. One option is to use R^2 values as the effect size for the key outcome or dependent variables of interest. In the current model, these were intentions (R^2 = .772) and fruit and vegetable consumption (R^2 = .261). Converting these to f^2 values (1.32 for intentions and .354 for behaviour), we used G*Power to compute reproduced power with alpha set at .05, sample size at 84, and four predictors for intentions (attitudes, subjective norms, perceived

characteristics of the sample at the two time points are presented in Table 2. Attrition analyses indicated that there were no significant differences in age (t(172) = -.382, p = .703), BMI (t(184) = 1.428, p = .155), number of years driving (t(175)= -.547, p = .585), weekly kilometres driven (t(164) = -.607, p = .545), highest education attainment (χ^2(5) = 6.804, p = .236), and ethnicity (χ^2(5) = 4.720, p = .451) between participants that dropped out of the study and those who remained. Attrition analysis indicted there were differences between participants remaining and those who dropped out on some of the psychological and behavioural variables (Wilks' Lambda = .891, F(7,138) = 2.417, p = .023, partial eta-squared = .109). Post-hoc analysis revealed significantly higher levels of attitudes (F(1,144) = 12.226, p = <.001, η_p^2 = .078), intentions (F(1,144) = 4.550, p = .035, η_p^2 = .031), subjective norm (F(1,144) = 4.471, p = .036, η_p^2 = .030), and autonomous motivation (F(1,144) = 11.697, p = .025, η_p^2 = .034) in the participants who completed both time point one and two compared to those who dropped out. There was no differences between fruit and vegetable consumption of participants who dropped out at T1 and the participants who remained at T2 (t(189) = -.568, p = .571).

Preliminary analysis

Measurement model statistics from the VB-SEM confirmed that the latent variables met criteria for construct and discriminant validity. Factor loadings for each latent factor exceeded the .700 criterion supporting the validity of the factors. Composite and Cronbach alpha (α) reliability coefficients, AVE, and intercorrelations for model variables are presented in Table 3. Reliability coefficients exceeded the .700 criterion and AVE values exceeded the recommended .500 criterion. Correlations among the latent variables also indicated no problems with discriminant validity. The

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behavioural control, past behaviour) and five predictors for behaviour (action planning, coping planning, intentions, perceived behavioural control, past behaviour). The analysis produced statistical power values of 1.000 and .992 for intentions and behaviour, respectively, indicating sufficient statistical power.

correlations showed significant positive relations among the TPB variables as well as significant and positive relations among past behaviour and most of the model variables. The strong, positive correlation between past behaviour and future FV consumption shows behavioural stability for HGV drivers' dietary decisions. Goodness of fit statistics revealed acceptable overall fit of the model with the data according to the multiple indices adopted (GoF Index = .523; APC =.212, p =.010; ARS = .331, p <.001; AVIF = 1.702.

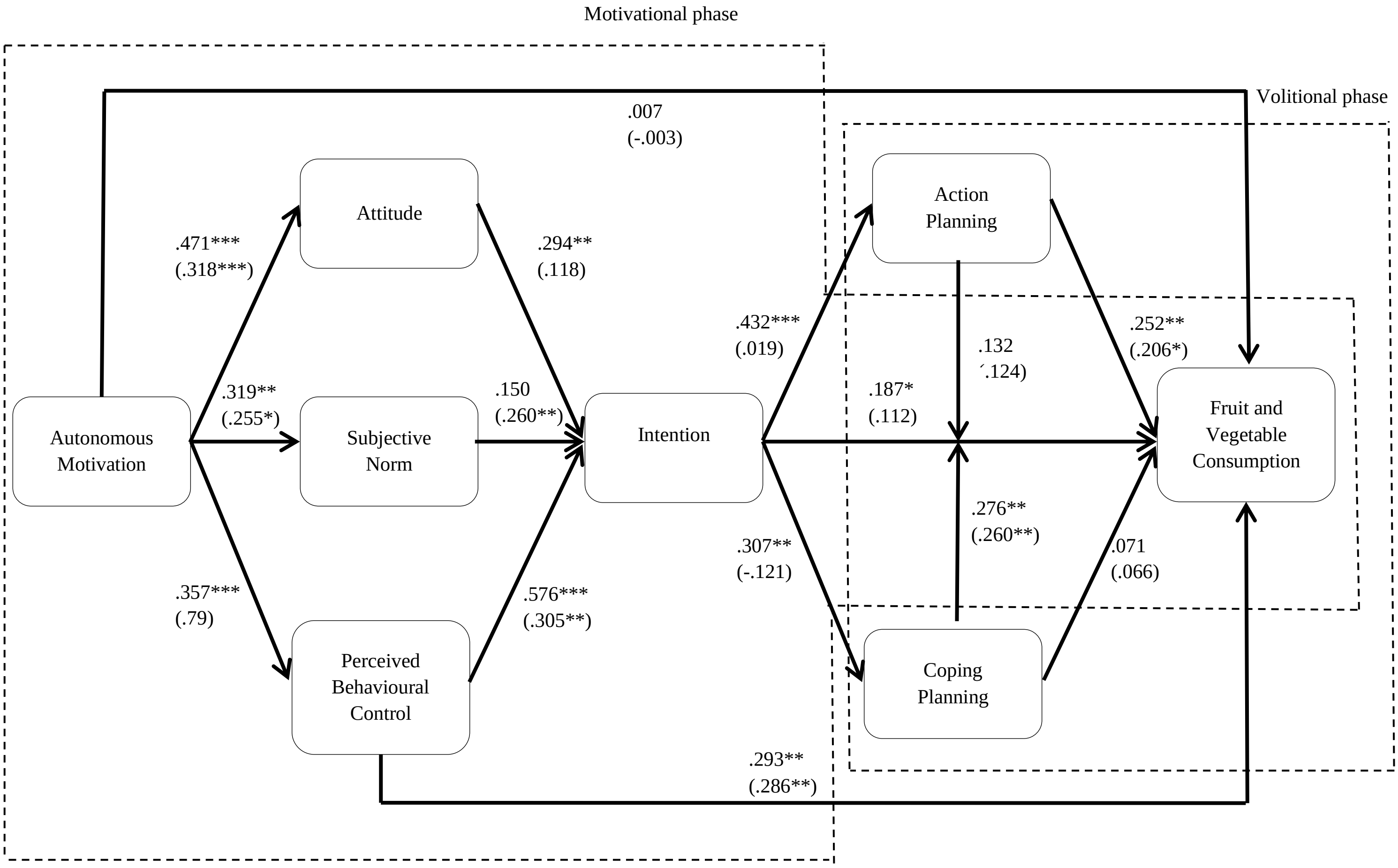

Figure 1. Hypothesised multi-phase, multi-theory model of health behaviour. Note: Effects of age and past behaviour on each of the variables has been omitted for clarity but standardised path coefficients for each relationship can be found in Table 5. Figures in parentheses are standardised path coefficients inclusive of the effects of past behaviour in the hypothesised model.

Model Effects

Standardised parameter estimates for the hypothesized relations among model factors are presented in Figure 1 and Table 4. Overall, the model accounted for 77.2% of the variance in HGV drivers' intentions to eat fruit and vegetables and 26.1% of the variance in their fruit and vegetable consumption. With regards to the motivational phase of the model, autonomous motivation had a statistically significant positive direct effect on attitudes (H_1), subjective norm (H_2), and perceived behavioural control (H_3), as predicted. Also, as hypothesized, attitude (H_4) and perceived behavioural control (H_6) were statistically significant positive predictors of intentions, but subjective norms (H_5) was not, leading us to reject this hypothesis. There was a statistically significant positive effect of intentions (H_7) and perceived behavioural control (H_8) on fruit and vegetable consumption, as predicted. There was no direct effect of autonomous motivation on fruit and vegetable consumption (H_{13}), as predicted.

Table 2. *Participant (N = 84) characteristics and descriptive statistics for study variables for those that completed the initial survey (Time 1) and those that completed the initial and follow-up survey (Time 2)*

Variable	Time 1	Time 2
Participants, *N*	212	84
Age, *M* years (SD)	45.18 (11.90)	45.94 (12.07)
BMI, *M* (SD)	30.91(8.05)	29.90 (6.08)
Weekly work kilometres	4353.59 (4253.84)	5183 (6314.51)
Ethnicity:		
Caucasian	196	75
Indigenous	6	3
Maori	2	1
Indian	1	1
Other	6	4
High education level:		
Primary School	3	1
Some high school	43	18
Junior high school	53	21
Senior high school	43	10
Tafe / trade	61	29
University	9	5
Attitude	5.53 (1.72)	6.04 (1.37)
Subjective norm	5.77 (1.25)	5.92 (1.18)
Perceived behavioural control	4.74 (1.69)	4.84 (1.68)
Intention	4.75 (1.62)	4.93 (1.18)

Autonomous motivation	5.23 (1.59)	5.64 (1.39)
Action planning	3.54 (1.92)	3.81 (1.85)
Coping Planning	3.21 (1.79)	3.28 (1.72)
Past fruit and vegetable consumption	3.83 (2.19)	4.02 (2.31)
Fruit and vegetable consumption	-	3.89 (2.04)

Contrary to expectations there were no indirect effects of attitudes (H_{17}), subjective norms (H_{18}), and perceived behavioural (H_{19}) on fruit and vegetable consumption mediated by intentions. However, we found a total indirect effect of autonomous motivation on intentions mediated by attitudes, subjective norms, and perceived behavioural control (H_{20}). There was no significant indirect effect of autonomous motivation on behaviour (H_{21}) mediated by attitudes, subjective norms, or perceived behavioural control, and intentions

Focusing on the volitional phase of the model, intentions significantly predicted action planning (H_9) and coping planning (H_{10}), and action planning (H_{11}) significantly predicted fruit and vegetable consumption as hypothesised. There was no effect of coping planning on fruit and vegetable consumption (H_{12}), so we rejected our hypothesis for this effect. As predicted, coping planning moderated the relationship between intention and fruit and vegetable consumption (H_{15}). Specifically, the intention-behaviour relation was stronger in the presence of coping planning. Action planning did not moderate the intention-behaviour relationship, so we rejected our hypothesis (H_{14}). There was no indirect effect of intention on fruit and vegetable consumption mediated by action planning (H_{22}) or coping planning (H_{23}), leading us to reject these hypotheses.

Finally, past behaviour was shown to be a significant predictor of all but two of the variables in the model, although the effects did approach conventional levels for statistical significance for subjective norms (p = .084) and behaviour (p = .088) (H_{16}). The inclusion of past behaviour resulted in a number of effects in the model being reduced to trivial values and failed to reach statistical significance including the direct effect of autonomous motivation on perceived behavioural control; the direct effect of attitudes on intentions; the direct effects of intentions on action planning, coping planning, and behaviour; the indirect effects of autonomous motivation on intentions via attitudes and perceived behavioural control; and the total indirect effect of autonomous motivation on intentions and fruit and vegetable consumption via attitudes, subjective norms, and perceived behavioural control.

Table 3.

Factor intercorrelations, composite reliabilities, and average variance extracted for latent variables in the multi-theory, dual phase model for FV consumption (N = 84)

	ρ	α	AVE	R^2	1	2	3	4	5	6	7	8	9	10
1. Autonomous motivation	.941	.930	.801	.271	.895									
2. Attitude	.918	.920	.736	.294	.421***	.858								
3. Subjective norm	.894	.849	.739	.182	.268*	.334**	.860							
4. PBC	.851	.744	.740	.357	.338**	.242*	.496***	.860						
5. Intention	.950	.919	.864	.772	.486***	.503***	.549***	.734***	.929					
6. FV Behaviour	.965	.937	.901	.261	.311**	.285**	.317**	.496***	.527***	.949				
7. Action planning	.958	.961	.850	.409	.551***	.199	.072	.405***	.442***	.389**	.922			
8. Coping planning	.944	.950	.809	.102	.479***	.191	-.013	.250*	.239*	.266*	.670***	.900		
9. Age	-	-	-	-	-.117	.099	-.128	-.053	-.086	.069	-.043	.011	1.000	
10. Past behaviour	-	-	-	-	.487***	.431***	.211	.570***	.689***	.510***	.605***	.382***	.032	1.000

Note. ρ = Composite reliability coefficient; α = Cronbach's alpha; AVE=Average variance extracted; Values on principal diagonal are square-root of average variance extracted (AVE); PBC = Perceived behavioural control; FV = Fruit and vegetable consumption.
***$p < .001$ **$p < .01$ *$p < .05$.

Table 4.

Standardised parameter estimates for the direct, indirect effects, and total effects of the multi-theory, dual-phase model of fruit and vegetable consumption (N = 84)

Effect	Without Past Behaviour				With Past Behaviour			
	β	*p*	95%CI		β	*p*	95%CI	
			LL	UL			LL	UL
Direct Effects								
Autonomous motivation → Attitude	.471	<.001	0.284	0.657	.318	<.001	0.124	0.512
Autonomous motivation → Subjective norm	.319	.001	0.124	0.513	.255	.007	0.057	0.453
Autonomous motivation → PBC	.357	<.001	0.164	0.549	.079	.230	-0.131	0.289
Attitude → Intention	.294	.002	0.098	0.490	.118	.133	-0.088	0.324
Subjective norm → Intention	.150	.077	-0.053	0.353	.268	.005	0.070	0.466
PBC → Intention	.576	<.001	0.395	0.756	.305	.001	0.109	0.501
Autonomous motivation → FV Behaviour	.007	.476	-0.206	0.220	-.003	.489	-0.217	0.211
PBC → FV Behaviour	.293	.002	0.097	0.489	.286	.003	0.090	0.482
Intention → FV Behaviour	.187	.037	-0.014	0.388	.112	.145	-0.096	0.320
Intention → Action planning	.432	<.001	0.243	0.620	.019	.429	-0.193	0.231
Intention → Coping planning	.307	.001	0.111	0.503	-.121	.127	-0.327	0.085
Action planning → FV Behaviour	.252	.007	0.054	0.449	.206	.024	0.004	0.408
Coping planning → FV Behaviour	.071	.253	-0.138	0.280	.066	.270	-0.144	0.276
Action planning X Intention → FV Behaviour	.132	.107	-0.073	0.337	.124	.121	-0.082	0.330
Coping planning X Intention → FV Behaviour	.276	.004	0.078	0.473	.260	.006	0.062	0.458
Age → Autonomous motivation	-.121	.126	-0.326	0.084	-.141	.091	-0.347	0.065
Age → Attitude	.143	.088	-0.062	0.348	.123	.123	-0.083	0.329
Age → Subjective norm	-.224	.016	-0.423	-0.024	-.237	.011	-0.437	-0.037
Age → PBC	-.053	.312	-0.262	0.156	-.128	.113	-0.334	0.078
Age → Intention	-.067	.265	-0.276	0.142	-.081	.224	-0.291	0.129
Age → Action planning	-.145	.085	-0.350	0.060	-.130	.109	-0.336	0.076
Age → Coping planning	.043	.347	-0.168	0.254	-.007	.473	-0.221	0.207
Age → Behaviour	.162	.061	-0.041	0.365	.140	.093	-0.066	0.346
Past behaviour → Autonomous motivation	-	-	-	-	.506	<.001	0.322	0.690
Past behaviour → Attitude	-	-	-	-	.292	.002	0.096	0.488
Past behaviour → Subjective norm	-	-	-	-	.143	.088	-0.063	0.349
Past behaviour → PBC	-	-	-	-	.552	<.001	0.370	0.734
Past behaviour → Intention	-	-	-	-	.452	<.001	0.266	0.638
Past behaviour → Action planning	-	-	-	-	.603	<.001	0.425	0.781
Past behaviour → Coping planning	-	-	-	-	.342	<.001	0.148	0.536
Past behaviour → Behaviour	-	-	-	-	.146	.084	-0.058	0.350
Indirect Effects								
Attitude → Intent → FV Behaviour	.055	.235	-.094	.204	.013	.432	-.138	.164
Subjective norm → Intention → FV Behaviour	.028	.357	-.123	.179	.030	.347	-.120	.179
PBC → Intention → FV Behaviour	.108	.076	-.041	.257	.034	.327	-.115	.183
Autonomous motivation → Attitude → Intention	.139	.032	-.006	.284	.038	.312	-.111	.187
Autonomous motivation → Subjective norm → Intention	.048	.265	.057	.355	.068	.184	-.081	.217
Autonomous motivation → PBC → Intention	.206	.003	.063	.349	.024	.377	-.127	.175
[a]Autonomous motivation→TPB constructs→ Intention	.392	<.001	.205	.585	.130	.109	-.076	.336
Autonomous motivation → Attitude → Intention → FV Behaviour	.026	.340	-.097	.149	.004	.473	-.119	.127

Autonomous motivation → Subjective norm → Intention → FV Behaviour	.009	.443	-.114	.132	.008	.451	-.115	.131
Autonomous motivation → PBC → Intention → FV Behaviour	.038	.269	-.084	.160	.003	.483	-.120	.126
[a]Autonomous motivation→TPB constructs→Intention→FV Behaviour	.073	.247	-.140	.283	.015	.447	-.199	.229
Intention → Action planning → FV Behaviour	.109	.075	-.038	.256	.004	.479	-.147	.155
Intention → Coping planning → FV Behaviour	.022	.388	-.129	.173	-.008	.459	-.159	.143
Total effects								
Autonomous motivation → Intention	.392	<.001	0.202	0.582	.130	.109	-0.080	0.336
Attitude → FV Behaviour	.094	.142	-0.080	0.265	.013	.443	-0.160	0.187
Subjective norm → FV Behaviour	.048	.294	-0.120	0.220	.029	.372	-0.140	0.201
PBC → FV Behaviour	.476	<.001	0.290	0.662	.319	<.001	0.125	0.513
Autonomous motivation → FV Behaviour	.236	.011	0.036	0.436	.034	.378	-0.180	0.246
Intention → FV Behaviour	.318	<.001	0.124	0.512	.108	.154	-0.100	0.316

Note. β = Standardized parameter estimate; 95%CI = 95% confidence intervals of standardized parameter estimates; LL = Lower limit of 95% confidence intervals; UL = Upper limit of 95% confidence intervals; PBC = Perceived behavioural control; FV = Fruit and vegetable consumption. [a]Effect represents total indirect effect through TPB constructs (attitude, subjective norm, PBC) as multiple mediators.

Discussion

The aim of the current study was to apply an integrated multi-theory, dual-phase model to predict fruit and vegetable consumption in a sample of long-distance HGV drivers in Australia. The model integrates constructs and hypotheses from self-determination theory, the theory of planned behaviour, the model of action phases, and the health action process approach. Findings supported a number of effects found in similar integrated theories applied to health behaviour (Hagger & Chatzisarantis, 2014; Hamilton, Cox, et al., 2012; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017; Mullan, Wong, Kothe, et al., 2013; Perugini & Bagozzi, 2001; Schwarzer et al., 2010), including effects of autonomous motivation, and belief-based social cognitive variables on intentions to consume fruit and vegetables. However, the inclusion of past-behaviour resulted in the attenuation of model effects. Critically, the effect of intentions on behaviour was non-significant and trivial on the inclusion of past behaviour. This finding is consistent with multiple studies in the field which have observed similar attenuating effects of past behaviour, particularly the intention-behaviour relationship (Danner, Aarts, & Vries, 2008; Norman & Conner, 2006). Overall, current findings indicate that very little of the variance in fruit and vegetable consumption is accounted for by variables in the model beyond past behaviour.

Focusing first on the prediction of intentions, results of our test of the integrated model are consistent with previous research (Chatzisarantis et al., 2009; Hamilton, Cox, et al., 2012; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017) that has identified autonomous motivation as an indirect predictor of intention mediated via the TPB variables. For long haul HGV drivers, attitudes and perceived behavioural control, but not subjective norms mediated autonomous motivation on intentions. These findings suggest that long-haul HGV drivers' intentions to eat fruit and vegetables are based on internalised, personally-relevant motives, tastes and beliefs regarding their ability to eat the recommended serves each day, and are less influenced by their beliefs about significant others expectations. This result is consistent with the solitary lifestyle of a long-haul HGV driver who is likely to eat by themselves for days or weeks at a time (Apostolopolous et al., 2013) and therefore has less exposure to normative influences. However, it is important to note that when past behaviour was included in the model the indirect relationship between autonomous motivation and intention through the TPB variables did not hold. This attenuation effect probably models the fact that the drivers had made these kinds of decisions in the past, and that any decisions are largely dominated unmeasured, possibly implicit, processes. Importantly, inclusion of past behaviour in the model did not lead to the extinction of the significant direct effect of PBC on FV consumption. This effect suggests that HGV drivers' perception of control within their work context is an important factor to consider. It is unsurprising that given HGV drivers' low control over food choices, particularly healthy food choices at truck stops, plays a significant role in their overall FV consumption (Hamilton & Hagger, 2017). This low perceived control within the HGV drivers' work context is consistent with research which identified poor availability of healthy food as a significant barrier for drivers (Passey et al., 2014). Drivers have also indicated they would eat healthier food choices if they are available (i.e., within their control to purchase) (Jacobson, Prawitz, & Lukaszuk, 2007).

However, effects of past behaviour in the current research were more wide-reaching than effects of social cognitive and motivational variables on intentions alone. Past behaviour was found to significantly and positively correlate with most of the psychological variables in the model and such attenuated many of the relationships within the model. This was expected given previous research that has found similar attenuation effects in other health behavioural contexts (Danner et al., 2008; Gardner, de Bruijn, & Lally, 2011; Norman & Conner, 2006). Most important, the effect of intention on behaviour was reduced to a trivial value and was not statistically significant, meaning that if the current study were to be replicated on multiple occasions, zero would be a probable value for the intention-behaviour relationship 95% of the time. Given that past behaviour does not capture a specific variable or construct, interpreting the attenuation effects is difficult. To speculate, past behaviour may model habitual effects, possibly mediated by unmeasured implicit cognition. Alternatively, it may model unmeasured variables that predict behaviour and account for (mediate) the effects of past behaviour on future behaviour.

Research has shown that past behaviour may serve as a proxy for habitual behaviour (Gardner, 2014; Gardner et al., 2011). In this case, past behaviour may model the fact that HGV drivers have undergone the deliberative decision-making processes multiple times in the past. The significant positive correlation of FV consumption at T1 and T2, that is, the effects of past behaviour on subsequent behaviour, demonstrates the stability of the FV consumption. The measure of past behaviour may also represent other unmeasured implicit representations of the action and context, initiated by relevant contextual cues (e.g., pulling into the service station or observing snack foods placed on a plinth near a service station checkout). This would be consistent with research on dual-process models which show that constructs and measures representing the non-conscious, automatic processes play an important role in predicting health behaviour (Hagger et al., 2017; Strack & Deutsch, 2004). The attenuating effect of past behaviour in the current model test may provide an analog for the effects of these implicit constructs on action in the current integrated model. A possible avenue for future research would be to examine effects of past behaviour alongside other constructs representing non-conscious and automatic processes to arrive at a more comprehensive understanding of health behaviour (Gardner, 2014; Gardner et al., 2011; Hagger & Chatzisarantis, 2014; Sniehotta et al., 2014; Strack & Deutsch, 2004).

Focusing on the volitional processes in the current integrated model, current findings are in line with the hypotheses drawn from the model of action phases (Heckhausen & Gollwitzer, 1987). Specifically, we found support for a moderating role of coping planning on the intention–behaviour relationship. The predictions regarding action planning and coping planning drawn from the HAPA (i.e., a mediating role: Schwarzer, 1992) were not found, although the mediating effects of action planning did approach conventional levels for statistical significance (p = .075). Interestingly, the inclusion of past behaviour had little attenuating effect on the moderating role of coping planning on the intention-behaviour relationship, demonstrating this effect is independent of behavioural repetition. Given that some HGV drivers may have multiple delivery destinations, it follows that their plans to overcome general barriers to consume fruit and vegetables (i.e., coping plans) are able to consolidate intentions given coping plans are less reliant on specific dates, times, or destinations. Action plans, however, have been shown to play an important role in behaviours that can be performed in a consistent context (e.g., physical exercise; de Bruijn et al., 2012; Luszczynska et al., 2016), or in general population samples (e.g., eating fruit and vegetables in adults; van Osch et al., 2009). The continually changing context of HGV drivers may disfavour the rigidity of action plans to further strengthen intentions. More generally, this result is consistent with propositions that planning variables are able to strengthen intentions, a moderating effect, rather than explain the intention-behaviour relationship, a mediating effect (Hagger & Chatzisarantis, 2014; Heckhausen & Gollwitzer, 1987; Wiedemann et al., 2009). The results seem to point to the key role of planning as a volitional strategy that augments intentions and leads to more efficient, effective implementation (Heckhausen & Gollwitzer, 1987). In contrast, the mediating effect in which planning explains the effect did not occur, despite action planning significantly predicting fruit and vegetable consumption. Overall, current findings imply that planning alters rather than explains the effects of intentions on fruit and vegetable consumption.

The current study had a number of strengths including identifying a hard-to-reach and under-researched group of male long-haul HGV drivers with a high risk of health problems due to their lifestyle, the adoption of an appropriate integrated theoretical approach for the prediction of fruit and vegetable consumption, and explicitly testing how effects in the integrated model are affected by past behaviour. The research, however, is not without limitations. To reduce the time-burden on drivers we did not collect overall fruit and vegetable consumption but targeted whether drivers were eating the recommended serves. This data would have allowed us to compare adherence rates to other epidemiological studies. Also, the sample size of the current investigation is small with high attrition. HGV drivers is a hard-to-reach population many of whom have never engaged in research before and are naturally wary of answering questions outside their community. This is may be a reason for the high attrition rates. Future research may overcome this issue by working closely with relevant HGV organisations to reduce any perceived distrust with researchers. Future research may also benefit from a smaller questionnaire to reduce the burden of completing them in such a time-poor population. While we had sufficient statistical power, results must still be treated with caution given the high attrition rate and possibility of that we recruited a sample of individuals who were favourable to healthy eating. The research also relied on self-report data which may have facilitated socially desirable responses. However, anecdotally, the authors found through face-to-face data collection that many of the long-haul drivers were equally at ease verbally reporting their unfavourable as well as favourable attitudes towards fruit and vegetable consumption. A further limitation is the current study adopted a correlational design, so the direction of proposed effects can only be inferred from theory and not the data. Future research could use intervention or cross-lagged designs to confirm causality and the direction of the relationships. Similarly, future research would benefit from utilising a daily or situational assessment measure (i.e., ecological momentary assessment) to gain a deeper understanding of the timeline of dietary decisions.

Overall, current findings suggest that the integrated model is adequate in accounting for intentions to eat fruit and vegetables in HGV drivers, but fails to account for substantive variance in actual behaviour once accounting for past behaviour. Taken together, these findings seem to indicate that drivers' decisions to eat fruit and vegetables is not controlled by intentional processes, and may be controlled by habitual or implicit processes that affect behaviour beyond the drivers' awareness. We cannot be sure of the nature of the factors that result in these decisions as we did not measure habits, automaticity, or implicit cognition which may have served to mediate the past behaviour effects and provide an explanation for this pathway. We can speculate that because of constraints on availability and the routine nature of their profession, drivers do not engage in much conscious deliberation over their fruit and vegetable intake. Rather, since their decisions have been repeated consistently, it is likely that habits and non-conscious processes predominate for this behaviour, as it is likely for all their dietary behaviours. This presents considerable challenges for interventions aimed at promoting fruit and vegetable consumption in this vulnerable group. Strategies that might assist would be those that help raise awareness of contextual eating cues (e.g., when and where food is eaten, what alterative choices are available), assist in self-monitoring of consumption, identifying alternative courses of action, and planning suitable alternatives when a self-directed cue is presented.

Appendix A. *Scale Items for Constructs of the Multi-theory, Dual-Phase Model of Fruit and Vegetable Consumption*

Variable	Item	Scale
Intention	Do you agree that in the next week…?	1 = "strongly disagree", 7 = "strongly agree".
	…I intend to eat fruit and vegetables following the recommended serves every day	
	…I plan to eat fruit and vegetables following the recommended serves every day	
	…I expect that I will eat fruit and vegetables following the recommended serves every day	
Attitude	For me to eat fruit and vegetables following the recommended serves every day in the next week would be:	1 = "bad", 7 = "good"
		1 = "unfavourable", 7 = "favourable"
		1= "undesirable", 7 = "desirable"
		1 = "harmful", 7 = "beneficial"
Subjective norm	Do you agree that in the next week…?	1 = "strongly disagree", 7 = "strongly agree".
	…Most people who are important to me would approve of me eating fruit and vegetables following the recommended serves every day	1 = "strongly disagree", 7 = "strongly agree".
	…Those people who are important to me think that I should eat fruit and vegetables following the recommended serves every day	1 = "strongly disagree", 7 = "strongly agree".
	…The people in my life whose opinion I value would think my eating fruit and vegetables following the recommended serves every day is desirable	
Perceived behavioural control	Do you agree that in the next week…?	1 = "strongly disagree", 7 = "strongly agree".
	…I have complete control over whether I eat fruit and vegetables following the recommended serves every day	1 = "strongly disagree", 7 = "strongly agree".
	…I am confident that I could eat fruit and vegetables every day following the recommended serves everyday	
Autonomous motivation	The reason I would eat the recommended serves of fruit and vegetables each day …	
	… Because I personally believe it is the best thing for my health	1= "not at all true", 7= "exactly true"
	… Because I have carefully thought about it and believe it is very important for many aspects of my life	1= "not at all true", 7= "exactly true"
	… Because it is an important choice I really want to make	1= "not at all true", 7= "exactly true"
	… Because it is very important for being as healthy as possible	1= "not at all true", 7= "exactly true"
Action planning	I have made a plan regarding …	
	… When to eat fruit and vegetables	1= "not at all true", 7= "exactly true"
	… Where to eat fruit and vegetables	1= "not at all true", 7= "exactly true"
	… How to eat fruit and vegetables	1= "not at all true", 7= "exactly true"
	… How often to eat fruit and vegetables	1= "not at all true", 7= "exactly true"
Coping planning	I have made a plan regarding …	
	… What to do if something interferes with my plans	1= "not at all true", 7= "exactly true"
	… How to cope with possible setbacks	1= "not at all true", 7= "exactly true"

	… What to do in difficult situations in order to stick to my intentions	1= “not at all true”, 7= “exactly true”
	… When I have to pay extra attention to prevent lapses	1= “not at all true”, 7= “exactly true”
Past fruit and vegetable consumption	On how many days in the course of the past week, did you eat fruit and vegetables following the recommended serves?	0 = “0 days”, 7 = “7 days”
Fruit and vegetable consumption (T2)	In the previous week, to what extent did you eat fruit and vegetables following the recommended serves every day?	1 = “not at all, 7 = “a large extent”
	In the previous week, on how many days did you eat fruit and vegetables following the recommended serves every day?	0 = “0 days”, 7 = “7 days”
	In the previous week, how often did you eat fruit and vegetables following the recommended serves every day?	1 = “never’, 7 = “very often”

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Chapter 4: The Mediating Role of Constructs Representing Reasoned-Action and Automatic Processes on the Past-Future Behavior Relationship (Paper 2)

This chapter contains a paper based on Aim 2 of the thesis that has been accepted for publication to the journal *Social Science and Medicine* (Impact Factor 3.087; SCImago ranking Q1). Note that this chapter is presented in US English in compliance with the requirements of the journal. The PhD Candidate is the first author of the paper and co-authors are part of the supervisory team. The PhD Candidate takes overall responsibility for the publication and all co-authors meet criteria for authorship. Electronic supplementary material to the paper are attached at the end of the chapter. The data file, analysis code, and output files from all are available at the Open Science Framework: psyarxiv.com/qrm5b

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

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The Mediating Role of Constructs Representing Reasoned-Action and Automatic Processes on the Past-Future Behavior Relationship

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Abstract

Objective: Past behavior has been consistently shown to predict and explain future behavior. It has been proposed that past behavior exerts influence on future behavior via both reasoned-action and automatic processes. The current study sought to explore the mediation of past-to-future behavior via these processes across three populations and behaviors: binge drinking in university students, flossing in adults, and parental sun safety behavior of children 2 – 5 years of age. Furthermore, this study sought to use a measure of past behavior that combined long-term, recent, and routine patterns of behavioral engagement. **Methods.** A prospective design with two waves of data collection spaced six weeks apart was adopted. Participants (Total *N* = 754) completed an initial survey containing measures of past behavior (frequency, recency, and routine), social cognition (attitudes, subjective norms, perceived behavioral control), and behavioral automaticity. Six weeks later, participants (*N* = 454) completed a self-report measure of behavior and behavioral automaticity. **Results.** Structural equation modelling revealed that automatic, but not reasoned-action processes, mediated the past-to-future relationship, across the three behaviors. Results further revealed that long-term, recent, and routine patterns of behavioral engagement were highly correlated and indicated a second-order past behavior latent variable. **Conclusions.** While both reasoned-action and automatic factors can predict a range of health behaviors, automatic processes appear to explain the effect of past behavior on future behavior. Further investigations should focus on exploring the role of other non-conscious and automatic processes such as counter-intentional habits and implicit beliefs in explaining engagement in heath behaviors.

Data Availability Statement: Data files and analysis output are available online: https://osf.io/2nk3s/?view_only=f959ebced6274964a3c8dc3d5a65fc44

Keywords: past behavior, reasoned action, habit, heath behavior change, heath model

Introduction

To develop effective interventions in order to modify people's behavior one needs to first isolate the mechanisms that guide the behavior and then test the extent to which the mechanisms magnify or diminish behavioral engagement. Previous research has often turned to theories of social cognition to guide investigations aimed at identifying the determinants for health behaviors and, importantly, the processes by which these determinants relate to each other and the behavior (Hagger et al., 2020). A close examination of the major theories that have been applied to the understanding of health behavior assumes that behavior is determined by a reasoned, intentional process in which an individual invests effort in order to pursue an action. The theory of planned behavior (TPB: Ajzen, 1991) is perhaps the most widely used social–cognitive theory of behavior. According to the theory, intention is the most proximal predictor of behavior, with intention determined by three social–cognitive variables: attitude (overall evaluations of performing the behavior), subjective norm (social pressure from important others to perform the behavior), and perceived behavioral control (perceived amount of control over behavioral performance; also more recently theorized as moderating the intention-behavior relationship; Ajzen, 1991). Meta-analytic studies support the use of the TPB in predicting health-related behaviors (Hamilton et al., 2020; e.g., McEachan et al., 2011; Rich et al., 2015)

Social cognition theories such as the TPB tend to focus on a relatively narrow set of determinants that include constructs that represent reasoned, intentional determinants of action. Such approaches tend not to explicitly account for the pervasive effects of past behavior on key constructs of psychological theories and their relations with health behaviors (e.g., Albarracín et al., 2001; Conner et al., 1999; Martin S. Hagger et al., 2018). However, research has demonstrated that including past behavior in these theories accounts for substantive additional variance in subsequently measured (future) behavior through the *residual* effect of past behavior on future behavior. Inclusion of past behavior has also been shown to attenuate the size of the effects of intention and other social-cognition constructs on future behavior. Some argue that these residual effects are likely an artifact of assessing past behavior and future behavior using the same measure, leading to shared method variance (Ajzen, 1991, 2002). However, research using different measures of past and future behavior has also revealed residual effects (Brown et al., 2018; Verplanken, 2006). Others, therefore, argue that the residual effects afforded by past behavior may model non-conscious processes including habits and decisions based on implicit cognition or behavioral 'scripts' (Martin S Hagger, 2020; Martin S. Hagger & Chatzisarantis, 2014; Strack & Deutsch, 2004; Triandis, 1977).

In seeking to understand the effects of past behavior in social-cognitive theories, Ouellette and Wood (1998) proposed two pathways by which past behavior relates to future behavior: a direct pathway and an indirect pathway. The direct effect is said to model an automatic process, similar to that proposed in dual-process theories (Strack & Deutsch, 2004). The second, indirect pathway, in which past behavior affects future behavior via the mediation of model constructs that represent conscious, intentional processes, such as those characterized in social-cognition theories (Ajzen, 1991; Schwarzer & Hamilton, 2020). Ouellette and Wood (1998) hypothesized that well-practiced behaviors, occurring in consistent contexts are those likely to become habitual and are expected to be repeated in the future with little deliberation. These automatic behaviors can be intentional and goal-dependent or be perceived as non-volitional and counter-intentional (i.e., outside of an individual's awareness/control or in opposition to an individual's intention; Gardner et al., 2015; Ji & Wood, 2007). Conversely, the authors describe how novel or less practiced behaviors are likely governed by conscious, intentional processes. While past behavior has been shown to attenuate the effects of social cognitive variables (Brown et al., 2018), studies suggest that their constructs still account for unique variance in behavior and mediate, at least partially, the effects of past behavior on future behavior (Martin S. Hagger et al., 2018).

Although previous research has demonstrated support for the direct and indirect effects of past behavior on future behavior in social cognition theories (Ouellette & Wood, 1998), few studies have tested the effects of other constructs that reflect non-conscious decision making, such as habits, on behavior alongside past behavior (Bamberg et al., 2003; Hamilton et al., 2020; Phipps et al., 2020; van Bree et al., 2015; Verplanken, 2006). If indirect effects of past behavior on future behavior model automatic, spontaneous processes to behavioral enactment as proposed in dual process theories (Strack & Deutsch, 2004) and, thus, capture the automaticity component of habit, they would be expected to mediate the effect of past behavior on subsequent behavior. We aimed to examine these propositions in the present study by testing the TPB in a range of health behaviors and included measures of past behavior and behavioral automaticity across two time-points.

An additional issue with research examining the role of past behavior in social cognition theories is the large variation in arbitrary time frames used to measure past behavior. For example studies have measured past behavior over one week (Mullan et al., 2015), four weeks (Caudwell et al., 2019), and six months (Luszczynska & Cieslak, 2009). Measuring past behavior over arbitrary timeframes may miss patterns of behavioral engagement that could potentially be informative on the mechanisms and processes that determine subsequent health behavior. For example, engagement in sun safety behaviors is likely to be highly seasonal in that they are performed frequently in the summer months and seldom in winter months (Sun et al., 2014; Xiang et al., 2015). A measure of past behavior that refers to sun safety behaviors in close proximity to subsequent behavior is likely to lead to stronger past behavior effects than if the time frame of the past behavior measure extended beyond the current season. Furthermore, Ouellette and Wood (1998) suggested that a different pattern of past behavior effects will occur for infrequently compared to regularly performed behaviors. It would seem reasonable to account for both long-term (i.e., distal) and short-term (i.e., recent) enactments of past behavior as well as the frequency with which the behavior is measured. Perugini and Bagozzi (2001) proposed differentiating between long-term (up to 1 year) and more recent (within the last month) measures of past behavior. Similarly, others have used items relating the extent to which the behavior is routinized to further capture the regularity of daily behavioral performance (Verplanken & Orbell, 2003). Extending this research, the present study tested effects of past behavior using multiple methods that account for the frequency, recency, and routinization of behaviors. Specifically, the measure included items assessing long-term (last year), short-term (last month), and routine patterns of behavior, proposing that these would indicate a multi-component measure of past behavior that would capture the essence of individuals past performance of health behaviors.

The Current Study and Hypotheses

Based on Ouellette and Wood's (1998) propositions, we propose a set of key hypotheses relating to the effects of reasoned, intentional pathways and non-conscious, automatic pathways to action for three health behaviors in three independent samples: binge drinking in university students, dental flossing in community-dwelling adults, and parental sun safety behaviors of their 2 to 5 year-old children. The proposed model is presented in Figure 1. In the model, the reasoned, intentional processes are represented by the effects of the social-cognition constructs from the TPB. Specifically, attitude, subjective norm, and perceived behavioral control are expected to significantly and directly predict intentions and intentions and perceived behavioral control are expected to significantly and directly predict the target behaviors. We also expect the effects of the TPB constructs on behavior would be mediated by intentions (Ajzen, 1991).

Based on Ouellette and Wood's (1998) proposals, we expected an indirect effect of past behavior on behavior mediated by the social cognition constructs of the TPB (attitudes, subjective norms, perceived behavioral control) and intentions. This effect is expected to reflect that individuals' beliefs with respect to future participation in health behaviors is informed by previous decision making and belief formation (Ajzen, 2002). Furthermore, we included a self-report measure of behavioral automaticity at both the initial time point and at follow-up alongside the measure of behavior. Self-reported behavioral automaticity is a meta-cognitive measure, which prompts individuals to reflect on the extent to which the behavior of interest is performed with little cognitive input and in a routine manner. Consistent with the proposal that past behavior represents non-conscious, automatic processes, we expected measures of automaticity to mediate the effects of past behavior on subsequent behavior. We therefore also expected indirect effects of past behavior on subsequent behavior via behavioral automaticity. Finally, the extent to which past behavior is represented by long-term frequency, recency, and routine as proposed by Perugini and Bagozzi (2001), we expect the three measures to be significantly correlated and converge on a higher order factor that captures the essence of the multiple components of past engagement in behavior.

Method

Participants

Participants comprised three samples of Australian residents (total N = 754). Sample 1 (n = 319) comprised first-year undergraduate students from Griffith University, recruited through the university research participant pool in return for course credit and reported having previously participated in binge drinking, a hazardous pattern of alcohol consumption (NHMRC, 2009). Sample 2 (n = 251) comprised adult members of the Australian public, recruited online through social media and university broadcast emails, and focused on dental flossing. Sample 3 (*n* = 184) comprised parents with at least one child aged between 2 and 5 years who usually resided in the same household as the parent, recruited via online advertising (e.g., social media websites such as "Facebook") and face-to-face (e.g., swim schools), and investigated sun safety behaviors that parents performed for their child. All participants were offered the opportunity to enter a prize draw to win one of three movie vouchers per sample. Sample demographic characteristics for the full sample and separately for each sample are available in Appendix A (supplemental materials).

Design and Procedure

Approval for study procedures was granted prior to data collection from Griffith University Human Research Ethics Committee. The study used a two-wave prospective, correlational design with study measures administered to each sample at an initial point in time (T1), with follow-up measures administered at a second point in time, 6-weeks later (T2). At T1, participants completed a survey assessing social cognitive constructs (attitude, subjective norm, perceived behavioral control, and intention), behavioral automaticity, past behavior, and demographic factors. At T2, participants completed a follow-up survey to assess their behavioral automaticity and behavior for the target behaviors performed over the previous six weeks. Survey data was collected online and presented using the Qualtrics™, an online survey tool. Participant data across the time points were de-identified and matched using a unique code identifier created by the participant.

Measures

The social cognition constructs and behavior were measured using multi-item psychometric instruments, that were previously developed and validated using standardized guidelines (Ajzen, 1991; Gardner et al., 2012; Perugini & Bagozzi, 2001; Verplanken & Orbell, 2003). Measures were adapted to refer to the target behaviors in the current study. Participants provided their responses on scales with 7-point response options. Brief details of the measures are provided below, and a full set of items is available in Appendix B (supplemental materials). Items from each instrument were used as indicators of latent variables representing each model construct in a structural equation model. Past behavior was included in the model as a second-order latent variable indicated by first-order latent factors represented by items from frequency, recency, and routine scales.

Target behaviors. The target behaviors were binge drinking (“engaging in binge drinking”), dental flossing (“flossing my teeth on a daily basis”), and sun safety behaviors (“performing sun-protective behaviors for my child”). *Binge drinking* was defined as consuming more than four standard drinks on a single occasion (NHMRC, 2009). A pictorial guide providing examples of a standard drink for common alcoholic beverages was provided to participants. *Dental flossing* was defined as flossing one’s teeth on a daily basis (Australian Dental Association, 2017). Parents were asked to think of the sun-protective behaviors they engaged in for their youngest child aged 2 to 5 years every time their child was outdoors in direct sunlight for more than 10 minutes. Parents were told that s*un safety* comprised the following behaviors: (a) applying SPF 30+ sunscreen; (b) wearing sun-protective clothing such as a hat, long-sleeved shirt, and sunglasses; and (c) seeking shade between 10 am and 3 pm (Cancer Council Australia, 2017).

Social cognition constructs. Measures of social cognition constructs from the TPB were assessed at T1 and developed according to published guidelines (Ajzen, 2002). *Intention* was measured by three items each for binge drinking, dental flossing, and sun safety (e.g., “I intend to floss my teeth on a daily basis …”). *Attitude* was measured by three items each for binge drinking and dental flossing, and five items for sun safety (e.g., “For me to binge drink in the next 6 weeks would be …”). *Subjective norm* was measured by four items each for binge drinking, and dental flossing, and five items for sun safety (e.g., “Most people who are important to me think I should perform sun-protective behaviors for my child …”). *Perceived* *behavioral control* was measured by four items each for binge drinking, dental flossing, and sun safety (e.g., "I have complete control over whether I floss my teeth on a daily basis …").

Behavioral automaticity. Behavioral automaticity at T1 and T2 was measured using the four-item self-reported behavioral automaticity index (Gardner, 2012) (e.g., "Binge drinking is something I do automatically").

Behavior. *Past behavior* at T1 was measured using items assessing frequency, recency, and routine. *Frequency* was measured using four items that focused on behavior that was performed over the last year (e.g., "How often did you floss your teeth on a daily basis in the past year? …"; Perugini & Bagozzi; 2001). *Recency* was measured using four items that focused on behavior that was performed over the last 4 weeks (e.g., "To what extent did you binge drink in the past four weeks?"; Perugini & Bagozzi, 2001). *Routine* was measured using one item adopted from the Self Report Habit Index (e.g., "Do you agree that performing sun-protective behaviors for your child is something that belongs to my normal routine?"; Verplanken & Orbell, 2003). *Behavior* at T2 was measured using 2 items (e.g., "Think about the past 6 weeks. In general, how often did you floss your teeth on a daily basis?").

Data Analysis

Variance-based structural equation modelling (VB-SEM) was used to test our hypothesized model. VB-SEM uses a partial least squares estimation method that is based on ranked rather than ordinal data. The analysis is less affected by model complexity or departures from normality than covariance-based methods (Henseler et al., 2009). Models were estimated using the Warp PLS v6.0 software (Kock, 2018). Missing data were treated using hierarchical regression imputation. All proposed paths among constructs detailed in Figure 1 were specified as free parameters in the model. In addition, we statistically controlled for the effects of age, highest educational achievement, and gender by setting these variables as predictors of all other variables in the model.

The validity of the proposed measures was assessed by the measurement aspects of the model. The loading of each indicator on its respective latent factor was expected to exceed .700. Composite reliability coefficients (ρ) and average variance extracted (AVE) statistics, which test the sufficiency of scale items as indicators for the latent variables and whether the items account for sufficient variance in the factor, respectively, were expected to exceed .700 and .500. Discriminant validity was supported if the square-root of the AVE for each latent variable exceeded its correlation coefficient with other latent variables. Overall model fit was evaluated using multiple criteria: the goodness-of-fit (GoF) index with values of .100, .250, and .360 corresponding to small, medium, and large effect sizes, respectively; the average path coefficient (APC) and the average R^2 (ARS), which should both be significantly different from zero for an adequately-fitting model; and the average variance inflation factor for model parameters (AVIF) statistic, which should be less than 5.000 for a well-fitting model (Kock, 2018).

Multi-group analysis was used to make pairwise comparisons of path coefficients for the hypothesized model across the three samples. Multi-group analysis calculates a ratio using the difference in the path coefficients for a hypothesized model path across two samples and the pooled standard errors for the specified path, as outlined in Kock (2018). The ratio produces a test of difference for hypothesized paths across each sample.

Finally, a sensitivity analysis was used to test whether model effects differed according to the method used to treat missing cases. Specifically, we estimated the model effects in each sample with missing data handled either by listwise deletion of cases with missing data or imputed using a linear multiple regression method advocated by Kock (2018).

Results

Participants and attrition analysis

Demographic characteristics of the three samples and descriptive statistics of the study variables at both time points are presented in Appendix A (supplemental materials). One hundred and forty-two participants dropped out at follow-up in sample 1, 74 dropped out in sample 2, and 84 dropped out in sample 3. Attrition analysis for sample 1 indicated no significant differences in age ($t(313) = 1.253$, $p = .211$, $d = 0.14$), educational achievement ($t(291) = -.363$, $p = .716$, $d = 0.05$), or gender ($t(289) = 1.155$, $p = .249$, $d = 0.11$) between participants who dropped out and those who remained in the study at T2. Also, no differences were observed on the psychological and behavioral variables (Wilks' Lambda = .983, $F(6,295) = .827$, $p = .550$, $\eta_p^2 = .017$). Attrition analysis for sample 2 indicated no significant differences in age ($t(152) = 1.045$, $p = .093$, $d = 0.14$) or educational achievement ($t(138) = 1.156$, $p = .952$, $d = 0.16$) between participants who dropped out and those who remaining in the study. There was, however, a significantly higher proportion of females among participants who dropped out than those who remained in the study at T2 ($t(162) = -2.192$, $p < .001$, $d = 0.30$). Initial tests suggested potential differences in psychological and behavioral variables (Wilks' Lambda = .941, $F(6,224) = 2.329$, $p = ..033$, $\eta_p^2 = .059$), however follow-up analyses found no significant differences. Attrition analysis for sample 3 indicated no significant differences in age ($t(175) = .064$, $p = .949$, $d = 0.01$) or educational achievement ($t(159) = .645$, $p = .520$, $d = 0.09$). There was a greater proportion of males among participants who dropped out than those who remained in the study at T2 ($t(149) = 2.614$, $p = .010$, $d = 0.38$). Last, no differences were found in the psychological and behavioral variables (Wilks' Lambda = .986, $F(6,170) = .402$, $p = .877$, $\eta_p^2 = .014$).

Preliminary analysis

Measurement components of the VB-SEM confirmed that the latent variables met or approached the criteria for construct and discriminant validity and had good model fit, see Table 1. Factor loadings for the latent factors approached or exceeded the .700 criterion, supporting construct validity of the factors. Importantly, the second-order factor loadings for the frequency, recency, and routine indicators of the past behavior latent variable were large (>.884) and statistically significant (p < .001) for all behaviors. Composite (ρ) reliability coefficients, AVE, and intercorrelations for model variables are presented in Appendix C (supplemental materials). Reliability coefficients exceeded the .700 criterion, and AVE values exceeded the recommended .500 criterion. Correlations among the latent variables also indicated no problems with discriminant validity. Missing values analysis using Little's (1988) missing completely at random (MCAR) test revealed a significant value for the flossing behavior sample (χ^2 = 437.599, df = 357, p = .002), but not for the binge drinking behavior (χ^2 = 431.810, df = 416, p = .286) or parent sun safety behaviors (χ^2 = 296.450, df = 385, p = 1.000) samples.

Model Effects

Standardized parameter estimates for the hypothesized relations among factors are presented in Figure 1 and in tabular form in Appendix D (supplemental materials). Overall, the model accounted for 68.8%, 64.0%, and 61.6% of the variance in intention to binge drink, floss, and adopt safe sun behaviors, respectively, and 39.4%, 77.6%, and 27.9% of the variance in the binge drinking, flossing, and sun-safe behaviors, respectively. Results revealed statistically significant effects of attitudes on intentions to engage in binge drinking and flossing, but not for sun safety behaviors. There was a statistically significant effect of subjective norms on intentions for flossing, but not for the other behaviors. Perceived behavior control significantly predicted intention for binge drinking and flossing but not for sun safety behaviors. Intention statistically predicted flossing, but no effect was found for binge drinking and sun safety behaviors. There was a statistically significant effect of perceived behavioral control on behavior for sun safety behaviors, but not for the other behaviors. Automaticity at T1 predicted automaticity 6-weeks later (T2), and automaticity at T2 predicted behavior, for each of the three behaviors. Statistically significant effects were found from past behavior on attitude, subjective norms, perceived behavioral control, intentions, and automaticity at T1 and T2 for all behaviors. There was a statistically significant effect of past behavior on behavior for binge drinking, but not for flossing or sun safety behaviors.

Focusing on the indirect effects, we found no indirect effect of attitudes, subjective norms, or perceived behavioral control on behavior mediated by intention. We did find indirect effects of T1 automaticity on behavior mediated by T2 automaticity for all behaviors. We found no indirect effects of past behavior on behavior through attitudes, subjective norms, perceived behavioral control, and intention in each of the models. There was, however, a statistically significant indirect effect of past behavior on behavior via T1 automaticity, and via T2 automaticity for all behaviors.

Multi-group analyses identified a few differences in effects across the three samples, although the differences reflected the relative size of the effects across samples, rather than differences reflecting effects that were different from zero and those that were indistinguishable from zero. Effects of attitudes and perceived behavioral control on intentions were significantly smaller in the sun safety sample relative to the binge drinking and flossing samples. Effects of perceived behavioral control on behavior were significantly larger in the sun safety sample relative to the binge drinking and flossing sample. The effect of past behavior on attitude was significantly larger in the binge drinking sample than the sun safety sample. The effects of past behavior on T1 and T2 automaticity were significantly greater in the flossing sample compared to the binge drinking sample. The effect of past behavior on intention was significantly smaller in the binge drinking and flossing samples relative to the sun safety sample.

For completion, we compared model effects without imputation of missing values, using listwise deletion of data with missing cases instead. The model estimated with listwise-deleted data did not result in substantive differences in the pattern of effects across the samples. Full results of these analyses are presented in Appendix D (supplemental materials).

Discussion

Social cognition theories tend to focus on a narrow range of determinants of health behaviors. As a consequence, they may not account for effects of other variables that could be potentially informative when it comes to predicting health behaviors. One potential variable whose effects within social cognition models may provide important information on the determinants of behavior is past behavior. There is already a substantive body of research examining past behavior effects within social cognition theories. Studies including frequency of past behavior within these theories have consistently shown that past behavior attenuates effects of intention and other social cognition constructs on subsequently measured (future) behavior. However, there is some debate over what such effects represent. Some researchers have argued that past behavior may model non-conscious and automatic processes, such as habit (Ouellette & Wood, 1998). Others have argued that past behavior effects should be mediated by constructs from social cognition theories if the theory is to be considered sufficient as an account for further behavior (Ajzen, 1991, 2002). Drawing on Ouellette and Wood’s (1998) propositions, we tested a set of key hypotheses related to reasoned action and automatic processes in a social cognition model including past behavior in three health behaviors, with three, independent samples: binge drinking in university students, dental flossing in community-dwelling adults, and sun safety behaviors by parents for their 2 to 5 year-old children. Furthermore, we adopted a comprehensive measure of past behavior, which encompassed frequency, recency, and routine patterns of previous behavior.

Results revealed a consistent pattern of effects for the proposed model in the binge drinking and dental flossing behavior samples consistent with the TPB. These findings suggest that individuals are more likely to engage in these behaviors when they have positive attitudes toward performing the behavior in future and believe doing so is within their control. Subjective norms did not predict any of the behaviors, suggesting a lesser role for the perceived influence of significant others for these behaviors. Importantly, behavior was also predicted by automaticity in all three samples, suggesting, that the very least, all three behaviors were somewhat determined by habits or routine. These findings suggest that constructs representing both reasoned and automatic processes determine behavior simultaneously. A possible interpretation of this pattern of effects, provided by Hagger et al. (2016), is that these behaviors are determined by constructs representing one or the other of the processes for groups of participants within the sample, each with sufficient strength so as to present as statistically significant overall. The key challenge for future research is to identify the moderator variables that determine when each pattern of effect pervades.

In contrast with previous studies (Hamilton, Kirkpatrick, Rebar, & Hagger, 2017), none of the TPB variables predicted parents' intentions, and intentions did not predict behavior for parental sun safety behaviors. One possible reason for this pattern of effects may be that these behaviors are highly routinized and habitual, particularly in an Australian context where exposure to the sun is both likely and regular. A means to test this hypothesis would be to examine effects of the constructs representing the reasoned process predict behavior when effects of constructs representing the automatic process are removed. We therefore re-estimated the model removing effects of automaticity in the model for this behavior. As predicted, results revealed intentions predicted parental sun safety behavior (β =

.227, $p < .01$). This attenuation effect has been observed consistently in previous studies (see Hagger et al., 2016, 2018), and suggests automaticity is the pervading determinant of behavior in this context.

Research has suggested that past behavior-future behavior relations effectively represent habits (Hagger, 2019; Hagger et al., 2016, 2018; Ouellette & Wood, 1998). We reasoned that if this was the case, residual effects of past behavior on future behavior should be mediated by automaticity, to the extent that individual's reflections on automaticity sufficiently capture a key component of habit. Consistent with previous research (van Bree et al., 2015), our results revealed consistent indirect effects of past behavior on future behavior through automaticity at both time points. This result substantiates one of the propositions set by Ouellette and Wood (1998), that effects of past behavior model habitual or automatic actions.

However, contrary to previous research (Hagger et al., 2016, 2018) and the proposals by Oullette and Wood, effects of past behavior were not found to be mediated by the social cognition constructs in the current model. Ajzen (2002) suggested that the TPB constructs should account for the effects of past behavior if it is to provide a sufficient account of behavior. He suggested that indirect effects may reflect having made similar decisions in the past or the effect of past experience in informing beliefs regarding future performance of the behavior. However, it seems that for the current set of behaviors, beliefs regarding future participation in behavior are not based on past experience. One possible interpretation is that a minority of individuals in these samples perhaps have low levels of previous experience and, thus, their beliefs toward performing the behaviors in future are not based on their past experience. However, for the majority, these behaviors are likely determined by habits. For example, it is well documented that university students frequently engage in hazardous binge drinking (Davoren et al., 2015), even compared to their non-student peers (Kypri et al., 2005). Similarly, sun safety practices is a relevant behavior for most parents in an Australian context (Hamilton et al., 2016; Hamilton, Kirkpatrick, Rebar, White, et al., 2017). It is therefore likely that the behaviors are likely those that are largely habitually determined.

Unlike other proposed models that include deliberative and automatic pathways (Caudwell et al., 2019; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017; van Bree et al., 2015), a novel aspect of the current research is the measurement of automaticity over two time points, this may have contributed to the full mediation of past behavior effects by automaticity for the dental flossing and parental sun safety behavior samples. A residual effect of past behavior was still observed in the binge-drinking sample, which suggest that automaticity may not fully account for effects of automatic, non-conscious behaviors. For example, it could suggest that individuals self-report of automaticity for binge drinking may not be entirely precise because they do not take into account of ‘in-the-moment’ decision making. Other constructs that reflect automatic evaluations of binge drinking behavior such as implicit attitudes toward alcohol, impulsivity, and implicit alcohol identity may be further important mediators of past behavior effects (Caudwell & Hagger, 2014; Hamilton et al., 2020; Houben & Wiers, 2009).

An innovative contribution of the current study is the use of a second-order latent variable of past behavior that included long-term frequency of performance, recent performance (up to 1 month), and routine performance of the target behavior. Typically, past behavior is measured using an arbitrary time frame, such as 1 week. Such measures may miss previous patterns of behavior that may be important in the determination of future behavior. Bagozzi and Warsaw (1990) in their theory of trying, and later Perugini and Bagozzi (2001) in their model of goal-directed behaviors, argued that past behavior should be separated into long-term and recent components. They argued that while the two components may be related, they are conceptually different and therefore add important independent information in the prediction of behavior. For example, an individual may have only recently taken up an activity (e.g., flossing after advice from their dentist), or could have regularly engaged in an activity over a long period, but has not been able to recently (e.g., an individual who usually binge drinks each weekend but has recently reduced spending to save for their university text-books). Perugini and Bagozzi (2001) proposed that recency of behavioral engagement may influence future behavior by anchoring biases that may carry implicit information about intentions to a degree higher than by what is consciously available. Furthermore, consistent with Ouellette and Wood's (1998) premise, they suggest that long-term frequency of behavioral engagement likely maps to habitual occurrences of the behavior. Despite these premises, we found that these conceptually distinct components of past behavior were highly correlated and served as indicators of a second-order past behavior latent variable. These findings suggest that all three components are captured by an overall past behavior construct. Measures of the different past behavior components tend to converge in large samples, and separation of the different components do not offer additional information in terms of the prediction of future behavior. In fact, separation of the different components would likely confound analyses due to multi-collinearity due to the high intercorrelations. Nevertheless, justification for separating past behavior into separate components may be justified when studying past behavior effects of infrequently performed behaviors, like blood donation, or new behaviors that have only just been initiated.

The pervasive effects of habit on the health behaviors in the current study have important implications for practitioners and clinicians. Findings suggest that once an individual has adopted a health-behavior, such as applying sun-safe practices to their children or flossing, they should focus their efforts on building behavioral automaticity to maintain the health-behavior. Strategies that promote habits such as increasing behavioral performance in the presence of a cue could therefore be adopted. Furthermore, previous research has demonstrated that habit formation follows an asymptotic curve; automaticity grows fastest in the initial weeks of habit formation, and then plateaus (Lally et al., 2010). This pattern may mean that while it can take several months for a habit to fully form (Lally et al., 2010), the more intensive work to build the habit (e.g., focusing on building a response to a stable and applicable cue) can be performed in the initial few weeks of an intervention before sufficient self-regulatory actions (e.g., development of self-monitoring charts) could enable persistent repetition of the habitual action. In addition, interventions may need to focus on building the awareness of when an unhealthy habit is being cued. The focus of interventions may be to break or swap a habitual response, for example, if an individual regularly begins binge-drinking after work on a Friday, they may change their response to the cue (i.e., 'finishing work on a Friday) with something more healthy (e.g., eating at a restaurant that does not serve alcohol or by engaging in physical exercise). This work requires effortful, conscious reflection and decisions, and therefore future interventions may also need to use techniques that focus on the social–cognitive aspect of the current model (i.e., focus on building perceived behavioral control and positive attitudes to change).

Strengths, Limitations, and Research Directions

The current study has a number of strengths, including a comprehensive test of a model that included constructs representing reasoned and automatic processes in three distinct behaviors: dental flossing, binge drinking, and parents' sun safety behaviors for their children. Importantly, this is the first study, to the authors' knowledge, to use a measure of three distinct components of past-behavior: frequency, recency, and routine. The research is also innovative as it explores the extent to which effects of the past behavior factor on future behavior were accounted for by measures of behavioral automaticity, a key component of habit. Also unique was the measurement of automaticity at two points in time, which takes the temporal stability of this construct into account.

However, this study is not without limitations, which we outline next along with directions for future research. The current study used a prospective correlational design, so the direction of relations can only be inferred from the proposed relationships outlined in the relevant theories. Cross-lagged panel and experimental designs are needed to confirm the direction of causality (Chan et al., 2020; Liska, 1984). The current study primarily recruited relatively homogenous samples of participants that was low on diversity, which places limits on the generalizability of the results (Henrich et al., 2010). Another limitation is the reliance on self-report measures of behavior. Given one of the behaviors could be socially undesirable (i.e., binge drinking), and another could be seen as an evaluation of positive parenting practices (i.e., the use of sun safety behaviors on your child), social desirability effects have unduly inflated reports of these behaviors. Future studies should focus on collecting behavioral data that does not rely on self-reports which may obviate these biases (Buller & Borland, 1999). In addition, the parental sun safety behavior was defined as a collection of behaviors, which may have had unintended consequences in the way some participants reflected on the automaticity of the behavior. For example, it is plausible that different sun safety behaviors may vary in their degree of automaticity, which may have made it problematic for participants to respond to the measure. However, given each of these behaviors are likely cued in the same way (e.g., going outside during the day) and that the collection of behaviors have been advocated to occur together in a long-standing public health campaign in Australia (Montague et al., 2001), it is likely that each has a similar level of automaticity. Last, automatic processes in the current model were represented by self-reported automaticity alone. Future research should consider including other measures that tap into these processes, such as counter-intentional habits (Gardner et al., 2015) and implicit beliefs (Martin S. Hagger & Chatzisarantis, 2014; Strack & Deutsch, 2004). These additional constructs may play an important role in accounting for effects of past behavior (Martin S. Hagger et al., 2017).

Conclusion

The current study tested a social cognition model that encompassed constructs representing reasoned action and automatic processes to predict three health behaviors in three separate samples: binge drinking in university students, dental flossing in community-dwelling adults, and parental sun safety behaviors for their 2 to 5 year-old children. Results indicated that constructs representing the reasoned action and automatic processes significantly predicted flossing, whereas binge drinking and sun safety behaviors were generally predicted by constructs representing automatic behaviors. The current investigation also found support for the mediation of the past behavior-future behavior relationship by automaticity. The current study fills a knowledge gap in the current literature on the multiple processes that guide behavior and provide further evidence that constructs that represent automatic processes play a key role. Future research should focus on exploring the role of other constructs that represent automatic processes such as counter-intentional habits and implicit beliefs.

Table 1

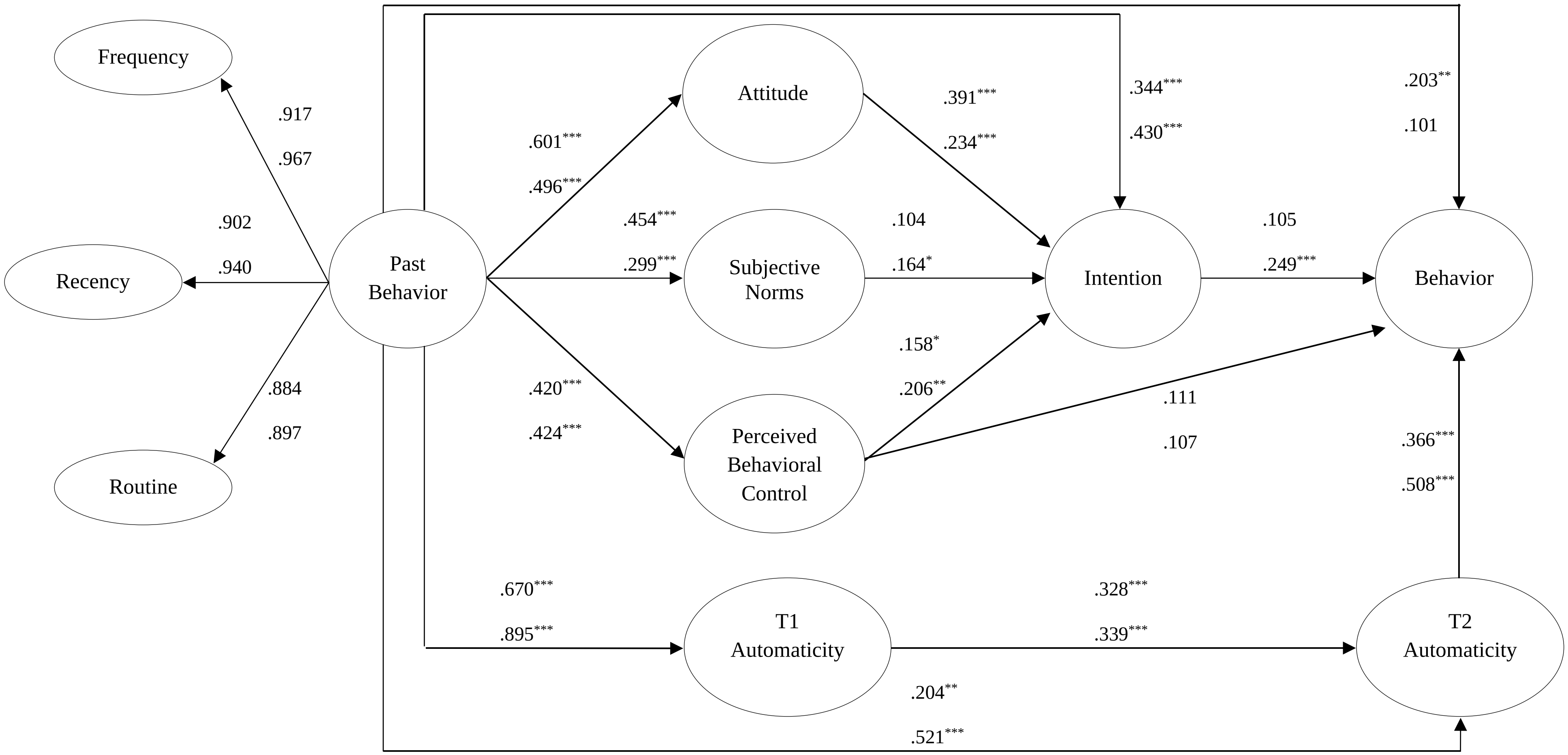
Model Fit and Quality Indices for Structural Equation Models for Binge Drinking, Flossing, and Sun Safety

Index	Binge drinking	Flossing	Sun safety
GoF	.575	.672	.592
AR^2	$.382^{***}$	$.508^{***}$	$.382^{***}$
APC	$.164^{**}$	$.186^{**}$	$.201^{**}$
AVIF	1.272	1.581	1.342

Note. $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Figure 1. Relations among proposed model constructs including standardized parameter estimates.

Estimates on the upper, center, and lower lines are estimates for the binge drinking, flossing, and sun safety behaviors, respectively. Effects of age, gender, and education on each model construct have been omitted for clarity.



Appendix A

Table 1.

Characteristics of Study Participants Who Completed the Initial Survey (Time 1) and Who Completed the Initial and Follow-Up Survey (Time 2) by Behavior

Variable	Total sample		Binge drinking		Flossing		Sun safety	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Participants, *N*	754	454	319	177	251	177	184	100
Age, *M* years (*SD*)	29.05 (10.34)	29.55 (10.77)	23.01 (7.48)	23.47 (7.87)	32.02 (12.11)	32.50 (12.58)	35.10 (5.12)	35.12 (5.07)
Gender (%)								
Male	20.10	18.80	23.50	20.90	17.50	20.30	19.00	12.00
Female	78.20	81.00	75.90	78.50	82.10	79.70	81.00	88.00
Other/non-disclosed	0.40	0.20	0.60	0.60	0.40	-	-	-
Education level (%)								
Junior/senior school	33.20	32.00	57.10	56.50	22.70	22.00	8.70	6.00
TAFE/Diploma	21.90	22.70	25.70	28.80	21.50	19.20	18.50	19.00
UG degree	23.70	24.70	14.70	12.40	29.10	30.50	32.10	36.00
PG degree	19.20	20.30	2.20	2.30	26.70	28.20	38.60	38.00

Note. UG = Undergraduate; PG = Postgraduate.

Table 2.

Descriptive Statistics Across Behaviors for Study Variables for Those Who Completed the Initial Survey (Time 1) and Those Who Completed the Initial and Follow-Up Survey (Time 2)

Variable	Binge drinking		Flossing		Sun safety	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Attitude	2.99 (1.74)	3.06 (1.82)	6.03 (1.12)	6.04 (1.15)	6.41 (1.01)	6.37 (1.09)
Subjective norm	2.54 (1.49)	2.63 (1.47)	4.86 (1.54)	4.81 (1.50)	6.45 (0.71)	6.42 (0.79)
Perceived behavioral control	5.12 (1.52)	5.27 (1.42)	6.06 (1.10)	6.12 (1.08)	6.29 (0.75)	6.32 (0.75)
Intention	3.03 (2.08)	3.05 (2.04)	4.98 (1.87)	5.02 (1.86)	6.55 (0.87)	6.55 (0.91)
T1 automaticity	2.49 (1.67)	2.38 (1.52)	2.90 (2.05)	2.84 (2.02)	5.23 (1.39)	5.15 (1.36)
Past behavior	2.58 (1.52)	2.61 (1.56)	3.95 (2.04)	4.01 (1.99)	6.35 (0.82)	6.34 (0.93)
T2 automaticity	–	2.34 (1.49)	–	2.95 (2.06)	–	5.04 (1.40)
Behavior	–	2.16 (1.35)	–	4.12 (2.46)	–	5.16 (1.67)

Appendix B

Scale Items for Constructs of the Hypothesised Model

Variable	Item	Scale
Intention	It is likely I will [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	I intend to [behaviour]	
	I expect to [behaviour]	
Attitude	For me to [behaviour] in the next six weeks it would be:	1 = "bad", 7 = "good"
		1 = "unpleasant", 7 = "pleasant"
		1 = "worthless", 7 = "valuable" [ac]
		1 = "unfavourable", 7 = "favourable" [b]
		1 = "unwise", 7 = "wise" [b]
		1 = "awful", 7 = "nice" [b]
Subjective norm	Those people who are important to me would want me to [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	Most people who are important to me would approve of me [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	Most people who are important to me think I should [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	Those people who are important to me do [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	Other parents I know think that [behaviour]is a good thing to do [b]	1 = "strongly disagree", 7 = "strongly agree"
	Other parents I know [behaviour] [b]	
Perceived behavioural control	I have complete control over whether I [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	I am confident that I could [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	It is mostly up to me whether I [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
	It would be easy for me to [behaviour]	1 = "strongly disagree", 7 = "strongly agree"
Behavioural Automaticity	I do automatically	1 = "strongly disagree", 7 = "strongly agree"
	I do without having to consciously remember	1 = "strongly disagree", 7 = "strongly agree"
	I do without thinking	1 = "strongly disagree", 7 = "strongly agree"
	I start doing before I realise I'm doing it	1 = "strongly disagree", 7 = "strongly agree"
Frequency	Do you agree that [behaviour] is something I do frequently	1 = "strongly disagree", 7 = "strongly agree
	Do you agree that [behaviour] is something I have been doing for a long time	1 = "strongly disagree", 7 = "strongly agree
	How often did you [behaviour] in the past year?*	1 = "never", 7 = "very many times"
	To what extent did you [behaviour] in the past year?*	1 = "never", 7 = "very many times"

Recency	Do you agree that [behaviour] is something you have done recently	1 = "strongly disagree", 7 = "strongly agree
	Do you agree that [behaviour] is something you have done in the past four weeks	1 = "strongly disagree", 7 = "strongly agree
	How often did you [behaviour] in the past four weeks?*	1 = "never", 7 = "very many times"
	To what extent did you [behaviour] in the past four weeks?*	1 = "never", 7 = "very many times"
Routine	Do you agree that [behaviour] is something that belongs to my normal routine	1 = "strongly disagree", 7 = "strongly agree
T2	Think about the past 6 weeks. In general, how often did you [behaviour]?	1 = "never", 7 = "always"
Behaviour	Think about the past 6 weeks. In general, to what extent did you [behaviour]?	1 = "never", 7 = "a large extent"

Note. [a]Item only administered in the binge drinking survey. [b]Item only administered in the sun safety survey. [c] Item only administered in the flossing survey. *These items were given values for their intermediate scale points: 1 = "never", 2 = "almost never", 3 = "a very few times", 4 = "occasionally", 5 = "often", 6 = "quite often", 7 = "very many times".

Appendix C

Table 1

Factor Intercorrelations, Composite Reliabilities, and Average Variance Extracted for Latent Variables in the Structural Equation Model in Each Sample

	ρ	AVE	R^2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Attitude	.954	.873	.390	.934													
	.886	.724	.286	.851													
	.926	.716	.380	.846													
2. Sub. norm	.932	.775	.211	.620***	.880												
	.826	.665	.139	.388***	.815												
	.914	.683	.283	.348**	.826												
3. PBC	.834	.557	.216	.344***	.345***	.746											
	.814	.646	.199	.282***	.209**	.804											
	.815	.527	.347	.147	.312**	.726											
4. Intention	.969	.914	.688	.729***	.580***	.451***	.956										
	.952	.913	.640	.593***	.360***	.503***	.955										
	.973	.923	.616	.271**	.342***	.316**	.961										
5. T2 Behavior	.937	.881	.394	.339***	.226**	.221**	.421***	.938									
	.954	.956	.776	.425***	.242**	.483***	.721***	.978									
	.983	.967	.279	.211*	.057	.176	.471***	.983									
6. T1 Habit	.935	.782	.469	.313***	.293***	.317***	.516***	.301***	.884								
	.964	.904	.811	.389***	.219**	.329***	.593***	.703***	.951								
	.948	.821	.578	.195	.158	.296**	.572***	.388***	.906								
7. T2 Habit	.942	.802	.305	.276***	.225**	.168*	.302***	.430***	.431***	.896							
	.965	.905	.708	.332***	.263**	.404***	.619***	.814***	.794***	.951							
	.947	.816	.550	.174	.115	.292**	.572***	.525***	.673***	.903							
8. Age	-	-	-	-.136	-.110	-.098	-.206**	-.173*	-.140	-.154*	1.000						
	-	-	-	.154*	-.102	.074	.199**	.307***	.195*	.227**	1.000						
	-	-	-	-.115	-.053	-.053	-.233*	-.174	-.179	-.141	1.000						
9. Gender	-	-	-	.052	.004	-.024	.050	-.042	.096	.095	-.029	1.000					
	-	-	-	.142	-.115	-.132	.003	-.012	-.029	-.073	-.041	1.000					
	-	-	-	.157	.147	.271**	.010	-.056	.046	-.051	.149	1.000					
10. Education	-	-	-	.019	-.032	.007	-.074	-.062	-.026	.070	.443***	.047	1.000				
	-	-	-	.115	.147	-.038	.075	.105	.079	.079	.488***	-.071	1.000				
	-	-	-	-.045	.130	.160	.077	.038	-.190	-.152	.235*	.098	1.000				
11.Frequency	.954	.839	-	.541***	.435***	.420***	.685***	.425***	.692***	.417***	-.141	.028	.054	.916			
	.963	.900	-	.478***	.197**	.405***	.673***	.774***	.846***	.802***	.336***	.008	.121	.949			

	.924	.754	-	.272**	.404***	.469***	.725***	.402***	.705***	.656***	-.063	-.009	.052	.868			
12. Recency	.968	.883	-	.492***	.354***	.322***	.623***	.493***	.499***	.320***	-.228**	-.071	-.121	.758***	.940		
	.978	.937	-	.504***	.251***	.427***	.712***	.759***	.760***	.735***	.316***	.083	.127	.906***	.968		
	.949	.822	-	.410***	.322**	.222*	.743***	.442***	.602***	.577***	-.155	-.039	-.044	.776***	.907		
13.Routine	-	-	-	.514***	.312***	.168*	.511***	.397***	.550***	.300***	-.027	-.099	.097	.716***	.679***	1.000	
	-	-	-	.431***	.201**	.288***	.582***	.664***	.750***	.700***	.249***	-.034	.104	.800***	.725***	1.000	
	-	-	-	.406**	.262**	.326***	.727***	.404***	.647***	.590***	-.019	.042	.009	.791***	.826***	1.000	
14. Past behavior	.928	.812	-	.572***	.408***	.338***	.674***	.487***	.645***	.384***	-.147	-.052	.011	-	-	-	.901
	.928	.877	-	.496***	.232**	.401***	.702***	.784***	.841***	.798***	.322***	.021	.126	-	-	-	.935
	.951	.865	-	.356***	.354***	.364***	.787***	.447***	.700***	.653***	-.085	-.002	.006	-	-	-	.930

Note. ρ = Composite reliability coefficient; AVE = Average variance extracted; Values on principal diagonal are square-root of average variance extracted (AVE); Sub. Norm = Subjective norm; PBC = Perceived behavioral control; PB = Past behavior; Coefficients for binge drinking, flossing, and sun safety behaviors are depicted on the first, second, and third lines, respectively.
$^{***}p < .001$ $^{**}p < .01$ $^{*}p < .05$.

Composite reliability coefficients (ρ) and average variance extracted (AVE) statistics test the sufficiency of scale items as indicators for the latent variables and whether the items account for sufficient variance in the factor, respectively. They were expected to exceed .700 and .500, respectively.

Appendix D

Table 1

Standardized Path Coefficients (β) and 95% Confidence Intervals from Structural Equation Models for Binge Drinking, Flossing, and Sun Safety

Effect	Binge Drinking			Flossing			Sun Safety		
	β	CI_{95}		β	CI_{95}		β	CI_{95}	
		LL	UL		LL	UL		LL	UL
Direct effects									
Attitude→Intention	.391***c	0.256	0.526	.234***b	0.093	0.375	-.050bc	-0.244	0.144
Subjective norms→Intention	.104	-0.041	0.249	.164*	0.021	0.307	.089	-0.103	0.281
Perceived behavioral control→Intention	.158*c	0.015	0.301	.206**b	0.065	0.347	-.087bc	-0.279	0.105
T1 automaticity→T2 automaticity	.328***	0.191	0.465	.339***	0.202	0.476	.363***	0.185	0.541
Intention→Behavior	.105	-0.040	0.250	.249***	0.110	0.388	.135	-0.053	0.323
Perceived behavioral control→Behavior	.111c	-0.032	0.254	.107b	-0.038	0.252	-.164*bc	-0.352	0.024
T2 automaticity→Behavior	.366***	0.229	0.503	.508***	0.375	0.641	.428***	0.254	0.602
Past behavior→Attitude	.601***c	0.472	0.730	.496***	0.363	0.629	.364***c	0.186	0.542
Past behavior→Subjective norm	.454***	0.319	0.589	.299***	0.160	0.438	.369***	0.193	0.545
Past behavior→Perceived behavioral control	.420***	0.285	0.555	.424***	0.289	0.559	.466***	0.294	0.638
Past behavior→T1 automaticity	.670***a	0.541	0.799	.895***a	0.772	1.018	.710***	-0.897	2.317
Past behavior→Intention	.344***c	0.207	0.481	.430***b	0.295	0.565	.719***bc	0.558	0.880
Past behavior→T2 automaticity	.204**a	0.063	0.345	.521***a	0.388	0.654	.383***	0.207	0.559
Past behavior→Behavior	.203**	0.062	0.344	.101	-0.044	0.246	-.015	-0.211	0.181
Past behavior→Frequency[d]	.917			.967			.919		
Past behavior→Recency[d]	.902			.940			.933		
Past behavior→Routine[d]	.884			.897			.938		
Indirect Effects									
Attitude→Intention→Behavior	.050	-0.054	0.154	.058	-0.046	0.162	-.010	-0.149	0.129
Subjective norms→Intention→Behavior	.034	-0.070	0.138	.041	-0.063	0.145	.015	-0.122	0.152
Perceived behavioral control→Intention→Behavior	.022	-0.082	0.126	.051	-0.053	0.155	-.014	-0.151	0.123
T1 automaticity→T2 automaticity→Behavior	.120*	0.018	0.222	.172***	0.072	0.272	.155*	0.022	0.288
Past behavior→Attitude→Intention→Behavior	.030	-0.054	0.114	.029	-0.055	0.113	-.004	-0.118	0.110
Past behavior→Subjective norms→Intention→Behavior	.015	-0.069	0.099	.012	-0.072	0.096	.006	-0.108	0.120

Past behavior→Perceived behavioral control→Intention→Behavior	.009	-0.075	0.093	.022	-0.062	0.106	-.006	-0.120	0.108
Past behavior→T1 automaticity→T2 automaticity→Behavior	.080*	-0.004	0.164	.154***	0.072	0.236	.110*	0.000	0.220
Total effect									
Past behavior→Behavior	.477***a	.344	.610	.735***ab	0.608	0.862	.276**b	.094	.458

Note. [a]Significant difference ($p < .05$) between path in flossing data and binge drinking data in multi-group analysis; [b]Significant difference ($p < .05$) between flossing data and sun safety data in multi-group analysis; [c]Significant difference ($p < .05$) between binge drinking data and sun safety data in multi-group analysis; [d]Paramter estimate represents a second-order factor loading. β = Standardized path coefficient; CI_{95} = 95% confidence interval of path coefficient.
$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 2

Standardized Path Coefficients (β) and 95% Confidence Intervals from Structural Equation Models for Binge Drinking, Flossing, and Sun Safety with Listwise Deletion of Missing Data

Effect	Binge Drinking			Flossing			Sun Safety		
	β	CI_{95}		β	CI_{95}		β	CI_{95}	
		LL	UL		LL	UL		LL	UL
Direct effects									
Attitude→Intention	.382***	0.239	0.525	.250***	0.103	0.397	-.044	-0.250	0.162
Subjective norms→Intention	.090	-0.065	0.245	.130*	-0.021	0.281	.092	-0.112	0.296
Perceived behavioral control→Intention	.146*	-0.005	0.297	.198**	0.049	0.347	-.089	-0.293	0.115
T1 automaticity→T2 automaticity	.309***	0.164	0.454	.313***	0.168	0.458	.310**	0.120	0.500
Intention→Behavior	.098	-0.055	0.251	.283***	0.136	0.430	.233*	0.037	0.429
Perceived behavioral control→Behavior	.116	-0.035	0.267	.124	-0.027	0.275	.282**	0.090	0.474
T2 automaticity→Behavior	.392***	0.249	0.535	.522***	0.383	0.661	.292**	0.100	0.484
Past behavior→Attitude	.594***	0.457	0.731	.487***	0.346	0.628	.317***	0.127	0.507
Past behavior→Subjective norm	.447***	0.306	0.588	.260***	0.113	0.407	.386***	0.200	0.572
Past behavior→Perceived behavioral control	.425***	0.284	0.566	.404***	0.261	0.547	.429***	0.245	0.613
Past behavior→T1 automaticity	.679***	0.544	0.814	.891***	0.762	1.020	.717***	0.546	0.888
Past behavior→Intention	.366***	0.223	0.509	.449***	0.308	0.590	.723***	0.554	0.892
Past behavior→T2 automaticity	.196**	0.047	0.345	.545***	0.406	0.684	.421***	0.237	0.605
Past behavior→Behavior	.216**	0.067	0.365	.034	-0.121	0.189	.025	-0.183	0.233
Indirect Effects									
Attitude→Intention→Behavior	.044	-0.066	0.154	.071	-0.037	0.179	-.014	-0.161	0.133
Subjective norms→Intention→Behavior	.030	-0.080	0.140	.037	-0.073	0.147	.027	-0.120	0.174
Perceived behavioral control→Intention→Behavior	.018	-0.092	0.128	.056	-0.054	0.166	-.025	-1.495	1.445
T1 automaticity→T2 automaticity→Behavior	.121*	0.013	0.229	.163**	0.057	0.269	.091	-0.052	0.234
Past behavior→Attitude→Intention→Behavior	.026	-0.064	0.116	.034	-0.056	0.124	-.004	-0.124	0.116
Past behavior→Subjective norms→Intention→Behavior	.013	-0.077	0.103	.010	-0.080	0.100	.010	-0.110	0.130
Past behavior→Perceived behavioral control→Intention→Behavior	.008	-0.082	0.098	.023	-0.067	0.113	-.011	-0.131	0.109
Past behavior→T1 automaticity→T2 automaticity→Behavior	.082*	-0.006	0.170	.146***	0.058	0.234	.065	-0.053	0.183
Total effects									

Past behavior→Behavior	.493***	.354	.632	.708***	0.575	0.841	.499***	.319	.679

Note. β = Standardized path coefficient; CI_{95} = 95% confidence interval of path coefficient; $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

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Chapter 5: A Dual-Process Model Applied to Two Health-Promoting Nutrition Behaviours (Paper 3)

This chapter contains a paper based on Aim 2 of the thesis that has been prepared for submission. The PhD Candidate is the first author of the paper and co-authors are part of the supervisory team. The PhD Candidate takes overall responsibility for the publication and all co-authors meet criteria for authorship. Electronic supplementary material to the paper are attached at the end of the chapter. The data file, analysis code, and output files from all are available at the Open Science Framework: psyarxiv.com/zkfrc/

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

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The PhD Candidate's contribution to the paper involved the conceptualization, collection of the data, analysis and interpretation of the data, writing the manuscript, and revising the manuscript in the publication process. The PhD Candidate's supervisors provided supervision and advice at all stages and provided comments on the manuscript drafts.

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A dual-process model applied to two health-promoting nutrition behaviours

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Abstract

Objective: High sugar-sweetened beverage consumption and low fruit and vegetable intake are associated with a range of health issues such as cardiovascular disease and diabetes. Both intentional and automatic processes have been found to determine nutrition behaviours; however, previous research has tended to focus on goal-directed habits. It is, however, similarly important to understand the role of other types of habit constructs, such as counter-intentional habits, in explaining behaviour given many individuals likely have habits that run counter to their stated goals. The aim of the current study is to test a dual process model incorporating constructs that reflect both intentional and automatic processes (i.e., goal-directed and counter-intentional habits) in two health behaviours (i.e., eating the recommended serves of fruits and vegetables a day and restricting sugar-sweetened beverage consumption) across two samples: middle school students aged 11–14 years and university students aged 17–24 years. **Methods**: A prospective study design with two waves of data collection separated by one week was adopted. Participants (total N = 606) completed an initial survey comprising self-report measures of past behaviour, intention, goal-directed habits, and counter-intentional habits. One week later, participants (N = 414) completed a self-reported measure of behaviour. **Results**: A structural equation model revealed that intentions significantly predicted both behaviours in both samples. Goal-directed habits predicted fruit and vegetable consumption in both samples, while counter-intentional habits only predicted restriction of sugar-sweetened beverages in the middle-school sample. Counter-intentional habit moderated the goal-direct habit on behaviour relationship in restricting sugar-sweetened beverages of the middle school sample. No other significant moderation effects were found. **Conclusions**: Current findings indicate that

different types of automatic factors may determine different nutrition behaviours. Specifically, habits specifying avoidance of the target behaviour (i.e., a habit to avoid consumption) did not predict future behaviour. The moderating effects between the habits may suggest strong goal-direct habits override counter-intentional habits. Future research should explore the concept of avoidance-oriented habits.

Introduction

Health-promoting nutrition behaviours such as consuming adequate fruit and vegetables and limiting foods and drinks with added sugars, is significantly associated with reducing chronic diseases such as cardiovascular diseases, cancer, diabetes and chronic respiratory diseases (WHO, 2013). Typically, dietary patterns are established in childhood (Smithers, Golley, Brazionis, & Lynch, 2011) and remain relatively stable into adulthood (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2005). Given the role of dietary behaviours in the prevention of chronic conditions, exploring the psychological and behavioural determinants of health promoting nutrition behaviours may provide formative evidence to guide more effective behavioural change interventions. This study, therefore, explored a dual process model, testing the effects of constructs representing both reasoned-action processes from models of social cognition (i.e., intention), and non-conscious processes (i.e., goal-oriented and counter-intentional habits) on two nutritional behaviours (i.e., eating the recommended serves of fruits and vegetables each day and restricting sugar-sweetened beverages) in two samples (i.e., middle-school children aged 11–14 years and university students aged 17–24 years).

Behavioural scientists and psychologists seeking to identify relevant determinants of nutrition behaviours and, in turn, predict and explain nutrition behaviours have, to date, most often applied theories of social cognition. Theories of social cognition, like the theory of planned behaviour (Ajzen, 1991), assume that behavioural engagement is determined by an individual’s desire, expectation, or willingness to engage in the behaviour (i.e., intention). These theories identify intention as the most proximal determinant of behaviour, and have been shown to be effective in predicting engagement in a number of health behaviours, including dietary behaviours (Brown, Hagger, Morrissey, & Hamilton, 2018; McKee et al., 2019; Mullan, Wong, & Kothe, 2013). Reviews of such theories indicate their constituent constructs explain, on average, around 20% of the variability in dietary behaviours (McEachan, Conner, Taylor, & Lawton, 2011), and around 45% of the variance in specific dietary behaviours, such as fruit and vegetable consumption (Guillaumie, Godin, & Vezina-Im, 2010). Despite the effective application of these theories, there remains a number of unresolved issues with respect to the determinants of nutrition behaviours that have been raised. For example, theories of social cognition typically specify determinants of behaviour that reflect deliberative processes, with the underlying assumption being that behavioural engagement is governed by reasoned, conscious processes. However, emerging research is demonstrating support for the addition of constructs that represent non-conscious processes such as habit/behavioural automaticity, which have typically not been represented within theories of social-cognition (Albani, Butler, Traill, & Kennedy, 2017; Brown, Hagger, & Hamilton, 2019; Hagger, Trost, Keech, Chan, & Hamilton, 2017; Hannan, Moffitt, Neumann, & Kemps, 2019).

The role of non-consciousness, automatic processes in determining behaviour

Dual process theories aim to provide more comprehensive means to explain variance in behaviour by incorporating constructs that represent non-conscious, automatic processes alongside constructs representing deliberative, reasoned processes (Rothman, Sheeran, & Wood, 2009; Strack & Deutsch, 2004; Triandis, 1977). Deliberative processes represent individuals' reasoned deliberative consideration of the merits or concerns of performing a particular course of action before making a decision, often referred to as a *system-2* process (Kahneman, 2011; Kahneman & Frederick, 2002). The effects of constructs of theories of social cognition on behaviour are often considered to reflect system-2 processes. Non-conscious processes are expected to reflect well-learned patterns of evaluations, contextual-cues, and behaviours (i.e., a schema) that are activated on presentation of behavioural cues or behaviour-related information, and lead to efficient behavioural enactment with little deliberation. Such behaviours are often considered to be enacted *non-consciously*, beyond the individual's awareness, and are often referred to as a *system-1* process. Habit is defined as a highly automated action generated in response to well-learned situational cues or specific contexts (Gardner, 2015; Ouellette & Wood, 1998), and reflects a specific form of non-conscious process in dual process models.

Research supports the role of habits within dual process models applied to predict behaviour, including dietary behaviours (Hamilton, Kothe, Mullan, & Spinks, 2017; Phillips, Johnson, & More, 2019). Self-reported habit, in the context of dual process models, has been hypothesised to act as both a proximal determinant of future behaviour (Triandis, 1977) and mediator between other important determinants (Ouellette & Wood, 1998). For example, habit, along with intention, was found to mediate the relationship between the home environment and soft-drink consumption of adolescents (Tak et al., 2011). Habit has similarly been hypothesised to act as a moderator between intention and behaviour. It has been argued that habit might support the enactment of healthy behaviours if motivation is compromised (Verplanken & Wood, 2006). In a meta-analysis strong support was found for the moderating role of habit applied to dietary and physical activity domains (Gardner, de Bruijn, & Lally, 2011), although other studies have since failed to support this pattern (de Bruijn, Rhodes, & van Osch, 2012; Murtagh, Rowe, Elliott, McMinn, & Nelson, 2012; Norman, 2011; Norman & Cooper, 2011).

There are, however, methodological arguments regarding the validity of whether habits do override intentions on behaviour. Gardner, Corbridge, and McGowan (2015) argue that, given most studies measure habit and intentions concurrently (e.g., habit to eat vegetables, intention to eat vegetables), habit would be expected to correlate with intention. They suggest that data which show strong habits and weak intention (or vice versa) likely lack ecological validity (Gardner et al., 2015). Furthermore, weak intention to do one behaviour should not infer a strong intention to do an alternative behaviour (Gardner, 2015; Richetin, Conner, & Perugini, 2011), suggesting that interactions between habit and intentions are best investigated by measuring the counter-intentional habit. In the context of restricting high-sugar drink consumption, an example of this would be testing the moderating effect of the habit to drink sugary drinks on the effect of intention to restrict sugar-sweetened beverages on behaviour. Similarly, measuring counter-intentional habits may be simpler and easier for participants to reflect upon in self-report measures. For example, participants may find it difficult to reflect on avoidance-oriented habits (e.g., the habit to avoid drinking sugary beverages) (Gardner & Tang, 2014) or have not made specific cue-response associations for such an avoidance-habit. In these circumstances, if the goal-directed behaviour is to avoid sugary drinks, there may be a methodological advantage to using the counter-intentional habit (i.e., a measure of the habit to drink sugary beverages) (Lally & Gardner, 2013; Martiny-Huenger, Martiny, Parks-Stamm, Pfeiffer, & Gollwitzer, 2017).

Initial research understanding the role of counter-intentional habits has found inconclusive results. Research into unhealthy snack intake among adolescents found that, while intentions for healthy eating were significantly associated with reducing unhealthy snack consumption, habit strength for eating unhealthy snacks (i.e., the counter-intentional habit) was more strongly and positively associated with unhealthy snack intake (De Vet, Stok, De Wit, & De Ridder, 2015). So, this suggests that counter-intentional habits may usurp intention to be healthy. In contrast, another study found that counter-intentional habits to eat unhealthy snacks did not override intentions to avoid eating unhealthy snacks (Gardner et al., 2015). The latter finding suggests that counter-intentional habits can be inhibited in favour of goal-directed actions. This may be dependent on available resources to overcome the counter-intentional habit, such as knowledge and ability to use self-regulation skills to overcome the habit (Holland, Aarts, & Langendam, 2006; Verhoeven, Adriaanse, De Ridder, De Vet, & Fennis, 2013). However, inconsistent findings of the role of counter-intentional habits highlight the need for further research in this area to understand their effects, particularly the circumstances in which habits and counter-intentional habits determine nutrition-related behaviours.

Finally, an individual's past actions are an important contributor to future behaviour. Past behaviour is argued to reflect both intentional and automatic pathways to future behaviour (Ouellette & Wood, 1998). However, including past behaviour in theories of health behaviour has been found to attenuate model effects (Hagger, Chan, Protogerou, & Chatzisarantis, 2016; Hagger, Polet, & Lintunen, 2018; Norman, 2011; Norman & Conner, 2006; Norman, Conner, & Bell, 2000; Norman & Cooper, 2011), including when they are applied to nutrition behaviours (Brown et al., 2018). The inclusion of past behaviour is, therefore, important to include in a dual process model. If the inclusion of past behaviour reduces the effects of the constructs reflecting either deliberative or non-conscious processes, possible to the point of being comparatively trivial, then it provides a test of sufficiency to those determinants as effective means to predict and explain the behaviour.

The Current Study and Hypotheses

The aim of the current study is to test a dual process model incorporating constructs reflecting deliberative processes (i.e., intention) and non-conscious processes (i.e., habit operationalised as goal-directed and counter-intentional) in two distinct nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables a day and restricting sugar-sweetened beverage consumption) across two samples (i.e., middle school students aged 11–15 years and university students aged 17–24 years). The proposed model is presented in Figure 1. It is first hypothesised that, in accordance with theories of social cognition, intention will predict behaviour (H_1). Drawing from habit theory, it is hypothesised that goal-directed (H_2) and counter-intentional (H_3) habits will have a direct effect on each behaviour. Furthermore, it is hypothesised that goal-directed (H_4) and counter-intentional (H_5) habits will moderate the intention-behaviour relationship. It is also expected that counter-intentional habits will moderate the effect of goal-directed habit on behaviour (H_6). In line with other dual process models, it is expected that past behaviour will indirectly predict future behaviour via the constructs reflecting both deliberative (i.e., intention, H_7), and automatic (i.e., goal-direct habits, H_8; and counter-intention habit H_9) pathways. In accordance with previous research showing the attenuating effects of past behaviour, it is expected that a dual process model that includes the effects of past behaviour will have smaller effects compared to a model without past behaviour (H_{10}).

Last, we seek to compare the differences in the size of the effects of relations between the constructs of the proposed models across the two samples.

Method

Participants

Participants in the school sample (*N* = 266; 45.9% female; *M* age = 12.61 years, *SD* = .61 years, range = 11 to 14 years) were year 7 and 8 students recruited from two co-educational schools in South East Queensland, of which one was a public school, and the other a private school. The index of community and socio-educational advantage (ICSEA), an indicator of socioeconomic status based on national census, was sourced for each school. The index was above the national average for the private school, while the index for the public school was slightly below the national average (Australian Curriculum, Assessment and Reporting Authority, 2015). Participants in the university sample (*N* = 340; 73.2% female; *M* age = 19.22 years, *SD* = 1.88 years, range = 17-24 years) were first year undergraduate psychology students from Griffith University in South East Queensland.

Design and Procedure

Ethical clearance was obtained from the Griffith University Human Research Ethics Committee as well as the relevant school authority for the school sample. A prospective survey design was adopted, with participants completing self-report measures of the target behaviour and psychological variables at an initial point in time, time 1 (T1) and measures of the target behaviour at a follow-up point, time 2 (T2), one week later.

Schools were recruited via an email which provided an invitation to participate and information about the research. Following approval from school principals, study procedures and resources were developed and administered in partnership with the school teaching staff. Participants were required to obtain parent/guardian consent prior to completing the surveys by providing a consent form signed by their parent/guardian. Participants provided consent to participate in the study by completing a consent item on the first page of the T1 survey. No incentives were offered to the school students or schools for participation. Participants from the university sample were recruited from a first-year psychology participant pool and via emails sent to the broader university student population. University students recruited via the psychology participant pool were provided partial credit for survey completion; however, no other incentives were offered to students recruited outside the participant pool.

A combination of online and paper-based surveys was used in the school sample, while the surveys used for the university sample were exclusively online. School students completed the questionnaire in class time for both time points. University students completed the questionnaire at a time of their choosing for both time points. Data across time-points for both samples were matched using a unique code identifier provided by participants.

Measures

Constructs were measured using previously validated multi-item psychometric instruments adapted to refer to target behaviours in the current study. Participants provided their responses on seven-point scales. Brief details of the measures are provided below, and a full set of measures are available in Appendix A (supplemental materials).

Target Behaviours. The target behaviours for the current research were restricting sugar-sweetened beverage consumption and eating the recommended serves of fruit and vegetables per day. The measures for these target behaviours were derived from the Australian dietary guidelines (NHMRC, 2013). The guidelines, as well as examples of sugar sweetened beverages and standard servings of fruit and vegetables, preceded the survey measures in the T1 and T2 surveys to enhance participants' understanding of the target behaviours.

Intention. The measure of intention measured at T1 was developed using standardised procedures set out by Ajzen (1991). Intention items for both behaviours used the stem: "Do you agree that in the next week…" which preceded three items (e.g., "I intend to [restrict my sugary-drink consumption/eat the recommended serves of fruit and vegetables per day]").

Goal-directed habit. Goal-directed habits, measured at T1, are defined as habits consistent with performing the target behaviour (i.e., the habit of eating the recommended serves of fruit and vegetable and the habit to restrict sugar-sweetened beverages consumption). The automaticity subscale (i.e., the self-report behavioural automaticity index; Gardner, Abraham, Lally, & de Bruijn, 2012) of the self-report habit index (Verplanken & Orbell, 2003) was used to measure goal-directed habit for each behaviour. The respective common stems, "Restricting my sugary-drink consumption is something…" and "Eating the recommended serves of fruit and vegetables per day is something…" were followed by four items (e.g., "I do automatically")

Counter-intentional habit. Counter-intentional habits, measured at T1, are defined as the habit to perform the opposite of the target behaviour (i.e., the habit to drink sugar-sweetened beverages and the habit to avoid eating the recommended serves of fruit and vegetables). The same behavioural automaticity scale used to measure goal-directed habits was used with changes in the common stem to reflect the counter-intentional behaviour (i.e., "Drinking sugary-drinks is something…" and "Avoiding eating the recommended serves of fruit and vegetables per day is something…").

Behaviour. Standardised procedures set out by Ajzen (1991) were used to develop a scale to measure behaviour for restricting sugar-sweetened beverage consumption and behaviour for eating the recommended serves of fruit and vegetables per day. For both behaviours the common stem, "Think about the past 7 days…" preceded two questions ("…in general, how often did you [restrict your sugary-drink consumption/eat the recommended number of serves per day of fruit and vegetables]?" and "…on how many days did [restrict your sugary-drink consumption/eat the recommended number of serves per day of fruit and vegetables]?"). Participants indicated their responses using seven-point scale (1 *never*/*0-1 days* and 7 *always*/*7 days*).

Data-analysis

Variance-based structural equation modelling (VB-SEM) was used to test our hypothesized model. VB-SEM uses a partial least squares estimation method based on ranked instead of ordinal data. The analysis is less affected by model complexity or departures from normality than covariance-based methods (Henseler, Ringle, & Sinkovics, 2009). Models were estimated using the Warp PLS v6.0 software (Kock, 2018). Items from each instrument were used as indicators of latent variables representing each model construct in a structural equation model. Missing data were imputed using hierarchical regression imputation. All proposed paths among constructs detailed in Figure 1 were specified as free parameters in the model. In addition, we statistically controlled for the effects of age, ethnicity, gender, and past behaviour by setting these variables as predictors of all other variables in the model.

The measurement aspects of the model are used to assess the validity of the proposed measures. The loading of each indicator on its respective latent factor was expected to exceed .700. Composite reliability coefficients (ρ) and average variance extracted (AVE) statistics, which test the sufficiency of scale items as indicators the latent variables and whether the items account for sufficient variance in the factor, respectively, were expected to exceed .700 and .500. Discriminant validity was supported if the square-root of the AVE for each latent variable exceeded its correlation coefficient with other latent variables. Overall model fit was evaluated using multiple criteria: the goodness-of-fit (GoF) index with values of .100, .250, and .360 corresponding to small, medium, and large effect sizes, respectively; the average path coefficient (APC) and the average R^2 (ARS), which should be significantly different from zero for an adequately-fitting model; and the average variance inflation factor for model parameters (AVIF) statistic, which should be less than 5.000 for a well-fitting model (Kock, 2017).

Multi-group analysis was used to test pairs of path coefficients in the hypothezied model across the two samples. The analysis calculates a ratio using the differences in path coefficients between two samples and the pooled standard errors for the specified path coefficients, as outlined in Kock (2018). The ratio produces a *t*-value and *p*-value for the comparison of each hypothesized path across the samples. Due to multiple comparisons, the critical value for *p* for the difference tests was set at .01.

Results

Participants and attrition analysis

Demographic characteristics of participants in each sample are presented in Appendix B. Seventy-five participants (28.2%) dropped out of the school student sample, and 117 participants (34.3%) dropped out of the university student sample, across the two time points.

Attrition analysis for the school student sample indicated no differences in age (F(1,264) = .105, p = .746, η^2 = < 0.001), ethnicity (F(1,264) = .310, p = .578, η^2= 0.001), or gender (F(1,264) = .214, p = .644, η^2= 0.001) between participants that remained in the sample and those who dropped out. In addition, there were no differences between participants remaining and those who dropped out on the automaticity, intention, and behavioural variables (Wilks' Lambda = .985, F(1,263) = 1.02, p = .397, η_p^2 = .015). Attrition analysis for the university student sample indicated no differences in age (F(1,335) = 2.290, p = .131, η^2= 0.07), ethnicity (F(1,337) = .549, p = .578, η^2= 0.002), or gender(F(1,338) = .900, p = .343, η^2= 0.003) between participants that dropped out and those who remained. There were also no differences on automaticity, intention, and behavioural variables (Wilks' Lambda = .972, F(1,332) = 2.33, p = .056, η_p^2 = .028).

Preliminary Analyses

The goodness of fit statistics revealed an acceptable overall fit of the model with the data according to the multiple indices adopted, as shown in Table 1 and 2. Measurement components of the VB-SEM confirmed that the latent variables met or approached criteria for construct and discriminant validity. Factor loadings for the latent factors exceeded the

.700 criterion and AVE scores exceeded the .500 criterion supporting construct validity. Composite (ρ) reliability coefficients, AVE, and intercorrelations for model variables are presented in Table 3. Reliability coefficients exceeded the .700 criterion, and AVE values exceeded the recommended .500 criterion. Correlations among the latent variables also indicated constructs achieved discriminant validity.

Model Effects

Restricting Sugar-Sweetened Beverages Behaviour. Standardized parameter estimates for the hypothesized relations among factors are presented in Table 4. Overall, the model accounted for 40.5% of the variance of behaviour in the school student sample and 35.0% of the variance in behaviour of the university student sample. Results revealed statistically significant effects of intention on behaviour for both samples. Goal-directed habit did not directly predict behaviour in either sample, however counter-intentional habit negatively predicted behaviour in the school sample, but not the university sample. There were no significant moderation effects of either goal-directed or counter-intentional habits on the intention – behaviour relationship in either sample. Counter-intentional habits moderated the goal-directed habit on behaviour relationship in the school sample. A review of the simple slopes (see Appendix C) revealed that as counter-intentional habits increased, goal-directed habits were less predictive of future behaviour. No moderation effect was found in the university sample. There were statistically significant indirect effects of past behaviour on future behaviour via intention in both samples, but not through either habit measures. Multi-group analyses revealed no differences in the hypothesised relationships across the samples. Last, past behaviour significantly predicted all variables in the model. When past behaviour was excluded from the model, effect sizes of all model effects were larger, corroborating the attenuating effect of past behaviour on model effects observed elsewhere. Multi-group analyses between the model with and without past behaviour found no statistically significant differences in effects.

Eating the Recommended Serves of Fruit and Vegetables Model Behaviour. Standardized parameter estimates for the hypothesized relations among factors are presented in Table 5. Overall, the model accounted for 79.5% of the variance of behaviour in the school student sample and 75.4% of the variance in behaviour of the university student sample. Results revealed statistically significant effects of intention on behaviour for both samples. Goal-directed habit significantly and directly predicted behaviour in the school sample but not the university sample. Counter-intentional habit did not predict behaviour in either sample. There were no significant moderation effects in either sample. Past behaviour statistically predicted future behaviour via both intention and goal-directed habit in both samples. No indirect effects were found via counter-intentional habit in both samples. Multi-group analyses revealed significantly higher effects for the past behaviour on future behaviour relationship in the university sample. Last, past behaviour significantly predicted all variables in the model. When past behaviour was excluded from the model, the size of model effects was larger and the goal-direct habit on behaviour relationship in the university sample was found to be significant. Multi-group analyses found a significantly higher effect between the goal-direct habit on behaviour relationship in the university sample with past behaviour excluded from the model, but no other differences.

Discussion

Models of behavioural prediction have typically focused on understanding a narrow set of social cognitive determinants (Sniehotta, Presseau, & Araújo-Soares, 2014).

Emerging research has complemented these variables by exploring the role of non-conscious and automatic factors such as habit (Brown et al., 2019; Gardner, 2015; Phillips et al., 2019). Within the habit literature, researchers typically focus on goal-directed habits, which, therefore, miss other important habit constructs such as effects of counter-intentional habits: the habit to engage in the opposite of the goal-directed behaviour (Verplanken & Faes, 1999). Drawing from dual process models such as theory of interpersonal behaviour (Triandis, 1977), the current study tested a number of hypotheses related to constructs representing deliberative (i.e., intention) and non-conscious processes (i.e., goal-directed habit and counter-intentional habit) in two distinct nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables a day and restricting sugar-sweetened beverage consumption) across two samples (i.e., middle school students aged 11–15 years and university students aged 17–24 years).

Consistent with other research which hypotheses intention as a proximal predictor of behaviour (Ajzen, 1991), the current research found significant, direct effects of intention on each of the behaviours, in each of the cohorts. This suggests that middle-school students' and university students' intention to adhere to healthy eating practices (i.e., both eating the recommended serves of fruits and vegetables and restriction of sugar sweetened beverages) predicts their self-reported performance of their behaviour. This demonstrates that irrespective of previous behaviour or current habits, efforts to enhance intention to healthy eating practices will likely increase nutrition behaviour. Behaviour change techniques related to manipulating intention could focus on strengthening goal-formation by using techniques such as making specific action plans (Luszczynska, Tryburcy, & Schwarzer, 2006; Schwarzer et al., 2010; van Osch et al., 2009).

The current study also found a number of direct effects the automatic constructs. Specifically, for goal-directed habits, significant direct effects were found for eating the recommended serves of fruits and vegetables for the middle school student sample. This demonstrates the importance of building strong cue-response associations to help maintain and further increase fruit and vegetables for middle school students. As eating behaviours are often complex, interventions could focus on increasing the automaticity of specific parts of the habit formation process (e.g., habitual instigation; habitually choosing one extra serve of vegetable to take to lunch) (Gardner, Phillips, & Judah, 2016), or to build on the automaticity of one specific behaviour (e.g., to eat one piece of fruit with breakfast) (Albani et al., 2017; Lally, van Jaarsveld, Potts, & Wardle, 2010). A significant attenuation effect was found in the university sample for the effect of goal-directed habit for eating the recommended serves of fruit and vegetables on behaviour when past behaviour was included in the model. This shows that frequency of past behaviour accounts for the unique variation in future behaviour, over and above the contribution of the automaticity of eating fruit and vegetables. As past behaviour is not a construct, it does not provide information on the conditions that lead to the stability of this behaviour. This attenuation effect likely suggests that the current model is missing other important variables that account for the stability of fruit and vegetable intake in university students, such as implicit beliefs or self-control. Identifying these constructs may allow for efficacious interventions to be created to increase the fruit and vegetable consumption of university students.

Contrary to our hypotheses, no direct effects were found for the goal-directed habits to avoid drinking sugar-sweetened beverages. One explanation for the lack of significant effects may be that individuals find it difficult to reflect on whether they automatically restrict or avoid behaviours as some of the contextual cues relevant to the habit are more ambiguous and less salient in memory (McDaniel & Einstein, 2000). Alternatively, participants may not believe the restriction of sugar-sweetened beverages is a non-conscious, automatic process when answering the SRBAI (i.e., which is what the measurement of behavioural automaticity attempts to capture). In an exploratory think aloud study on measurements of habit, the authors found that the most frequent occurring problem was participants deviation from the intended meaning of the measurement (Gardner & Tang, 2014). They found a number of their participants reflected an uncertainty in their response which could be related to whether participants believe they *habitually* do not engage in a behaviour or simply do not engage in that behaviour. Furthermore, Danner, Aarts, and Vries (2008) found that mental accessibility of past behaviour moderated the intention-behaviour relationship. It could be that accessing memories of specific instances of avoiding sugary-sweetened beverages is more difficult than approach-oriented behaviours, such as when an individual has consumed sugar-sweetened beverages habitually, which may have contributed to the non-significant effects.

The current study found inconclusive findings for the direct effects of counter-intentional habits on behaviour. Counter-intentional habit for the restriction of sugar-sweetened beverages (i.e., the habit *to drink* sugar-sweetened drinks) predicted behaviour in the middle-school sample, whereas no other counter-intentional habit predicted behaviour in either sample. Thus, for the middle-school students, focused efforts on understanding the cues which stimulate the response to drink sugary drinks may be needed to further reduce this behaviour in future (Webb, Sheeran, & Luszczynska, 2009). For example, middle-school students may have strong environmental cues (e.g., getting home from school and watching television) which trigger the response to drink a soft drink. Intervention efforts could, therefore, be aimed at removing the availability of soft drinks in the family home to break the established mental link between the cue (getting home and watching television) with the response (drinking soft drink) (Luszczynska et al., 2013). For university students, this could suggest that, unlike the younger middle-school students, they are able to resist the habitual action of drinking sugary-drinks. Self-regulatory capacity increases through childhood (Raffaelli, Crockett, & Shen, 2005), therefore, irrespective of the habitual impulse, university students may have greater ability to use self-control to adhere to healthy nutritional goals (such as not drinking sugary drinks). Furthermore, research has demonstrated that self-control plays a more significant role in regulating unhealthy but not healthy nutrition behaviours (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014).

Counter-intentional habits were also found to play a moderating role to the goal-directed habit on behaviour relationship for middle-school students' restriction of sugar-sweetened beverages. This suggests that as middle-school students' habit to consume sugary drinks strengthened, so the effect of their habit of restricting their sugar-sweetened beverage consumption on restricting their actual consumption was attenuated. This demonstrates that for this sample and behaviour, two distinct habitual processes exist and are in competition with each other. It is important to note that this moderation effect was not found in any of the other samples or behaviours and so, overall, current results do not provide strong evidence for this pattern of moderation. However, this effect may also depend on the level of specificity of the habit (e.g., the habit to eat cake when someone has offered it to you). Such a habit also has limited responses (e.g., to eat it or not to eat it). The habit strength of one response will likely be negatively correlated to habit strength of the other option. With more broadly specified habits (e.g., to exercise frequently) there are many potential cues and responses that will not necessarily always negatively correlated with each other. Future studies may provide a better indication of the consistency of the effect.

Habits should, theoretically, override intentions in guiding behaviour in associated settings (Orbell & Verplanken, 2010). Much of the research testing this hypothesis has used concordant intentions and habits, finding significant effects (Gardner et al., 2011). Given others have found null or opposing findings, it has been argued that the moderation effect only makes sense when using counter-intentional habits. The current investigation was the first to examine the simultaneous moderation effects of goal-directed and counter-intentional habits. Results found that neither of the two forms of habit moderated the intention on behaviour relationship across both samples and behaviours. Given the current study used similar methods and measures of habits, intentions, and behaviour to other studies, it calls into questions the validity of the expectation that habit will consistently override intentions in generating behaviour. It may be that habits will only override intentions under specific circumstances (e.g., an individual is preoccupied or is experiencing depleted self-regulatory capacity compared to feeling highly motivated to be healthy), or in certain contexts (e.g., eating in a social environment with friends compared to at home, alone). This result may also suggest that individuals engage in strategies that can inhibit habitual action. Studies have shown that students are aware of situations where habitually unhealth behaviours are more likely to occur and can then choose to engage in strategies, such as monitoring and distraction, to inhibit the habit impulse (Quinn, Pascoe, Wood, & Neal, 2010).

Dual process models suggest that the stability of behaviour (i.e., past behaviours effect on future behaviour) is explained by both deliberative and non-conscious pathways (Evans, 2008; Ouellette & Wood, 1998). Including past behaviour as a predictor in dual process models also acts as a test of sufficiency of the other determinants of behaviour in the model. The inclusion of past behaviour attenuated all model effects and reduced the effect of goal-direct habit on the restriction of sugar-sweetened beverages in university students to be not distinguishable from zero. Furthermore, the current research found mixed results for the role of both intentional and automatic factors in the mediation of past to future behaviour. In both samples and behaviours, past behaviour indirectly predicted future behaviour via intention. This demonstrates for middle school and university students, engagement in these nutrition behaviours appear to be in-line with explicit goals and intentions. Unlike other research that found sun safety, oral-hygiene, and alcohol-consumption behaviours were each explained by factors representing automatic processes (Brown et al., 2019), the current research only found that past behaviour indirectly predicted future behaviour via goal-directed habits for eating the recommended serves of fruit and vegetables in middle school students. Interestingly, while there was a significant, negative, direct effect of counter-intentional habits on the restriction of sugar-sweetened beverages, this did not translate to a mediation effect. Therefore, while the habit of drinking sugary drinks impacts the likelihood of restricting total sugary-drink consumption, it does not explain the stability of the restriction behaviours.

A large amount of variance (approximately 75 – 80%) was explained in fruit and vegetable consumption compared to the restriction of sugar-sweetened beverages. One explanation of this could be the likely stability of contexts in which fruit and vegetable consumption occurs compared to the restriction of sugar sweetened beverages. Typically, the consumption of fruits and vegetables will occur regularly and in a stable situation (e.g., daily in the kitchen or dining room), whereas there may be greater variability in the contexts where participants' restrict sugary drinks. Furthermore, there may be additional, unmeasured constructs that determine avoidance or inhibitory action, such as self-regulatory capacity and self-control. The model hypothesised in this research, therefore, accounts for a greater amount of variance in the behaviour that has smaller variability. This claim is substantiated by the strong effects of past behaviour on fruit and vegetable consumption compared to the restriction of sugar-sweetened beverages, demonstrating that fruit and vegetable consumption is quite stable.

It is important to note, that for both nutrition behaviours in this study, effects of the habits measures framed as avoidance of the behaviour (i.e., the habit to avoid eating the recommended serves of fruits and vegetables or the habit to avoid drinking sugary drinks) were not statistically significant. This could suggest that either participants do not habitually avoid specific nutrition behaviours or participants struggle to consistently and accurately reflect on their habits to restrict or avoid certain behaviours. Furthermore, it could be that this construct is only relevant to certain people and the effect is lost within the noise of the data. For example, two individuals may never drink sugary beverages. Person A would previously consume sugary drinks frequently but several months ago formed the habit to avoid buying them. Person A therefore now habitually avoids/restricts their sugar-sweetened beverage consumption. A second person, Person B, has never consumed sugar-sweetened beverages and therefore has never tried to restrict their consumption; they simply do not drink them. Does this second person *habitually* not drink sugar-sweetened beverages or simply does not drink sugar-sweetened beverages? How should Person B answer the measure of habit? As habits are built over time, via repetition (Lally & Gardner, 2013; Lally et al., 2010), conceptually, only Person A could have a habit to avoid sugary drinks but, as lay representations of habit and how lay-people answer measures of habit are not necessarily accurate (Gardner & Tang, 2014) we do not know if individuals necessarily answer the question accurately. Furthermore, younger participants have less opportunities to develop avoidance habits and their food and beverage consumption is more likely to be under the control of external forces, such as their parents' control. The two individuals might have different scores on the automaticity scale but have the same behavioural frequency, therefore losing the significant effect of behavioural automaticity on habit. This highlights the need to apply measures of habit that are relevant to the sample and behaviour, particularly with regards to avoidance-oriented behaviours, that are both conceptually meaningful and allow for consistent answering by participants.

Strengths, limitations, and future directions

The current study has several strengths including testing two distinct nutrition behaviours in two independent samples. The study tested two health promoting nutrition behaviours (i.e., fruit and vegetable consumption and the restriction of sugar sweetened beverages) in a middle school (students aged 11–15 years) and a young-adult university (students aged 17–24 years) sample. By using two behaviours and two distinct samples the consistency of effects can be evaluated, providing stronger evidence in support of the findings. Similarly, discrepancies between effects may provide insight into group level or behaviour-specific differences that could be further explored. This is the first study, to the authors' knowledge, to simultaneously measure both goal-directed and counter-intentional habits. By including two separate automatic variables, this study was able to explore a nuanced representation of the roles that habit may play in nutrition behaviours.

Findings of the current study should be interpreted in light of a number of limitations, which are outlined next alongside suggestions for future research. There is a lack of research with regards to the concepts of habitual avoidance, restriction, or the habit of ‘not doing’. While the authors of this study attempted to use language and provide sufficient level of specificity when describing each measure of habit, there still remains concerns about how participants may have interpreted and answered these questions. There have been many concerns raised in the literature (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Labrecque & Wood, 2015; Rebar, Gardner, Rhodes, & Verplanken, 2018) regarding the measurement of habit in general; yet, there remains a dearth of understanding about what the general population understand to be habits. Future research could focus on a deeper exploration of lay representations of habit to provide researchers knowledge about if and how measures of habit could be updated or refined to ensure they are measuring what is sought to be measured. Another limitation of this study includes the use of a prospective-correlational design. Given the exploratory nature of the research this design is appropriate; however, it reduces the interpretability of the results as the direction of effects can only be inferred from the theoretically driven relationship structure. Future research should seek to use cross-lagged panel designs and experimental designs that manipulate the variables, to provide better evidence to support directions of effect and causality (Liska, 1984). Last, the current study also relies exclusively on self-report measures. This may introduce bias to results as socially desirable responding or inaccurate memory retrieval may inflate effects (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995). Where possible, future research should corroborate finding using non-self-report measures.

Conclusions

The current study tested a dual process model including constructs representing both intentional and automatic processes in two distinct nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables and restricting sugar-sweetened beverage consumption) across middle school and university students. Results indicated that intention, representing a deliberative construct, significantly predicted both nutrition behaviours across both samples. There were inconclusive findings on the role of goal-directed and counter-intentional habits on behaviours. Only the goal-directed habit to eat the recommended serves of fruits and vegetables and the counter-intentional habit to restricting sugar-sweetened beverages in the middle-school sample (i.e., the habit to drink sugary drinks), significantly predicted behaviour. The current study begins to explore the role of different forms of habit on health promoting nutrition behaviours. Furthermore, it highlights the need to further explore the concept of counter-intentional habits. Future research should, therefore, focus on these areas including exploring lay representations, understandings, and use of “habit”. This will contribute to developing conceptually meaningful and accurate measurements of habit and to better understand the role both deliberative and automatic factors play in nutrition behaviour.

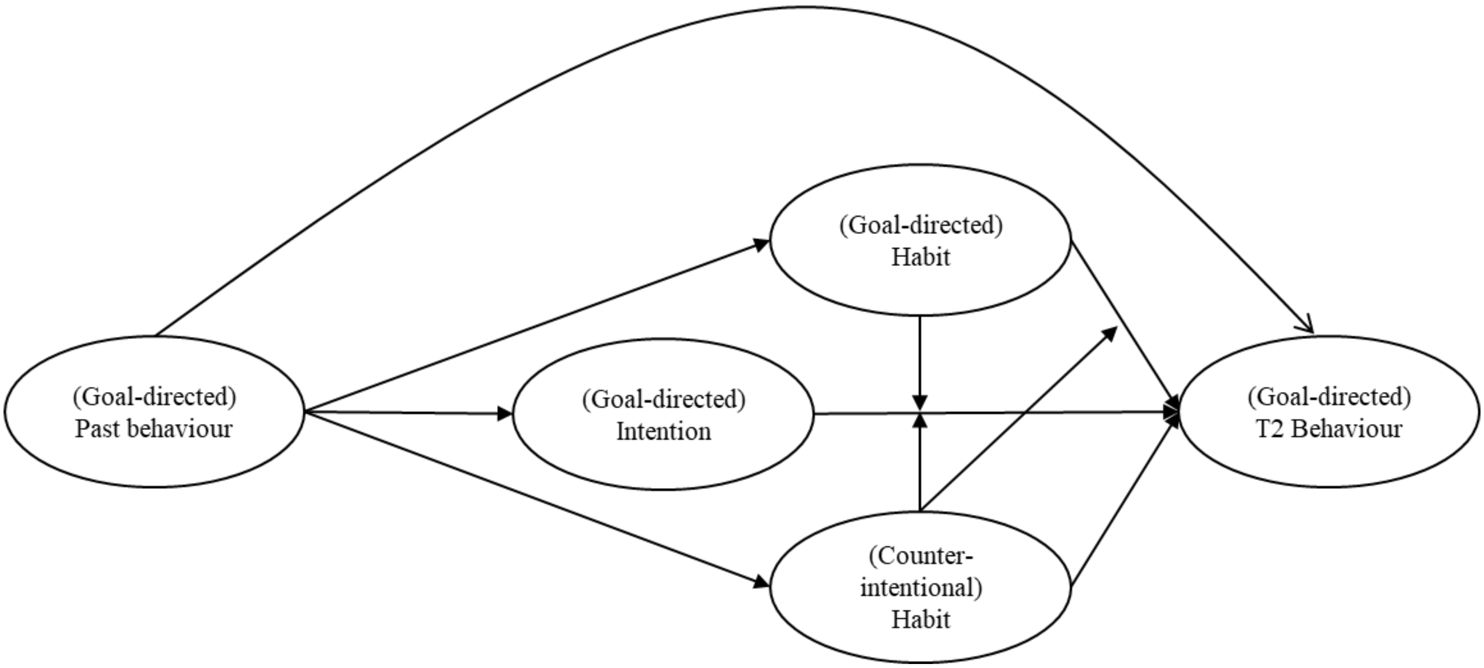


Figure 1. Hypothesized relations among model constructs. Direct effects of age, gender, and ethnicity on each model construct have been omitted for clarity. Standardized path coefficients for each effect are presented in Table 4 and Table 5

Table 1.

Model Fit and Quality Indices for Structural Equation Models for Restricting Sugar-Sweetened Beverages

Behaviour	Restricting Sugar-Sweetened Beverages without Past Behaviour		Restricting Sugar-Sweetened Beverages with Past Behaviour	
Index	School	University	School	University
GoF	.278	.311	.457	.520
AR^2	$.093^{*}$	$.104^{*}$	$.253^{***}$	$.294^{***}$
APC	$.107^{*}$	$.090^{*}$	$.142^{*}$	$.133^{*}$
AVIF	1.334	1.655	1.229	1.603

Note. $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$; GoF = Tenenhaus good of fit; AR^2 = Average R-squared; APC = Average path coefficient; AVIF = Average full collinearity variation inflation factor

Table 2.

Model Fit and Quality Indices for Structural Equation Models for Eating the Recommended Serve of Fruit and Vegetables

Behaviour	Fruit and Vegetable Consumption without Past Behaviour		Fruit and Vegetable Consumption with Past Behaviour	
Index	School	University	School	University
GoF	.434	.423	.684	.695
AR^2	.207***	.191***	.514***	.5156**
APC	.126*	.099*	.177**	.166**
AVIF	2.182	2.227	1.496	2.531

Note. * *p* < .05 ** *p* < .01 *** *p* < .001; GoF = Tenenhaus good of fit; AR^2 = Average R-squared; APC = Average path coefficient; AVIF = Average full collinearity variation inflation factor

Table 3. *Factor Intercorrelations, Composite Reliabilities, and Average Variance Extracted for Latent Variables in the Structural Equation Model*

	ρ	AVE	R^2	1	2	3	4	5	6	7	8
1. Intention	.962	.895	.516	.946							
	.953	.872	.259	.934							
	.967	.908	.517	.953							
	.973	.923	.357	.961							
2. Goal-directed habits	.945	.859	.541	.750***	.927						
	.906	.709	.198	.408***	.842						
	.980	.944	.581	.662***	.972						
	.978	.918	.276	.588***	.958						
3. Counter-intentional habits	.981	.946	.206	-.333***	-.428***	.973					
	.952	.832	.150	-.403***	-.284***	.912					
	.977	.914	.213	-.463***	-.463***	.956					
	.984	.941	.212	-.582***	-.618***	.970					
4. Past behaviour	.947	.900	-	.636***	.727***	-.443***	.948				
	.875	.777	-	.463***	.402***	-.378***	.882				
	.970	.943	-	.694***	.753***	-.445***	.971				
	.907	.830	-	.576***	.504***	-.417***	.911				
5. T2 Behaviour	.979	.960	.795	.752***	.680***	-.287***	.654***	.980			
	.897	.812	.405	.543***	.233**	-.378***	.492***	.901			
	.976	.954	.754	.704***	.713***	-.466***	.826***	.977			
	.934	.876	.330	.523***	.416***	-.347***	.514***	.936			
6. Age	-	-	-	.143*	.111	-.006	.060	.148*	1.000		
	-	-	-	.103	-.032	.047	-.001	.153*	1.000		
	-	-	-	.022	-.065	-.052	-.038	.035	1.000		
	-	-	-	.190**	.179**	-.178**	.152*	.167*	1.000		
7. Gender	-	-	-	.145*	.068	-.035	.053	.119	.115	1.000	
	-	-	-	.117	.104	-.039	.091	.063	.115	1.000	
	-	-	-	.096	.061	-.061	.011	.056	-.081	1.000	
	-	-	-	-.008	-.013	.055	-.008	.042	-.081	1.000	
8. Ethnicity	-	-	-	-.128	-.039	-.066	-.009	-.022	-.039	.032	1.000
	-	-	-	-.073	-.002	.044	-152*	-.110	-.039	.032	1.000
	-	-	-	-.038	.091	.021	.055	.036	-.069	.001	1.000
	-	-	-	-.040	-.069	.081	-.123	-.133*	-.069	.001	1.000

Note. ρ = Composite reliability coefficient; AVE=Average variance extracted; Values on principal diagonal are square- root of average variance extracted (AVE); Coefficients for eating the recommended serves of fruit and vegetables in school students, restricting sugar-sweetened beverage consumption in school students, eating the recommended serves of fruit and vegetables in university students, and restricting sugar-sweetened beverage consumption in university students are depicted on the first, second, third, and fourth lines, respectively; $^{***}p < .001$ $^{**}p < .01$ $^{*}p < .05$.

Table 4.

Standardized Path Coefficients (β) and 95% Confidence Intervals from Structural Equation Models for the Restriction of Sugar Sweetened Beverages Between School and University Sample.

Effect	Restriction of Sugar-Sweetened Beverages without Past Behaviour						Restriction of Sugar-Sweetened Beverages with Past Behaviour					
	School sample			University sample			School Sample			University sample		
	β	CI_{95}		β	CI_{95}		β	CI_{95}		β	CI_{95}	
		LL	UL		LL	UL		LL	UL		LL	UL
Direct Effects												
Intention→ Behaviour	0.389***	0.258	0.520	0.424***	0.302	0.546	0.321***	0.188	0.454	0.299***	0.176	0.422
GDH→ Behaviour	-0.054	-0.195	0.087	0.145*	0.018	0.272	0.112	-0.027	0.251	0.072	-0.057	0.201
CIH→ Behaviour	-0.223***	-0.358	-0.088	-0.005	-0.136	0.126	-0.177**	-0.314	-0.040	0.010	-0.121	0.141
GDH X Intention → Behaviour	0.044	-0.097	0.185	0.055	-0.074	0.184	0.012	-0.129	0.153	0.092	-0.037	0.221
CIH X Intention → Behaviour	0.007	-0.134	0.148	-0.005	-0.136	0.126	0.006	-0.135	0.147	-0.039	-0.168	0.090
CIH X GDH → Behaviour	0.131*	-0.008	0.270	-0.032	-0.163	0.099	0.118*	-0.021	0.257	0.049	-0.080	0.178
Past behaviour→ Intention	-	-	-	-	-	-	0.464***	0.335	0.593	0.574***	0.456	0.692
Past behaviour→ GDH	-	-	-	-	-	-	0.430***	0.301	0.559	0.500***	0.380	0.620
Past behaviour→ CIH	-	-	-	-	-	-	-0.373***	-0.504	-0.242	-0.426***	-0.548	-0.304
Past behaviour→ Behaviour	-	-	-	-	-	-	0.273***	0.138	0.408	0.283***	0.158	0.408
Indirect Effects												
Past behaviour→ Intention→ Behaviour	-	-	-	-	-	-	.149**	0.051	0.247	.171***	0.081	0.261
Past behaviour→ GDH→ Behaviour	-	-	-	-	-	-	0.048	-0.052	0.148	0.036	-0.056	0.128
Past behaviour→ CIH→ Behaviour	-	-	-	-	-	-	0.066	-0.034	0.166	-0.004	-0.096	0.088

Note. * $p < .05$ ** $p < .01$ *** $p < .001$; [a]Significant difference ($p < .05$) between paths in the school and university sample; [1]Significant difference between paths with and without past behaviour; GDH = Goal-directed habit; CIH = Counter-intentional habit

Table 5.

Standardized Path Coefficients (β) and 95% Confidence Intervals from Structural Equation Models for the Eating the Recommended Serves of Fruit and Vegetables Between School and University Sample.

Effect	Eating the Recommended Serves of Fruit and Vegetables without Past Behaviour						Eating the Recommended Serves of Fruit and Vegetables with Past Behaviour					
	School sample			University sample			School Sample			University sample		
	β	CI_{95}		β	CI_{95}		β	CI_{95}		β	CI_{95}	
		LL	UL		LL	UL		LL	UL		LL	UL
Direct Effects												
Intention→ Behaviour	0.558***	0.431	0.685	0.392***	0.062	0.270	0.460***	0.388	0.620	0.226***	0.101	0.351
GDH→ Behaviour	0.289***	0.156	0.422	0.404^{***1}	0.062	0.282	0.195**	0.019	0.251	0.102^{1}	-0.027	0.231
CIH→ Behaviour	-0.044	-0.185	0.097	-0.081	0.066	-0.210	-0.095	-0.059	0.173	-0.036	-0.167	0.095
GDH X Intention → Behaviour	-0.003	-0.144	0.138	-0.088	-0.217	0.041	-0.033	-0.174	0.108	0.004	-0.127	0.135
CIH X Intention → Behaviour	0.065	-0.074	0.204	0.091	-0.038	0.220	0.109	-0.030	0.248	0.056	-0.073	0.185
CIH X GDH → Behaviour	0.051	-0.090	0.192	0.035	-0.096	0.166	0.045	-0.096	0.186	-0.050	-0.179	0.079
Past behaviour→ Intention	-	-	-	-	-	-	0.671***	0.508	0.740	0.711***	0.595	0.827
Past behaviour→ GDH	-	-	-	-	-	-	0.714***	0.605	0.837	0.755***	0.641	0.869
Past behaviour→ CIH	-	-	-	-	-	-	-0.439***	-0.560	-0.328	-0.450***	-0.572	-0.328
Past behaviour→ Behaviour	-	-	-	-	-	-	0.297^{***a}	0.142	0.374	0.590^{***a}	0.472	0.708
Indirect Effects												
Past behaviour→ Intention→ Behaviour	-	-	-	-	-	-	0.308***	0.214	0.402	0.161***	0.071	0.251
Past behaviour→ GDH→ Behaviour	-	-	-	-	-	-	0.139**	0.041	0.237	0.077	-0.015	0.169
Past behaviour→ CIH→ Behaviour	-	-	-	-	-	-	0.042	-0.058	0.142	0.016	-0.076	0.108

Note. $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$; [a]Significant difference ($p < .05$) between paths in the school and university sample; [1]Significant difference between paths with and without past behaviour; GDH = Goal-directed habit; CIH = Counter-intentional habit

Appendix A

Scale Items for Constructs of the Hypothesised Model

Variable	Item	Scale
Intention	It is likely I will [behaviour]	1 = “strongly disagree”, 7 = “strongly agree”
	I intend to [behaviour]	1 = “strongly disagree”, 7 = “strongly agree”
	I expect to [behaviour]	1 = “strongly disagree”, 7 = “strongly agree”
Goal directed habit	[behaviour] is something I do automatically	1 = “strongly disagree”, 7 = “strongly agree”
	[behaviour] is something I do without having to consciously remember	1 = “strongly disagree”, 7 = “strongly agree”
	[behaviour] is something I do without thinking	1 = “strongly disagree”, 7 = “strongly agree”
	[behaviour] is something I start doing before I realise I’m doing it	1 = “strongly disagree”, 7 = “strongly agree”
Counter-intentional habit	[counter-intentional behaviour] is something I do automatically	1 = “strongly disagree”, 7 = “strongly agree”
	[counter-intentional behaviour] is something I do without having to consciously remember	1 = “strongly disagree”, 7 = “strongly agree”
	[counter-intentional behaviour] is something I do without thinking	1 = “strongly disagree”, 7 = “strongly agree”
	[counter-intentional behaviour] is something I start doing before I realise I’m doing it	1 = “strongly disagree”, 7 = “strongly agree”
Behaviour (T2)	Think about the last 7 days, in general, how often did you do [behaviour]	1 = “never, 7 = “always”
	Think about the last 7 days, in general, on how many days did you do [behaviour]	0 = “0/1 day”, 7 = “7 days”

Appendix B

Table 1

Participant Characteristics Across Cohorts for Study Variables for Those Who Completed the Initial Survey (Time 1) and Those Who Completed the Initial and Follow-Up Survey (Time 2)

Variable	School sample		University sample	
	Time 1	Time 2	Time 1	Time 2
Participants, *N*	266	191	340	223
Age, *M* years (SD)	23.05 (7.52)	23.47 (7.87)	19.22 (1.88)	19.33 (1.96)
Gender (%):				
Male	53.00	54.50	26.80	25.10
Female	45.90	44.00	73.20	74.90
Other identified/non-disclosed	1.10	1.50	0.00	0.00
Ethnicity (%):				
Caucasian	72.90	71.20	79.40	78.50
Other	22.60	24.10	20.30	21.50
Missing	4.50	4.70	0.30	0.00

Table 2.

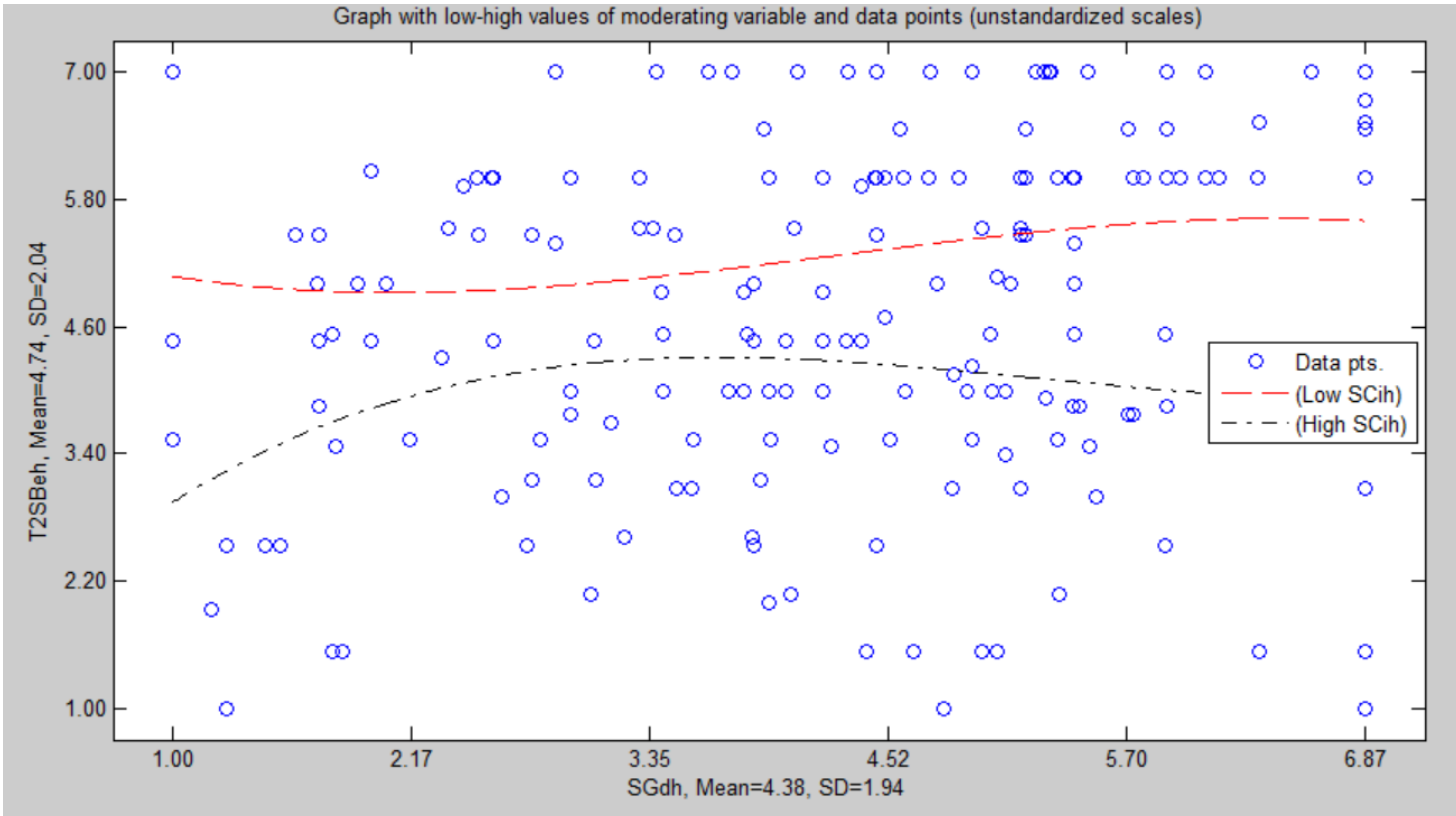
Descriptive Statistics Across Cohorts for Study Variables for Those Who Completed the Initial Survey (Time 1) and Those Who Completed the Initial and Follow-Up Survey (Time 2)

Variable	School sample				University sample			
	Time 1		Time 2		Time 1		Time 2	
	FV	SSB	FV	SSB	FV	SSB	FV	SSB
Intention	5.79 (1.30)	5.14 (1.57)	587 (1.24)	5.10 (1.57)	5.38 (1.40)	5.32 (1.59)	5.28 (1.44)	5.43 (1.57)
Goal-directed habit	5.20 (1.62)	4.48 (1.59)	5.30 (1.59)	4.45 (1.61)	4.36 (1.76)	4.34 (1.88)	4.22 (1.76)	4.39 (1.95)
Counter-intentional habit	2.78 (1.83)	2.96 (1.65)	2.72 (1.85)	2.94 (1.67)	2.81 (1.68)	3.50 (1.85)	2.82 (1.68)	3.40 (1.89)
T2 behaviour	-	-	5.62 (1.50)	4.73 (1.72)	-	-	4.41 (1.67)	4.22 (1.84)
Past behaviour	5.45 (1.45)	4.49 (1.71)	5.57 (1.40)	4.42 (1.72)	4.36 (1.64)	3.95 (1.75)	4.26 (1.69)	4.15 (1.79)

Note: FV = eating the recommended serves of fruit and vegetables; SSB = restricting sugar-sweetened beverage consumption

Appendix C.

Simple Slope Graph of the Moderation of Counter-Intentional Habit on the Goal-Directed Habit – Behaviour Relationship in the Middle School Sample of Restriction of Sugar-Sweetened Beverages



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Chapter 6: A Qualitative Investigation into Lay Representations of Habit (Paper 4)

This chapter contains a paper based on Aim 3 of the thesis that has been prepared for submission. The PhD Candidate is the first author of the paper and co-authors are part of the supervisory team. The PhD Candidate takes overall responsibility for the publication and all co-authors meet criteria for authorship. Electronic supplementary material to the paper are attached at the end of the chapter. The data file, analysis code, and output files from all are available at the Open Science Framework: psyarxiv.com/wf4ah

STATEMENT OF CONTRIBUTION TO CO-AUTHORED PUBLISHED PAPER

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A Qualitative Investigation into the Representations of Habit by Lay People

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Abstract

Objective: There is continued debate regarding the most useful and meaningful way to measure habit and how to form habits via intervention. To date, lay representations of habit have rarely been explored. Such understandings may provide clarity on how researchers might better define habit, develop valid measurements of habit, and evaluate habit-based interventions. This study aimed to explore how lay people represent habit, across two studies. **Methods:** Study 1 (*N* = 158) used an online, open-ended questionnaire to elicit what lay people believe to be the salient features of habit. Study 2 involved a series of interviews and focus groups (*N* = 27), to explore individual representations of habit. **Results:** Theoretical thematic content analysis across the two studies revealed that participants described habit by what it is (i.e., an explicit outcome or internal mechanism), by habit's features (i.e., automatic, frequent, stable cue/context, and emotionally rewarding), and by how they evaluated habits (i.e., being both "good" and "bad"). When describing the characteristics of habitual behaviours, participants identified that habits were either simple, discrete behaviours; clustered, repetitive behaviours synonymous with routine; or a self-identity characteristic. **Conclusions:** Current findings indicate that lay people hold consistent and contradictory representations of habit. Largely, lay representations were similar to scientific conceptualisations, with some notable difference. Participants appeared to misunderstand the cue-based mechanism of habits, interchangeably used 'habit' with 'routine', and believed that habits were emotionally rewarding. Future research should focus on integrating the beliefs identified in this research with new measures of habit and habit interventions.

Introduction

"Habit", as a concept, has a long history in the scientific literature (Barandiaran & Di Paolo, 2014; James, 1891; Triandis, 1977). Definitions of habit can be identified as far back as Aristotle in the Classical period; yet, it is only more recently that researchers started to examine and define the various features of habit (see Barandiaran & Di Paolo, 2014 for an overview). While researchers have typically agreed that habit can play a role in the initiation and enactment of behaviour (Gardner, 2015; Mullan & Novoradovskaya, 2018; Orbell & Verplanken, 2015; Wood & Rünger, 2016), there remains debate on what characterises habit. To date, researchers have typically, but not always, ignored the perspective of lay people and how they understand what the term 'habit' means, how habits are formed, and how habits might be broken (Gardner, 2015; Verplanken & Orbell, 2003; Wood & Rünger, 2016). As a result, self-reported responses to research investigating habit and/or to evaluate interventions seeking to modify habits are fraught with problems regarding the conceptualisation and operationalisation of habit.

This paper explores how lay people represent the concept of habit. First, the paper will outline scientific definitions and conceptualisations of habit that may be drawn upon in understanding the lay representations of habit. Then it will describe how understanding the way lay people represent habit may help refine the scientific conceptualisations of habit, as well as improve habit measurement and the evaluations of habit intervention. To do this, the current investigation involved an open-ended questionnaire design (Study 1) followed by in-depth interviews and focus groups (Study 2). The findings revealed that mostly lay people represent habit in similar ways to scientific conceptualisations; however, there were also some interesting differences. The findings provide further insights into lay people's understanding of habit that may help to refine future habit research.

Historically habit has been characterised from two perspectives. The first is that of a behavioural and 'associationist' perspective, whereby habits are considered to involve reactive automatism, unaffected by desires and cognitive processes (e.g., after a specific noise an action always ensues). The second is known as an "organiscism" trend whereby habits are part of a dynamic system; and are both cause and effect. The organicism trend suggests that habits interdepend on other internal processes which, in turn, determine the formation and maintenance of the habit (i.e., habits are the way individuals "typically" engage in the world) (Barandiaran & Di Paolo, 2014).

In a narrative review and examination of the multiple, modern definitions of habit, Gardner (2015) found both consistencies and contradictions that likely have important implications regarding how habit is measured, modelled, and manipulated (i.e., intervened upon). For example, across current definitions of habits, inconsistencies are found with regard to identifying what a habit is. As indicated above, some definitions of habit describe it as a behaviour (i.e., "behavioural patterns, based on learned context behaviour associations"; Gardner, de Bruijn, & Lally, 2012, p. 1; "behaviour that has been repeated until it has become more or less automatic"; Nilsen, Roback, Broström, & Ellström, 2012, p. 1), while others describe habit as a tendency towards a behaviour (i.e., "tendencies to repeat responses given a stable supporting context"; Ouellette & Wood, 1998, p. 55), or a type of automaticity (i.e., "A type of automaticity in responding that develops as people repeat actions in stable circumstances"; Verplanken & Wood, 2006, p. 91; "A type of automaticity characterized by a rigid contextual cueing of behavior"; Wood & Neal, 2009, p. 580).

More recently, researchers (e.g., Gardner, 2015) have argued that treating habit simply as a behaviour is incompatible with health behaviour models which treat habit as a determinant of behaviour (see e.g., Evans & Stanovich, 2013; Hagger, Trost, Keech, Chan, & Hamilton, 2017; Triandis, 1977; Wood, Quinn, & Kashy, 2002). It has also been argued that a definition of habit that treats habit as both the behaviour and the cause of the behaviour (Gardner, 2015; Maddux, 1997), results in an incoherent, circular, and potentially unhelpful definition. So, while research has demonstrated that habit can predict behaviour, and habitual behaviour can be frequent, according to many researchers a habit cannot be simultaneously both a behaviour and the determinant of the same behaviour (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014; Allom et al., 2018; Brown, Hagger, & Hamilton, 2019).

Other researchers define habit as an 'automatic behaviour' or a 'type of automaticity', which is to say habit is the act of doing something without forethought in response to a cue (Verplanken & Wood, 2006; Wood & Neal, 2009). Often the word 'automaticity' is used interchangeably with 'habit' and previous studies have used a scale of behavioural automaticity as a proxy of habit (Gardner, Abraham, Lally, & de Bruijn, 2012). The use of automaticity-as-habit has been argued to be problematic as, according to Wood & Rünger (2016), automaticity and habit are two distinct constructs. While automaticity may be one characteristic of habit, other non-habitual, implicit processes (e.g., classical conditioning and non-associative learning) are also partially characterised by automaticity. Therefore, to effectively distinguish between habit and other implicit processes, it is suggested that definitions of habit should feature, but not be solely represented by, automaticity (Evans & Stanovich, 2013; Wood & Rünger, 2016).

In attempting to address the aforementioned problems Gardner proposed a new definition of habit; "*a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations*" (Gardner, 2015, p. 280). Gardner (2015) argued that by defining habit as a process in which an action is cued instead of a behaviour itself, it overcomes the circularity of defining it as both a behaviour and a determinant of behaviour. Furthermore, this definition incorporates the characteristic of automaticity without conceptualising habit as only automaticity. While this definition overcomes previous criticisms in defining habit, it may be possible to refine our understanding and definition of habit further, by drawing on a' common-sense' approach, and incorporating the beliefs of lay people. Given that the term of habit is widely used in lay vernacular and popular media, there remains a knowledge gap in understanding how lay people understand and make sense of the term habit and how their understanding aligns with scientific conceptualisations. Investigating lay understandings of illness has helped researchers develop models to assist people to cope with illness (Hagger, Koch, Chatzisarantis, & Orbell, 2017; Hagger & Orbell, 2003; Leventhal, Phillips, & Burns, 2016) and in a similar way, understanding lay representations of habit, may provide clarity on how researchers could better define habit, develop valid measurements of habit, and evaluate habit-based interventions.

Given the lack of consensus around the definition of habit, understanding the best way to measure habit has also provoked much discussion in the literature. Given that some researchers also argue that the experience of a habit lies outside of conscious awareness (i.e. automatic), this probably reduces the reliability of self-report measures as individuals may not be able to accurately self-reflect on a non-conscious experience (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Sniehotta & Presseau, 2012). Similarly, depending on the lay representations of habit, their interpretation of any survey questions relating to habit may be different from the intended meaning, which in turn calls into question, the accuracy of habit measurement.

In an exploratory think-aloud study of a popular measure of habit (i.e., the self-report habit index; Verplanken & Orbell, 2003), the authors found a number of inconsistencies in how individuals interpret the measurement (Gardner & Tang, 2014). In particular, participants' interpretation of items deviated from the intended meaning of the measurement items (e.g., misinterpreting an item to be measuring memory capacity instead of whether the behaviour can be performed without having to consciously remember it) and problems with participants having difficulties comprehending the meaning of the items (e.g., misunderstanding whether the question referred to a generic or context-specific situation). Lay characterisations of habit, therefore, may help to improve measurement items as item wording can better reflect lay language, potentially resulting in reduced misinterpretation.

Similarly, such misinterpretations might affect the way habit interventions are subsequently evaluated. For example, there may be a mismatch between what a participant expects that will change (e.g., a behaviour will always be triggered across setting) compared with what the habit-based intervention is designed to change (e.g., an increase in behavioural automaticity strength that leads to an increase in behaviour after a very specific cue is encountered). Thus, without a sound understanding of lay representations of habit, participants of habit-based interventions may not understand the procedures or the expected changes that could occur. By understanding the lay representations of habit, interventions may increase face validity, become more implementable, and the evaluation of such interventions may be improved (Planas, 2008). One study has explored the experience of habit formation with participants enrolled in a weight loss intervention that was designed using habit-formation principles (Lally, Wardle, & Gardner, 2011). While participants reported experiences of automaticity development consistent with a scientific characterisation of habit, they also identified issues translating the new habitual behaviours to multiple settings. Participants in the study reported that they typically embedded the new habitual behaviour is an existing routine. In turn, the habitual behaviour did not occur outside of the routine, in other setting (e.g., such as weekends or holidays). By having an understanding of lay representations of habit (e.g., their belief that habitual behaviours will occur in all contexts), clinicians can pre-emptively provide clear expectations (e.g., a habit it a context-bound response) to align the participants experience with the intervention goals

Lay representations of habit may also provide clarity regarding individuals' use of the words 'habit' and 'routine' interchangeably, despite scientific conceptualisations treating them as distinct constructs. The overlap between habit and routine appears to be particularly prominent in popular media. For example, a Google search of "health habits" finds endless articles spruiking, for example, the 20 "health habits" that people should adopt (Kylstra, 2014) or one of a hundred books that purport to provide the key to making healthy habits. A number of these articles and books use the word "habit" to mean specific cue-response automatisms (e.g., set a specific time to disconnect from social media every morning) but, more regularly, is used to refer to broader lifestyle behaviours that are likely governed by deliberative, conscious decision making (e.g., “drink more water, in general”; “stop drinking soda”). Despite theorists defining habit and routine as distinct constructs, even throughout the scientific literature and in presentations at scientific meetings, the words ‘habit’ and ‘routine’ are often used interchangeably (Clark, 2000), which may reflect that the two constructs are socially constructed to have the same meaning. To date, despite how commonly the words habit and routine are interchangeably used, there is no published research, to the authors' knowledge, that seeks to understand what, if any, differences exist in lay representations of habit compared to a routine. To best understand how lay people characterise habit, it would seem beneficial to explore if or how lay people differentiate these two constructs, which may help to further refine current scientific conceptualisations of habit and, in turn, potentially improve habit measurement and intervention.

Exploring lay representations of habit

The overarching aim of the current investigation was to explore how lay people represent habit. The research explored how lay people explicitly define habits, the types of behaviours lay people identify as habitual, and how they differentiate ‘habit’ with the construct ‘routine’. The first study used an online, open-ended questionnaire to elicit what lay people believe to be the salient features of habit, and the second study involved a series of interviews and focus groups, to explore individuals representations of habit, including what behaviours participants identify as habitual and to what extent (if any) individuals differentiate habit and routine.

Methods

Participants

Participants were a convenience sample of adults recruited online through social media, the University broadcast email system, and the School's research pool for the opportunity to receive course credit. Study one involved 158 participants (79.7% female, aged between 17 and 75) and study 2 comprised of 10 participants interviewed individually, and 17 participants who were interviewed in seven focus groups (64.0% female and similarly aged between 18 and 65). No incentives or compensation were provided to participants. Sample demographic characteristics are displayed in Table 1. No participants who consented to be a part of the study later dropped out. Compared to population demographics, the current survey and interview/focus group samples had more female participants (Australian population = 51% female) (AIHW, 2019). Both samples also had higher education levels than the average population of Australia. In particular, there was a disproportionately higher amount of participants who had attained a bachelor degree or above in the survey sample (51.3% in the survey sample compared to 24.3% nationally) and a disproportionate amount of participants who had attained TAFE certificate or diploma in the interviews/focus group (48% in the interviews/focus groups compared to 30.6% nationally) (ABS, 2017).

Design and Procedure

The current investigation adopted an interpretivist approach to understanding lay (i.e., non-experts) representations of habit (Green & Thorogood, 2018). The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (Tong, Sainsbury, & Craig, 2007) and the APA Journal Article Reporting Standards for qualitative research (JARS-Qual; American Psychological Association, 2019), guided the reporting of the research. Approval for study procedures was granted prior to data collection from the Institution

Human Research Ethics Committee. Study 1 data was collected at one time-point, online, and presented using Qualtrics™, an online survey tool. Participants were asked "how would you describe a habit" and were provided an open, multi-line, text entry box with the stem "a habit is…". One, broad, open-ended question was used to understand the initial, most salient response of participants which would likely include important or prominent features of habit (Reja, Manfreda, Hlebec, & Vehovar, 2003).

For Study 2, a semi-structured interview guide was developed using open-ended questions to stimulate and explore participants' representations of habit. It was expected that this approach would produce data that most accurately presented the scope of lay understandings. The interview guide was reviewed by all authors and pilot tested on three participants that informed minor revisions of the guide, improving participant understanding and clarity of questions. The interview guide with suggested probing questions can be found in Appendix A (supplemental materials). Interviews and focus-groups took between 20 minutes and 1 hour with an average length of 30 – 40 minutes. An approximate sample size was chosen before recruitment based on previous research (e.g., Hamilton, Peden, Keech, & Hagger, 2019; Hamilton, Price, Keech, Peden, & Hagger, 2018) and the authors' previous experience in qualitative methodologies with the expectation that this would be adapted if new data was still being obtained (i.e., before theoretical/data saturation) (Glaser, Strauss, & Strutzel, 1968; Saunders et al., 2018). Participants chose to be interviewed either over the phone or face-to-face, individually or in small groups at the hosting Institution. All data collected over the phone was in a one-on-one interview format whereas data collected in person was a mix of one-on-one interviews and focus groups. Author DB, a male PhD candidate and clinically trained psychologist, conducted all interview and focus groups independently (i.e., no-one else was present). All participants were notified that the study was a component of DB's PhD research at the time of the interview. All authors have previously conducted research or written commentaries regarding the role of habit as an automatic process in health behaviours that likely shaped their interpretation of the data generated in the current study. Participants consented to be audio-recorded and later transcribed for data-analysis. Notes were made during each interview or focus group to aid the interviewer to further explore relevant concepts, but these were not used in data-analysis and were not provided to participants (Ortlipp, 2008).

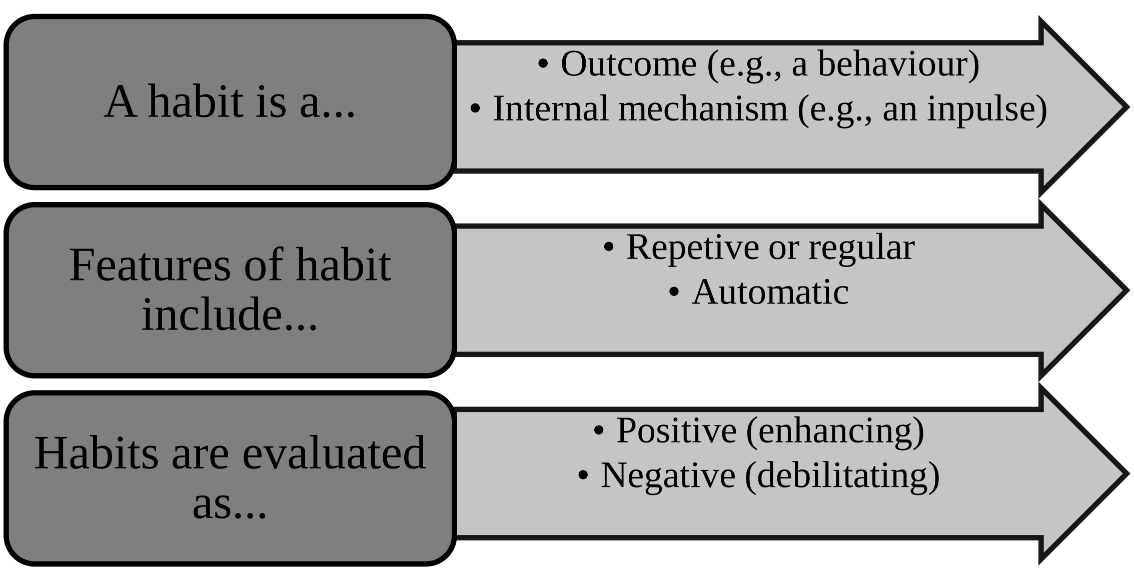
Analytic Strategy

For both study 1 and study 2 the data was analysed using theoretical thematic content analysis (Braun & Clarke, 2006, 2013; Joffe & Yardley, 2003) in Nvivo 12 qualitative analysis software. Each study was analysed separately and whilst study 1 was analysed before study 2 was complete, the results of study 1 did not directly inform study 2.This method was selected as it is guided by existing theoretical concepts, as well as the researchers' standpoint and disciplinary knowledge. The data were analysed in accordance with the six phases set out by Braun and Clarke (see Braun & Clarke, 2006, 2013 for a detailed description of the six phases). The theoretical concepts informing the interpretation of the coding were based on the authors' knowledge of the habit literature and from an analysis of the multiple habit definitions featured in the review conducted by Gardner (2015). The authors of the current investigation found three main components to the definitions identified in the Gardner (2015) review : habits were typically defined by what it is (e.g., a process, behaviour, tendency, or type of automaticity), by its features (e.g., the automaticity of the impulse or act, stimulated by a stable cue/context, which may be goal independent), and by how it is formed (e.g., via repetition over time and reinforced through rewards). These themes were used in helping the current authors identify and organise the themes that emerged in the analysis of Study 1 and Study 2. Author DB coded the data by first using specific words or phrases used by participants for relevant chunks of data. These initial codes were then amalgamated into relevant themes that both fit with a framework of habit adapted from the Gardner (2015) review and by those which were novel but still relevant. Codes were reviewed with author KH and inconsistencies resolved via discussion with both authors. The themes were also reviewed, discussed, and refined with author KH. Participants were not provided the opportunity to review or comment on themes.

Results

Study 1

Participants described habits in three broad ways (see Figure 1): by what it is (e.g., an explicit outcome or internal mechanism), by habit's features (e.g., it is enacted automatically and repeated), and by how they evaluated habits (e.g., being both "good" and



"bad"). Participants' answers provided an important first step to understanding how lay people represent habit and what a lay population perceive as most important.

Figure 1. Overview of themes identified in Study 1

What is a habit? The open-ended question began with the stem "a habit is…". This prompted many participants to begin their answer with what they believe the essential property of a habit is (i.e., a behaviour, a process, a pattern etc.). While many participants began their answer with "something that…", 74 participants specifically identified a habit as being *an outcome* such as a behaviour, an action, or by being some other type of explicit outcome (e.g., a pattern of behaviours, an activity, a thought, a task, a conduct, an emotional reaction, etc.). A smaller number (n = 14) of participants identified that habit is *an internal mechanism* and not based on any one specific outcome. These participants used phrases such as habit is "…a tendency", "…a practice", or "…an impulse".

Features of habit. Two prominent features of habit were identified in the open-ended survey responses. The first, and most common feature was that a habit is *repetitive* (n = 122). Participants described habits as something that is "repeated", that is engaged with some type of "regularity", is something that is "routinely" enacted, or is done "frequently" ("an action regularly repeated"; "something you do consistently [either daily, weekly etc.]…"; "an ingrained behaviour that you repeat, often…"). Some participants (n = 13) also described how habits are "developed over time", which extends on the concept of repetition, as to repeat something is to do it on multiple occasions over a length of time. For example, one participant wrote that a habit is "An unconsciously enacted behaviour…learned through repetition, over time", while another wrote a habit is "something someone does often after a long period of time doing it…".

Another common feature identified by participants was that habits are defined by their *automaticity*, with many participants (n = 85) defining habits by this feature. Participants described habits in terms of being “thoughtless”, “unconscious”, or “automatic”. Typically, the respondents used the words “without thought”, “unconscious”, and “automatic”; however, also described how a habit is “compulsive”, “instinctively done”, “uncontrolled”, and enacted “without knowing”. For example, one participant wrote, a habit is… “An action or thought that is repeated ‘automatically’; that is, with little conscious thought/attention to it”, while another stated a habit is a “recurring pattern of behaviour that is often automatic in nature…”. The notion of a habit being enacted automatically can be further inferred when participants described habits as “difficult to stop” (n = 19). If a behaviour is automatically enacted, without awareness, then this is similarly likely to be something that can be hard to control or inhibit; “an impulse which is hard to stop”; “…what you do on regular basis sometimes unconsciously and which is hard to get rid of”.

Evaluation of habit. A small sample of the participants (n = 9) specifically provided a subjective evaluation (i.e., whether habits are positive or negative) of habits. All but one of the participants who provided an evaluation specifically described how habits can be both positive or negative. For example, one participant wrote, “Habits can be good (like taking the stairs instead of the lift) or bad (like chewing your fingernails)”, while another wrote, “something that you do or practice regularly, which may or may not be beneficial to your health”.

Study 2

In Study 2, while participants were not asked to define habits, they were asked to reflect on their own habitual behaviours. In doing so, they also characterised habit in three broad ways: by the characteristics of behaviours they identified as habits (e.g., simple, discrete behaviours; clustered, repetitive behaviours synonymous with routine; self-identity characteristic), by the features of habit (e.g., automatic; frequent; stable cue / context; and emotionally rewarding), and by how they evaluated habits (e.g., being “good” and consistent with goal; being “bad” and inconsistent with goals). See (see Figure 2).

Furthermore, given individuals often use the word habit and routine interchangeably, participants were also asked to describe if these two constructs are distinct from each other. Three key differences emerged regarding the distinction between habits and routines: routines were identified as multi-step patterns of behaviour compared to the habitual behaviours which were seen as discrete and simple; there was a greater degree of agency with routines; and habits were seen as typically driven by emotions compared to routines. Participant responses are summarised below and provide a rich understanding regarding how lay people characterise habit and how they distinguish it from similar constructs.

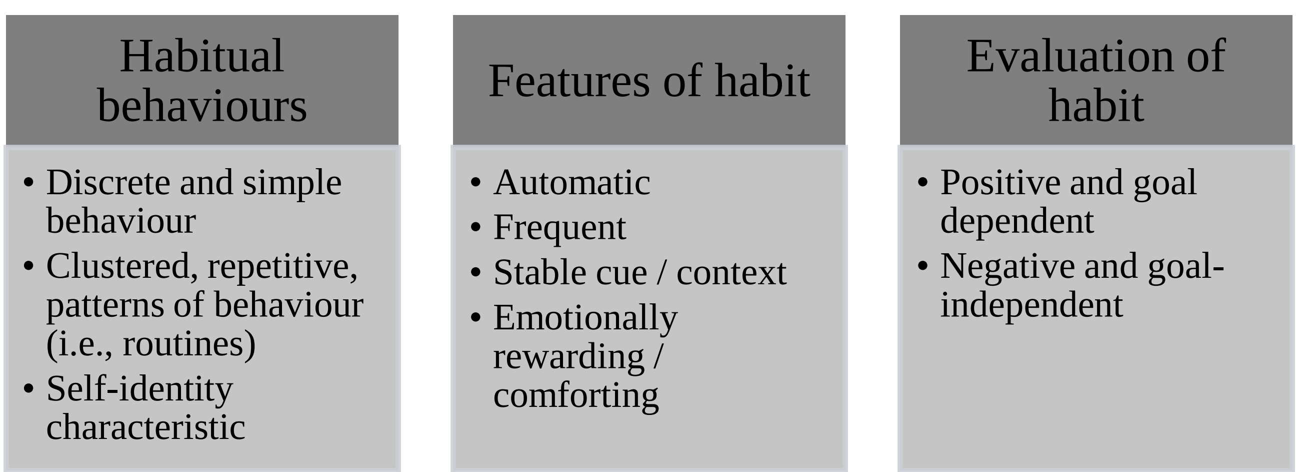


Figure 2. Overview of themes identified in Study 2.

Habitual behaviours. As indicated above, participants were asked to provide examples of habits and habitual behaviours. In analysing the types of behaviours they identified as habitual, three key findings emerged: participants described habits as either a discrete behaviour; clustered, repetitive, patterns of behaviours, synonymous with routines; or participants used habit to represent a characteristic of their identity.

When participants were asked to reflect upon which behaviours they described habits, first as comprising discrete, single-step, behaviours such as "biting my nails", "drinking beer", "having my morning coffee", or "going through my phone. Participants also described clustered, repetitive patterns of behaviours and used the word "routine" interchangeably such as "sleeping habits - the things I do before I go to bed", "my morning routine", and "I have a habit of, what I think is a habit to me, a routine. I must do certain things a certain way". The descriptions participants described for these clustered behaviours often had a latent goal (e.g., getting ready in the morning or going to sleep at night) but were likely made up of many smaller actions, steps, or behaviours. Given the complexity of these latent goals, it appears less likely that the whole process is 'outside of conscious awareness' although they are likely to be performed regularly consistent with the lay representation of habit identified in study 1. Third, some participants in the focus groups and interviews used the word habit to described personal characteristics that represented part of their identity. For example, one participant described how they 'habitually' used poor grammar while another one identified as a 'dog-walker'. While walking a dog could be a habit by both a scientific and lay definition of habit, the participant did not refer to walking a dog in this way (i.e., a triggered response) but as a characteristic of who they are. Similarly, another participant described a habit of "waking up early because I've been a barista for [many] years" [FG5] while another believed they had a habit of checking their bags before they left home because, as a parent, they needed to be organised. Each of these identity characteristics may or may not include specific habitual behaviours but were described as an representative of them instead of a specific cue-response mechanism.

Features of habit. Consistent with Study 1, in 15 of the interviews and focus groups, participants provided a description of habitual behaviour as being enacted *automatically*, that is "without thought", or "unconsciously" ("I think habit would be some sort of behaviour that you do without thinking" [interview 8; I8]). Automaticity was seen as a defining difference between habitual behaviours and other non-habitual behaviours when participants were probed to describe when they believed a behaviour had moved into being habitual ("Well I think that if you have to actively remember to do it, and remind yourself to do it, or have someone remind you to do it or you have to think about doing it, that's not really a habit" [focus group 3; FG3]).

More than half of the participants also described habitual behaviour as being *repetitive over time*. When describing the concept of repetitiveness, participants would describe this as being something that is either synonymous with *frequency* or *regularity* ("..cause a habit to me is really like the continuity of action, of doing something over time" [I6]; "…a habit is something I would classify I do on a regular basis" [FG1]). The idea of repetitiveness meaning any behaviour that is performed in *a patterned way* was also highlighted. Participants elaborating that these behaviours are those performed repeatedly at set times/days every day, week, or month ("the things that I do constantly every day, every week, every month, whatever, those sorts of things [are habitual]" [FG4].

In 10 of the interviews and focus groups, participants described an important feature of habit is that they are evident in the presence of *a stable cue or context*. When describing their habitual computer-gaming, one participant described the consistency of the context by stating "If I come home [I] game at a particular hour. I pretty much do it roughly around the same time for roughly around the same amount of time that I'm playing" [FG5]. Similarly, when a participant reflected on brushing their teeth, they reported "I'll always brush it after breakfast, in the morning. I always brush it last thing before I go to bed, so I don't eat anything before going to bed." [I8]. Similarly, some participants described how particular cues trigger a habitual response ("…it's like a behaviour that's usually triggered by an emotional response, but sometimes it's a hidden emotion" [FG3]; "I say it's a habit… because it stems from a stimulus… so it's like, for example, with the nail biting over a stressful situation, the habit is to bite my nails because it's what I always do" [I7]). Other participants described the *cue-response* or *triggered* feature of habits by describing how habitual behaviours can be performed within a routine (i.e., one behaviour is the trigger for the next behaviour in the sequence). For example, one participant stated "[there are] habits of just brushing your teeth, eating breakfast, having a coffee, I think that's just something that's related to routine that you just do it automatically every day" [I5].

Habits being described as *emotionally rewarding or comforting* was identified in 9 of the interviews and focus groups. These individuals suggested that a habit is often formed and maintained because it serves a function such as an emotional regulation strategy (e.g., biting nails when feeling anxious; "habits…are soothing or comforting or reassuring, things that you go to without thinking to… put you in a better state maybe" [I1].

Evaluation of habit. As with study 1, some participants described both positive and negative evaluations to habitual behaviours. Some of the participants in the interviews and focus groups went further and described how the "positive" habits were typically consistent with goals, while the "negative" habits were goal-independent (i.e., were inconsistent with goals or desires). For example, one participant reflected specifically on forming a nutrition-based habit to promote the health of their family ("… we weren't eating very good, so we've tried to make it a habit of blending vegetables in a drink [in the morning], and I think now whenever I don't have that in the morning it feels wrong" [FG7]. Another participant reflected how they believed that it is often the emotionally cued habits that are "bad" and therefore goal-independent ("I think there's two different types of habits. First there's the emotional response ones, but there's also the ones that you work towards becoming an automatic thing that you just do at that point in time, or after something. It just becomes something that you work towards not thinking needing to do about it" [FG3].

A habit or routine? Everyday language use of the word habit is, at times, used synonymously with the word routine (Clark, 2000; Kylstra, 2014). To further explore the distinct representations of habit, by lay people, participants were asked to describe what were, if any, the differences between a habit/habitual behaviour and a routine. Three key differences emerged: routines are multi-step patterns of behaviour compared to the habitual behaviours which are discrete and simple; there is a higher level of agency with routines; and habits are typically driven by emotions as opposed to being simply a routine.

In 13 of the interviews and focus groups, participants identified that they would distinguish a routine from a habit by the complexity of the behaviour. Routines were described as typically involving multiple steps or patterns of behaviours. For example, one participant stated “I think the difference between habits and routines is that habits are singular, whereas routines are multiple things strung together” [I7], and another participant reported, “[my] morning routine is my habit of meditating and getting up and making my child’s bottle and then brushing my teeth. Those are daily habits that I have that are in my routine” [I8].

In 16 of the interviews and focus groups, participants described how routines are enacted with a greater sense of agency and awareness. They described how there is a degree of flexibility and control in routines and, while they can be performed mindlessly, they can choose to complete the pattern of behaviours in a different sequence. One participant described the agency and choice of routines, “My bedtime routine would be I do my physio and then I have a shower and go to bed. But, some nights I might not have a shower because I’m too tired or I had a shower in the morning or whatever” [FG9]. Another participant described how they believed that most people likely complete their routines in the same order; however, could choose to change it easier than with habits (“There is more flexibility with routines when event though most people don’t think about them, you could, whereas habit is more automatic than that” [I8]).

When participants described their own routines to provide an illustration to their answers, they would always be in the context of an overarching goal (e.g., getting ready for work in the morning or getting prepared for bed at night). Participants contrasted this with examples of habitual behaviours which, they believed, could also be driven by an emotional need or function (e.g., biting nails in response to anxiety or eating junk food in response to boredom) whereas routines rarely were (“A habit like I bite my nails or whatever, it’s very…you get some gratification out of it or something like that. It’s a stronger feeling”

[FG4]; [a routine] is based on necessity like, you've to take your kids to school, you've got to go to work. Whereas habits are more…it's the behaviour you fall back into" [FG7]).

Discussion

Scientific definitions of habit include both consistent and contradictory features that impact on the way habit is measured, modelled, and intervened upon. To date, such definitions have often ignored how lay people represent habit. In this chapter we propose that identifying lay representations may help better account for individuals' beliefs about habit that may affect the measurement of habit as well as improve lay expectations and evaluations of habit-based interventions. The overarching aim of the research was to explore how lay people represent habits. Study 1 used an online open-ended questionnaire to elicit what lay people believe to be the salient features of habit. Study 2, in a series of interviews and focus groups, further investigated how lay people represent habit by exploring what lay people identify as habitual behaviour, the features of habit, and how lay people differentiate habit from the similar concept of routine.

The findings showed that similarly to scientific conceptualisations of habit, some lay people described habit as a psychological process, such as an impulse, whereas many people described habit as a type of outcome, such as a behaviour. Believing that an outcome, such as a behaviour, itself is a habit might be problematic. If lay-people believe that there is something inherent about a behaviour that makes it a habit, it may lead to inaccurate expectations when forming habits. For example, given lay people believe that habits are automatic and occur outside of conscious awareness, they may believe that they will always perform the behaviour, across settings and contexts instead of being triggered by a specific cue or set of cues. This belief could explain why participants in a weight-loss intervention program struggled to program effective cues to repeat their weight-loss behaviours and failed to repeat their behaviours in other contexts such as on weekends or on holiday (Lally et al., 2011) as they did not pair a cue that could occur across contexts.

When asked to describe habits, participants described a broad array of behaviours. For example, participants discussed discrete behaviours (e.g., biting nails) but similarly discussed clustered, repetitive, patterns of behaviour that are synonymous with routines (e.g., having a coffee, brushing teeth, showering, all in the morning) The clustered patterns of behaviours are likely governed by both automatic and reflective processes, particularly given they are, by definition, multi-step and complex behaviours (Mullan & Novoradovskaya, 2018). For example, an individual might habitually start the shower after they have brushed their teeth, but likely need to have some conscious reflection to ensure the water is at the right temperature and they wash their body and hair thoroughly (Gardner, Phillips, & Judah, 2016; Phillips, 2019). Yet, contrary to the idea of habits being multi-step, when participants were asked to identify what, if anything, differentiated habits from routines, they described routines as multi-step and complex patterns of behaviours and habits as typically simple and discrete behaviours. Furthermore, participants described how they had more control of routines. For example, while an individual may routinely have coffee, eat toast, brush their teeth, and watch the morning news, they could also choose to change the order, or have a tea instead of a coffee. Thus, when given the opportunity, participants differentiate habits from routines by, in part, the complexity and control involved in them; however, still describe complex routines as habit in their everyday language use.

Furthermore, some participants used the word habit to denote personal characteristics such as being “a dog-walker”. To describe habit in a way that it represents a part of one’s self-identity (i.e., dog walker) was a concept integrated into the development of the self-report habit index (SRHI), a widely used measure of habit (Verplanken & Orbell, 2003). Verplanken and Orbell (2003) believed that habits were a part of how people organise their everyday life and, therefore, likely reflect part of an individual’s self-identity. However, if the concept of habit is used to denote personal characteristics, it would lead to a large variety of actions to be classified as a habit that are likely outside of both the lay and scientific definition of habit (i.e., a cued, automatic response), reducing the specificity of the concept of habit. For example, one participant described themselves as having a habit of using poor grammar, which is unlikely to be an automatic cued response but more so representative of errors in their use of grammar that they frequently do. Taken together, it seems lay people believe habits to be a type of behaviour. When using the word habit or describing habitual behaviours, lay people describe a wide variety of behaviours from single-step, simplistic behaviours (e.g., brushing teeth after waking); to grouped, clustered, patterns of behaviours (e.g., healthy eating patterns); or behaviours that are typical of them and represent a part of their identity (e.g., a morning smoothie drinker).

This research also elicited how lay people characterise habits by, in part, exploring the features of habit. Across both Study 1 and Study 2, results showed some consistent descriptions of the features of habit. Specifically, lay people characterise habit as automatic and frequent or regular. The feature of automaticity was identified through participants describing habits as being outside of conscious awareness and enacted without thought. This is consistent with scientific definitions of habit that define habit as something which is elicited automatically. This knowledge is useful as the behavioural automaticity sub-scale of the SRHI (i.e., the self-report behavioural automaticity index [SRBAI]; Gardner, Abraham, et al., 2012), that focuses on the automatic component of habit, is widely used in the scientific literature as a proxy for habitual behaviour. Habit interventions that seek to intervene upon and increase behavioural automaticity will likely be consistent with what lay people expect to change within that intervention. For example, if an individual engages in a habit-intervention to increase fruit consumption, focusing on increasing the behavioural automaticity of fruit consumption will likely be consistent with what the participant expects to change from the intervention (de Bruijn, Gardner, van Osch, & Sniehotta, 2014; Orbell & Verplanken, 2010).

Participants also described the feature of frequency and regularity. While these two features are suggested to be distinct constructs in the scientific literature (i.e., "frequency" refers to something that happens often while "regularly" refers to something that happens in a constant or definite pattern; Merriam-Webster, 2019), they may actually be socially constructed by lay people to mean the same thing (e.g., an individual will brush their teeth frequently and regularly, every 12 hours). Participants often used the terms interchangeably, thereby making it difficult to identify whether habits are characterised by lay people as being one or both features. However, given some participants also described habit as occurring in a patterned way (e.g., occurring weekly or monthly), it is likely that both constructs form part of how lay people characterise habit. Furthermore, the concept of "frequency", "regularity", or "in a patterned way" was most often expressed in reference to time (e.g., a habit is regular if it occurs at the same time of week or time of day). This may be problematic given a scientific representation of habit suggests that once formed, a habit does not have to occur often (i.e., frequently), but should occur regularly *if appropriately cued*. Lay people may be misinterpreting the time-based regularity of some habitual behaviours as meaning that habits are, by their nature, consistently repetitive in a pattered way.

According to scientific definitions of habit, it is likely that some habits merely have time-based cues (Gardner, 2015; Orbell & Verplanken, 2010; Pimm et al., 2016). Thus, habits do not have to occur in a patterned way, the habit may simply be elicited regularly because the individual is exposed to a cue in a patterned way. For example, a person may eat a snack at 5 p.m. every day at work; therefore, the individual may believe they have an "eating a snack at 5 p.m." habit. However, it may be that the person happens to walk past a vending machine when they finish work at 5 p.m. each day and would similarly eat a snack at any other point during the day if they also walked past the same vending machine. Other research has similarly found that lay participants struggle to accurately identify the determinants or cues to their behaviour. For example, when asked to identity what triggered previous experiences of smoking or emotional eating, participants of two studies identified negative affect as a cue despite the researchers not finding affect associated with these behaviours (Adriaanse, Prinsen, de Witt Huberts, de Ridder, & Evers, 2016; Shiffman et al., 1997). Some participants did, however, identify that habits also occurred via different types of stable contexts or cues, including time, place, or mood. This is consistent with other research that has shown that different types of cues predict habit strength and behavioural frequency (Murphy, Eustace, Sarma, & Molloy, 2018; Pimm et al., 2016). This, again, has important implications for habit-based interventions as some participants may expect that the formation of their habit guarantees behavioural performance at the same time every day, week, month, or year, when this expectation may differ with the researcher or clinician. Results indicate, therefore, that lay people characterise a habit as occurring often (i.e., frequently), in a patterned way (i.e., regularly), and elicited via a context or cue. However, lay people may also be misinterpreting the frequency and regularity of a habit as something inherent about the habit rather than the outcome of frequently or regularly being exposed to the relevant cue.

Finally, some participants described habit as characterised as being emotionally rewarding or comforting. There appeared to be a difference between participants describing mood as a cue for certain habits (e.g., when anxious I bite my nails), and in describing habit as, in and of itself, gratifying to do which, in turn, provokes a feeling of loss if not performed. The experience of comfort evoked from a habit, compared to the experience of a non-habitual behaviour, may be explained by the process of habituation. Habituation is characterised by the decrease in arousal experienced from repeated exposure to a stimulus (Cyr & Romero, 2009; Thompson & Spencer, 1966). The process of habituation is purposefully used in exposure therapy for anxiety disorders, whereby patients are repeatedly exposed to feared stimuli to reduce their fear arousal in the stimuli's presence (Cooper, Clifton, & Feeny, 2017; Peterman, Carper, & Kendall, 2019). However, a version of this process may similarly apply to everyday habitual behaviours, promoting the feeling of familiarity when performing the habitual behaviour and provoking a stress-response if not performed. This is also consistent with research investigating lay representations of illness (Goodman, Morrissey, Graham, & Bossingham, 2005; Hagger & Orbell, 2003; Platt, Green, Jayasinghe, & Morrissey, 2014). The common-sense model of illness-representations (Leventhal, Nerenz, & Steele, 1984) proposes that people select coping strategies based on their cognitive or emotional representations of the illness. Similarly, self-regulatory behaviours (such as biting nails) may be repetitively engaged in, thus forming a habit, because of the beliefs held by lay people of the behaviour's capacity to self-regulate. This emotional experience is not typically included in scientific representations or definitions of habit (Gardner, 2015) and may be an important consideration for future conceptualisations of habit. Participants identified that this feature of habit was also what differentiated it from a routine. Participants described that the feeling of gratification was most likely induced from performing a habit compared to routines, which were more likely to be performed out of necessity or pragmatism. Despite this feature not being included in many definitions of habit, the SRHI includes an item that asks participants if they would "feel weird" if they did not engage in the behaviour (Verplanken & Orbell, 2003), although this item may not fully capture the emotional component being described by lay people as being a feature of habit. Affect and mood was, therefore, believed to both cue a habit and be evoked by performing or inhibiting a habit.

The emotional effect of some habits was also linked with some participants' evaluations of habit, with some participants describing habit as both positive and negative. Participants described that the "bad" or "unhealthy" habits were difficult to inhibit because they felt comforted. Similarly, however, participants described this as a positive experience for the "healthy" or "good" habits. Nearly all participants who choose to provide an evaluation of habit described how they could be both positive and negative. Drawing from the other features that participants characterised as part of habit, participants liked the idea that healthy behaviours could be enacted without thought and frequently. This belief could be used by clinicians to help promote habit-based interventions for healthy behaviours.

However, it may also be useful to deconstruct the idea that a habit is either “good” or “bad”. Given participants also believed that habits represented part of their identity, the promotion of the good/bad binary may be internalised to mean that the individual is inherently good or bad based on their habits. While some habitual behaviours may be physically unhealthy (e.g., eating chocolate), if this is done in response to stress, it may also be helping to emotionally regulate the individual (Evers, Dingemans, Junghans, & Boevé, 2018; Leehr et al., 2015). Demonising the habit, and in turn the individual, as “bad” is likely to be unhelpful given it may have a functional purpose (e.g., to emotionally regulate) (Stephens et al., 2018). Promoting a more neutral valence about habits (i.e., they are neither inherently good or bad but merely an automatic response to a cue) may increase an individual’s perceived behavioural control and, in turn, help they change their unhealthy habitual behaviours (Sheeran et al., 2016).

Strengths, Limitations, and Future Directions

Prior research has used a variety of scientific conceptualisations of habit to inform habit measurement and interventions. The current investigation, however, used a qualitative methodology across two studies to draw upon the beliefs lay people hold regarding how they represent habit, thus filling an important knowledge gap. By exploring how lay people subjectively construct their representation of habit, it provides insight into the similarities and contradictions compared to a scientific characterisation of habit, which may lead to inaccuracies in how research participants and individuals interpret measures of habit and their expectations in habit-based interventions. A strength of the current investigation is that it is one of the first, to the authors' knowledge, to qualitatively explore how the concept of habit is represented by lay people. Further, it used two studies to triangulate findings on the defining features of habit that lay people hold, with a good spread of demographic factors on age and education levels, increasing the validity and generalisability of the findings.

The findings from this study should however be considered cautiously, in light of some limitations. Most participants reported they were female, Caucasian, and had a higher educational level than the general population, and were primarily recruited through a university, reducing the generalisability of the findings. While it is hard to quantify the impact of recruiting a sample that has an overrepresentation of female, Caucasian, and highly educated individuals, it is possible that participants' experiences, shaped by their sociodemographic characteristics, has shaped their beliefs. For example, being Caucasian and highly educated may afford the expectation and resources of being able to easily change behaviours (e.g., by accessing health professionals) that may shape the belief habits can be inhibited or changed relatively easily. Furthermore, undergraduate psychology students may have been exposed to scientific representations of habit that influenced their beliefs. Future research could explore how other representative populations similarly characterise habits, perhaps in specific contexts such as habits at work or habits in the home. Further, while every effort was made to ensure participants in the interviews and focus groups understood there were no right or wrong answers, there may have been something inherently leading in some questions, such as asking about what, if any, differences existed between habit and routines. This question may have led participants to believe that they needed to identify differences even if they did not necessarily believe that there were any differences between habits and routines. While broader open-ended questions may eliminate this limitation, broad questions can sometimes miss the specificity necessary required in asking direct questions (Reja et al., 2003). Also, while this research focused on what a habit is, it did not explore other important beliefs that lay people may hold about habit, such as how they form and break habits. Future research should, therefore, investigate how lay people form a goal-directed habit or how they attempt to break unwanted habitual behaviours.

Conclusion

There are a number of scientific conceptualisations of habit that underpin habit measurement and interventions. Despite this, exploring and understanding lay representations of habit has received little attention. This knowledge is important as it can help to identify consistent and/or contradictory beliefs that may further inform scientific discourse, measures, and interventions on habit. The current investigation aimed to fill this knowledge gap by exploring lay representations of habits via two studies. Given this is one of the first studies, to the authors' knowledge, to explore lay representations of habit, it is hoped that the results of this study will inform and guide future confirmatory research. The results of the studies found that lay people hold many similar beliefs regarding habit that are largely consistent with scientific conceptualisations (e.g., habits are triggered automatically by a cue or in a specific context and occur frequently). However, the results also revealed that while participants believed habits were, at times, cued, they struggled to identify time-based cues and they may be confusing time-based cues with the belief that some habits are inherently automatic. The results also found that some lay people believed that habits are linked with emotional regulation. As per the illness-representation literature, this may suggest that some habits are formed because of the beliefs that they aid in emotional regulation. Finally, despite participants differentiating a habit from a routine via the complexity of the behaviour (i.e., a habit is simple/discrete, and a routine is complex and multi-step), they often called routinised patterns of behaviours a habit. Similarly, participants described behaviours as a habit when they represented a personal characteristic or aspect of their identity. This research is one of the first to explore how lay people characterise the concept of habit and has found some consistent and contradictory results compared to scientific definitions and conceptualisations. Given the exploratory nature of this research, further research is needed to understand each of the key findings and how they can be integrated into habit measurement, interventions and conceptualisations, as well as how lay people form and break habits.

Table 1.

Sample Demographic Characteristics of Participants in the Study 1 Survey and Study 2 Interviews and Focus Groups

Variable	Survey	In-person
Participants, N	158	25*
Age, M years (SD)	30.47 (13.90)	29.96 (11.70)
Gender (%):		
Male	19.60	33.30
Female	79.70	64.00
Other identified/non-disclosed	0.60	4.00
High education level (%):		
Junior/senior school	36.10	20.00
TAFE/Diploma	12.70	48.00
Undergraduate degree	22.80	16.00
Postgraduate degree	28.50	8.00
Non-disclosed/missing	0.00	8.00
Ethnicity (%):		
Caucasian	79.70	80.00
Other	19.00	20.00
Non-disclosed/missing	1.30	0.00

*Two participants chose not to answer the demographic questionnaire

Appendix A:

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Developed from:
Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

No. Item	**Guide questions/description**	**Reported on Page #**
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	7
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	7
3. Occupation	What was their occupation at the time of the study?	8
4. Gender	Was the researcher male or female?	7
5. Experience and training	What experience or training did the researcher have?	7
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	6
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	8
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	8

Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	6
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	6
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	6
12. Sample size	How many participants were in the study?	6
13. Non-participation	How many people refused to participate or dropped out? Reasons?	6
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	7
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	8
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Table 1
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	7
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	N/A
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	8
20. Field notes	Were field notes made during and/or after the interview or focus group?	8
21. Duration	What was the duration of the interviews or focus group?	7
22. Data saturation	Was data saturation discussed?	7
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		

24. Number of data coders	How many data coders coded the data?	8 and 9
25. Description of the coding tree	Did authors provide a description of the coding tree?	No
26. Derivation of themes	Were themes identified in advance or derived from the data?	8
27. Software	What software, if applicable, was used to manage the data?	8 and 9
28. Participant checking	Did participants provide feedback on the findings?	No
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Yes
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes
31. Clarity of major themes	Were major themes clearly presented in the findings?	9 - 16 (major themes clearly presented under their own heading)
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	9 - 16 (any minor themes formed within major themes and are discussed within the discussion of the major theme)

Additional information consistent with APA style reporting standards for qualitative research

Reporting Recommendation	**Reported on Page #**
Method: Describe the researchers’ backgrounds in approaching the study, emphasizing their prior understandings of the phenomena under study	8
Method: Describe any incentives or compensation	6
Analysis: Demonstrate consistency with regard to the analytic processes (e.g., analysts may use demonstrations of analyses to support consistency, describe their development of a stable perspective, interrater reliability, consensus)	8 and 9
Findings: Present synthesizing illustrations	11 and 17

Appendix B. Interview guide

Dear *participant*, thank you so much for participating today. I'm going to ask you a range of questions about what your understanding of habits are. I'm trying to understand what Australian's know about habits so I'm not expecting any particular "correct" answers.

Phase one:

1. Why don't we start by you telling me what type of habits you have?
    a. Can you tell me any habits related to health behaviours [such as brushing your teeth or exercising]?
    b. What aspects of that behaviour makes you think it is habitual or a habit?
        i. So you've said X and Y make this behaviour a habit. Can you think of any other characteristics of habits?
    c. So you've described all these things which make a habit. Can you tell me the difference between behaviours that aren't or can't become habits?
        i. For example – can giving blood/immunisations/screening behaviours become a habit? What is the difference between these and the behaviours you said can/are habits?
    d. You described all these characteristics of what a habit it. Can you tell me what, if anything, is then the difference between a habit and a routine? What are the different characteristics?
        i. Can you provide me some examples of routines (which aren't habits)?

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Chapter 7: General Discussion

Chapter Introduction

There are a variety of chronic health problems such as cardiovascular disease, diabetes, and cancer, that contribute to the majority of deaths in Australia, and indeed globally (AIHW, 2018). These health problems are often the result of modifiable patterns of behaviour including, for example, inadequate consumption of fruits and vegetables, poor oral hygiene practices, over exposure to the sun, and alcohol misuse. To understand better how to promote healthy patterns of behaviour and reduce unhealthy patterns, researchers have often adopted theories of social cognition to identify potential modifiable determinants for behaviour change. Meta-analytic research has demonstrated that such theories (e.g., the theory of planned behaviour, Hagger, Polet, & Lintunen, 2018; McEachan et al., 2016; health action process approach; Zhang, Zhang, Schwarzer, & Hagger, 2019) can explain a significant amount of variance across health behaviours. Despite this, these theories have also been criticised for their predominate focus on conscious, reflective processes and ignoring other more non-conscious, automatic processes (Evans & Stanovich, 2013).

In an attempt to address such criticisms, researchers have included measures of past behaviour into social cognitive models, often finding that the inclusion of past behaviour significantly increases the amount of variance explained, yet also simultaneously attenuating the effects of the social cognitive constructs (Hagger et al., 2018; Norman, 2011; Norman & Conner, 2006). Past behaviour, however, is not a modifiable construct and, therefore, offers little utility in understanding behaviour change. Similarly, measures of past behaviour provide little information about the conditions or processes that give rise to the behaviour. In an effort to identify means to capture the effect of past behaviour on future behaviour, other measures that reflect automatic processes such as habit have been used, although literature investigating the effect of habit in the context of existing theories of social cognition is scant. The overarching aim of the current thesis was to investigate the role of past behaviour and habit in health behaviours. To address this overarching aim, this thesis used mixed methods to quantitatively model constructs that underpin non-conscious, automatic processes and conscious, deliberative processes; and, qualitatively explore understandings of lay beliefs of habits. The three specific aims of the thesis were outlined in Chapter 2 and addressed in a series of four papers presented in Chapters 3, 4, 5, and 6.

Paper 1 (Chapter 3) addressed research aim one, and reported on the findings of a multi-theory, dual-phase model of fruit and vegetable consumption in Australian long-haul HGV drivers. The study was one of the first to test and include the effects of past behaviour in a model integrating motivational constructs from self-determination theory and the theory of planned behaviour with volitional constructs from the model of action phases and health action process approach. Results corroborated the attenuation effect of past behaviour on model effects that has been found in other studies that typically focus on constructs representing reflective, deliberative processes.

Paper 2 (Chapter 4) addressed research aim two and reported on the mediation effects from past to future behaviour in a dual process model across three separate health behaviours and populations. This study was also the first to use a comprehensive measure of past behaviour frequency, reflecting long-term, short-term, and routinised patterns of behavioural performance. The results indicated that past behaviour indirectly predicted future behaviour via behavioural automaticity measured at baseline and at follow-up. In two of the behaviours (i.e., daily flossing and parental sun safety), past behaviour no longer predicted future behaviour, suggesting that the model constructs accounted for past behaviours effects on future behaviour. Results substantiate one of the propositions set by dual process theories, that effects of past behavior model habitual or automatic actions, but not the proposition that behavior is simultaneously mediated through conscious, deliberative decision-making.

Paper 3 (Chapter 5) further addressed research aim two and tested a dual process model inclusive of constructs representing automatic processes (i.e., goal-directed habit and counter-intentional habit), along with intention in two nutrition behaviours across two samples. The results indicated that constructs reflecting a deliberative process (i.e., intention) consistently mediated the past-to-future behaviour relationship for the nutrition behaviours. Mixed results were found for the constructs representing automatic processes. No mediation effects were found and only the goal-directed habit to eat the recommended serves of fruits and vegetables and the counter-intentional habit of restricting sugar-sweetened beverages in the middle-school sample (i.e., the habit to drink sugary drinks), significantly predicted behaviour. Furthermore, only the moderation of counter-intentional habit to the goal-direct habit on restriction of sugar-sweetened beverages in the middle school sample was significant. Of note, only the habits worded with an approach-orientation yielded significant results. Current findings provide emerging evidence on the role that different forms of habit may have on health behaviours and highlights the need to further investigate the concept of habit. In particular, further work is necessary to understand habits to avoid or restrict behaviour.

Paper 4 (Chapter 6) addressed research aim three and used qualitative methods across two studies to understand how lay representations of habit. Lay people represented habit as being automatic discrete behaviours that occur frequently; yet, participants also described patterns of behaviours synonymous with routine or identity features. The multiple and, at times, contradictory beliefs held by lay people regarding the characterisation of habit may affect habit measurement as participants may interpret items in a way that is different from their intended meaning. Similarly, their beliefs may have a negative impact on the evaluation of habit interventions as current interventions may not be well aligned with participants expectations. The results of Paper 4 provide clarification of the beliefs held by lay people about habit and can contribute to refining the scientific conceptualisation of habit.

Taken together, the findings of this thesis fill a knowledge gap on the role of past behaviour and habit in health behaviours. This final chapter provides an overview and general discussion on the key findings arising from the research conducted in this thesis. The chapter begins with a discussion of the theoretical contribution of current findings to knowledge. This is followed by a section outlining practical implications of the findings arising from the thesis. The strengths and limitations of the research program is then discussed, with suggestions proposed for the directions of future research. The chapter concludes with a summary of the key highlights from this thesis.

Theoretical Contributions of the Key Findings

The effect of past behaviour on an integrated model of behaviour. An integrated multi-theory, dual phase model was tested on fruit and vegetable consumption in Australian male long-haul HGV drivers, a population that is at high-risk of ill-health and largely underrepresented in health research, in Paper 1. The model integrated hypotheses from SDT (Deci & Ryan, 2002), TPB (Ajzen, 1991), and model of action phases (Heckhausen & Gollwitzer, 1987) and HAPA (Schwarzer, 1992). Previous research using single theories, such as the TPB, have been criticised for not appropriately explaining the belief based antecedents of intention or bridging the intention – behaviour gap (Hagger & Chatzisarantis, 2009; Sniehotta, Presseau, & Araújo-Soares, 2014). In using integrated models of behaviour (Hagger & Hamilton, 2020) it overcomes limitations of previous research by combining both motivational and volitional phases together. However, hypotheses derived from these motivational and social-cognitive theories assume behaviour is enacted through a deliberative process. Evidence indicates that in addition to conscious, deliberative processes, non-consciousness, automatic processes also play an important role in health behaviour decision making (Evans & Stanovich, 2013; Ouellette & Wood, 1998; Wood, 2017). Thus, it is important to consider individuals' past actions in models of behaviour. Although there is consistent evidence that past behaviour increases the amount of explained variance in intentions and, particularly, future behaviour (Bamberg, Ajzen, & Schmidt, 2003; Norman & Conner, 2006; Norman & Cooper, 2011), research has rarely explicitly tested the impact of past behaviour using integrated models of behaviour (Caudwell, Keech, Hamilton, Mullan, & Hagger, 2019; Hagger, Trost, Keech, Chan, & Hamilton, 2017; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017). The aim of Paper 1, therefore, was to test the impact of past behaviour on the multi-theory, dual-phase model's ability to predict and explain fruit and vegetable consumption for long-haul HGV drivers.

Findings of Paper 1 supported a number of effects demonstrated in other studies that have used integrated models applied to health behaviour (Arnautovska, Fleig, O'Callaghan,

& Hamilton, 2017; Hagger & Chatzisarantis, 2009; Hamilton, Cox, & White, 2012), including effects of autonomous motivation, and the TPB-based social-cognitive variables on intentions to consume fruits and vegetables. Critically, however, the inclusion of past-behaviour attenuated model effects, and, moreover, the intention-behaviour relationship was reduced to a trivial value and no longer statistically significant. These results are of theoretical importance as they corroborate the findings of previous research that has found attenuating effects of past behaviour, but which has typically focused on single models of social cognition (Bamberg et al., 2003; Hagger et al., 2018). However, interpreting attenuation effects in the current findings and in previous research that has included past behaviour is problematic. This is because past behaviour does not capture a specific psychological construct. The past-future behaviour relationship has been speculated to model an automatic process (Ouellette & Wood, 1998), possibly mediated by unmeasured implicit cognition, similar to that proposed in dual-process theories (Strack & Deutsch, 2004), and which likely captures behavioural automaticity (Gardner, 2012). Alternatively, it may model unmeasured variables, such as implicit motivation, personality factors, and self-control (Hagger et al., 2018) that predict behaviour and account for (mediate) the effects of past behaviour on future behaviour. Taken together, these results highlight that a better understanding of the effects of past behaviour on social–cognitive models is still needed. It is argued, therefore, that models of behaviour must include measures of constructs that represent non-conscious processes to best explicate processes by which past behaviour affects future behaviour.

Research Aim 1 (Paper 1): *The first aim was to understand the effect of past behaviour in an integrated, dual-phase model of health behaviour that focuses on multiple deliberative processes*

Theoretical Implications

- A multi-theory, dual-phase model, integrating hypotheses from self-determination theory, the theory of planned behaviour, the model of action phases, and the health action process approach was able to explain a significant amount of variance in fruit and vegetable consumption
- The inclusion of past behaviour in the model attenuated model effects. Critically, the intention on behaviour relationship was non-significant with the inclusion of past behaviour
- The results corroborated results of previous research regarding the role of past behaviour of constructs representing reasoned-action processes

Practical Implications

- Interventions focused on truck drivers nutrition behaviours could focus on increasing their autonomous motivation as an indirect mechanism to increase their intention to eat fruit and vegetables
- Interventions could focus on increasing drivers' planning to eat fruit and vegetables
- Research could explore automatic processes that govern nutrition behaviours

Figure 7.1. Summary of the key findings of the first research aim

Summary of paper 1 findings and contributions. In addressing the first aim of the thesis, Paper 1 tested the effects of past behaviour on a multi-theory, dual-phase model's ability to predict and explain fruit and vegetable consumption for long-haul HGV drivers. The addition of past behaviour was able to explain additional variance in future behaviour; however, attenuated model effects, at times to non-significant trivial values. The results of Paper 1 corroborate the effects of past behaviour found in other research that has typically focused on one theory or phase. As past behaviour is not a modifiable construct, further research needs to explicate past behaviours effect on future behaviour, possibly focusing on the effect of constructs representing non-conscious and automatic processes.

Explaining the past-to-future behaviour relationship. Building on the finding paper 1 as well as propositions outlined by Ouellette and Wood (1998), Paper 2 proposed a set of key hypotheses relating to both conscious, intentional pathways and non-conscious, automatic pathways to action for three health behaviours in three independent samples (dental flossing in community–dwelling adults, binge drinking in university students, and parental sun safety behaviours of children 2 – 5 years old). Specifically, this paper tested the propositions of a direct effect of past behaviour on future behaviour, which is theorised to model an automatic process, captured in the current paper using a measure of behavioural automaticity (Gardner, 2012); and an indirect effect of past behaviour on future behaviour via conscious, intentional processes, captured in the current paper using measures that underpin the TPB social–cognitive constructs (Ajzen, 1991). Although direct and indirect effects on the past-future behaviour relationship have been observed in social–cognitive models (Hagger et al., 2018), few studies have tested other non-conscious constructs, such as habits, alongside past behaviour (Bamberg et al., 2003; van Bree et al., 2015). This limits understandings of the influence past behaviour exerts on future behaviour via both reasoned action and automatic processes. Including non-conscious constructs, such as habit, along with past behaviour may help to elucidate the extent to which habit mediates the effect of past behaviour on subsequent behaviour, thus providing evidence as to the types of non-conscious processes modelled by past behaviour.

Findings of Paper 2, and contrary to expectations, revealed only significant indirect effects of past behaviour on future behaviour via time-1 and time-2 behavioural automaticity, a measure representing the construct of habit, but not via constructs representing deliberative processes (i.e., attitude, subjective norms, perceived behavioural control, intention). Indeed, model effects in two of the samples (parental sun safety behaviours and flossing) accounted for a significant portion of the variance explained in future behaviour, to the extent that past behaviour did not directly predict future behaviour. These results are of theoretical importance as they substantiate the proposition that the effects of past behaviour may model habitual or automatic actions but may not simultaneously model deliberative decision making (Evans, 2008; Ouellette & Wood, 1998; Triandis, 1977). It has been suggested that reasoned action processes explain novel or infrequently enacted behaviours while frequent or regular behaviours are more likely governed by automatic processes (Ouellette & Wood, 1998). Given the behaviours in this paper were purposely chosen for their relevance to the specific populations (e.g., sun safety of children 2 – 5 years old is controlled by their parents), it might be expected that the target behaviour in the various samples would be performed often, and, thus, consistent with a mediation pathway via constructs representing automatic processes.

However, current findings are in contrast to previous research which has found significant indirect effects of past behaviour on future behaviour via constructs reflecting reasoned action processes (Ouellette & Wood, 1998; Protogerou, Johnson, & Hagger, 2018). It may be, then, that the lack of significant indirect effects from past on future behaviour via the reasoned action pathway reflect the relative difference between the factors that can predict behaviour, such as intentions and the factors that can predict stability of behaviour, such as habit (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). As constructs that reflect reasoned action processes have been found to have direct effects on future behaviour, it may be the case that for certain behaviours and for certain population groups that social-cognitive constructs have a less important role when explaining the maintenance or stability of behaviour over time, as current findings indicate. It should also be noted, and similar to previous research (van Bree et al., 2015), that for one of the behaviours (i.e., binge-drinking) a significant direct effect of past behaviour on future behaviour was still observed. This may suggest that other important factors are unaccounted for in this behaviour.

The role of opposing habits on goal-directed behaviour. Building on the findings of Paper 1 and Paper 2, Paper 3 sought to further explain the past-to-future behaviour relationship by exploring other non-conscious processes, specifically habit operationalised as goal-directed and counter-intentional. To date, much of the research that has explored the role of habit in models of social cognition in explaining behaviour have taken a unidimensional approach to the measurement of habit. Habit constructs have typically aligned with the goal-direction of behaviour, adhering to Ajzen's (1991) principle of compatibility (i.e., measures of constructs within a model should make reference to behaviour at the same level of specificity) and TACT (target, action, context, and time) framework. However, adherence to these principles may have led to models missing the influence of other important, competing, or opposing constructs, such as effects of counter-intentional habits (i.e., the habit to engage in the opposite of the goal-directed behaviour) (Gardner, Corbridge, & McGowan, 2015; Verplanken & Faes, 1999). Paper 3, therefore, aimed to test a dual process model that included constructs reflecting deliberative, reasoned processes (i.e., intention) and non-conscious, automatic processes (i.e., habit operationalised as goal-directed and counter-intentional) in two distinct nutrition behaviours (i.e., eating the recommended serves of fruits and vegetables each day and restricting sugar-sweetened beverages) across two samples (i.e., middle school students aged 11–15 years and university students aged 17–24 years), drawing from dual process models such as theory of interpersonal behaviour (Triandis, 1977).

Findings of Paper 3 showed that a measure of intention, reflecting a deliberative process, mediated the past-to-future behaviour relationship in each sample and each of the behaviours. Moreover, current findings found a number of direct, indirect, and attenuation effects of the automatic, habit constructs. First, results revealed a direct effect of the counter-intentional habit to restrict sugar sweetened beverages (i.e., the habit to drink sugary drinks) in middle school children and a direct effect of the goal-directed habit to eat the recommended serves of fruits and vegetables in the middle school sample. Results further revealed a statistically significant indirect effect; past behaviour to future fruit and vegetable consumption via goal-directed habits in the middle school sample. Last, the addition of past behaviour to the model attenuated model effects. Without past behaviour in the model, the effect of goal-directed habits on eating the recommended serves of fruits and vegetables in the university sample became statistically significant.

These results are of theoretical importance for a number of reasons. Different types of habit appear to play a role in predicting nutrition behaviour for the middle school sample. In particular, the habit measures that were worded with an approach orientation (i.e., a habit to eat the recommended serves of fruits and vegetables and the habit to consume sugar-sweetened drinks) significantly predicted behaviour. This suggests that using measures of counter-intentional habit may be useful when the behaviour of interest is described with an avoidance-orientation. In contrast, habit did not appear to play a role, over and above constructs reflection reasoned action processes, in predicting behaviour for the university sample. This may reflect differences in the samples, whereby the older university students have more choice and freedom in their eating behaviours and, therefore, are less likely to believe their nutrition behaviours are governed ‘without thinking or ‘automatically’. This may call into question the generalisability of the effects found in Chapter 4, whereby the factors/variables reflecting automatic processes mediated the past-to-future behaviour relationship. While Paper 2 found a full mediation of these effects across the three behaviours, it is likely that there will be certain behaviours that are more likely to be determined by conscious, deliberative processes. For example, as shown in Paper 3, some avoidance-oriented behaviours may be mostly determined by intentions and not avoidance-oriented habits. Importantly, the results of Paper 3 further contribute to theory as it was found habit does not consistently reflect the effects of past behaviour on future nutrition behaviour. In each of the behaviours, past behaviour significantly predicted future behaviour reflecting significant variance being unexplained by the constructs in the model. Past behaviours persistent effect on future behaviour suggests there are other unmeasured constructs missing from the model, such as approach-biases (Hannan, Moffitt, Neumann, & Kemps, 2019; Kemps & Tiggemann, 2015), implicit beliefs (Hagger et al., 2017), or other self-regulatory constructs (Zhang, Wong, Zhang, Hamilton, & Hagger, 2019).

Paper 3 also examined the moderation effects of goal-directed habit and counter-intentional habit on the intention – behaviour relationship. This moderation effect is expected to reflect the ability of habit to maintain behaviour when motivation is compromised (Verplanken & Wood, 2006). However, others have argued that the concurrent measurement of goal-directed habit and intentions lack ecological validity as goal-directed habits and intentions should highly correlate (Gardner et al., 2015). As a weak intention to do one behaviour is not the same as having a strong intention to do an alternative or inhibitory behaviour, Gardner et al. (2015) suggest that it only makes theoretical sense for a moderation effect to occur with counter-intentional habit on the intention – behaviour relationship. Thus far, there have been inconsistent findings in the literature with research showing both significant (Gardner, de Bruijn, & Lally, 2011) and non-significant findings (de Bruijn, Rhodes, & van Osch, 2012; Gardner et al., 2015; Murtagh, Rowe, Elliott, McMinn, & Nelson, 2012) for the moderation effects of goal-directed and counter-intentional habits on the intention – behaviour relationship. Furthermore, Paper 3 explored the moderation effect of counter-intentional habits on the goal-directed habit – behaviour relationship. The unidimensional approach to much of the research exploring the past-to-future behaviour relationship has led to a lack of empirical data exploring factors that may interfere with stable behaviour and goal-pursuit. In particular, there has been a dearth of research investigating the relationship between goal-directed and counter-intentional habits (Gardner et al., 2015; Verplanken & Faes, 1999 Results revealed only one significant moderation effect, whereby the counter-intentional habit to restrict sugar-sweetened beverages in middle school children moderated the goal-directed habit on behaviour relationship. No other moderation effects emerged. This suggests that as middle-school students' habit to consume sugary drinks strengthened, so the effect of their habit of restricting their sugar-sweetened beverage consumption on restricting their actual consumption was attenuated. These results are of theoretical importance as they show, at least for this specific sample and behaviour, that two distinct habitual processes exist and are, perhaps, in competition with each other. The identification that multiple and competing habits may exist gives insight into the shortcomings of the unidimensional and narrow focus on previous research that explores only the factors that contribute to, but not interfere with, behavioural enactment. However, it should be noted that this moderation effect was not found in any of the other samples or behaviours and so, overall, current results do not provide strong evidence for this pattern of moderation. Furthermore, this type of effect will likely also depend on the level of specificity in which habits are operationalised. It is likely, for example, that with broadly defined habit (e.g., to exercise frequently) there will be many potential cues and responses that will not necessarily always negatively correlated with each other.

Measurement of past behaviour. Measures of past behaviour frequency have been hypothesized to represent the effects of automatic processes, such as habit. However, participants are typically expected to answer measures of past behaviour with reference to arbitrary periods of time, such as one week or one month. Measures such as these may not adequately capture accurate patterns of past behavioural performance and, therefore, may not adequately capture the non-conscious or automatic processes that they are expected to represent (Perugini & Bagozzi, 2001). Paper 2, therefore, assessed past behaviour via a measure that integrated long-term, recent, and routinised patterns of behaviour. While there are similarities between these constructs, they are expected to be distinct. By measuring past behaviour across long-term, recent, and routinised patterns it may capture patterns of behaviour that may have been only recently started, used to be regular but now inhibited, as well as seasonal variability in health behaviours (Bagozzi & Warshaw, 1990; Perugini & Bagozzi, 2001). As the automaticity component of habits is expected to form via frequent repetition of behaviour and developed over time, using a measure that captures behavioural frequency over time (i.e., long-term and recent enactments of behaviour) as well as routinised patterns of behavioural performance, it provided a clear test of whether past behaviour models habits effects on future behaviour. A second-order latent variable called "past behaviour" was made in Paper 2, inclusive of the measures of long-term (up to 1 year), medium-term (up to 1 month), and routine frequency of behaviour. The results found

Research Aim 2 (Paper 2 and 3): *The second aim of the thesis was to explain the effects of past behaviour on future behaviour, with a focus on the role of habit.*

Theoretical Implications

- Findings of Paper 2 found that constructs representing automatic processes consistently mediated past to future behaviour
- Findings of Paper 3 found that constructs representing reasoned-action processes consistently mediate past to future behaviour
- A measure of past behaviour incorporating long-term, recent, and routinised patterns of behaviour may accurately represent a participant's previous behavioural frequency
- There may be multiple habits that compete in predicting future behaviour

Practical Implications

- To maintain some health behaviours, clinicians may need to focus on building habit strength by guiding individuals to build strong associations between a cue and the behaviour of interest.
- To maintain other behaviours, such as nutrition related behaviours, clinicians may need to focus on maintaining motivation and guiding individuals to translate their positive intentions into behaviour
- Measuring counter-intentional habits may provide important information for some avoidance-oriented health behaviours

that the three measures were highly correlated and mapped well onto the second-order latent variable of past behaviour. This is theoretically important as a comprehensive measure of past behaviour not only provides a nuanced representation of previous patterns of behaviour but also allows for an accurate test of whether measures of past behaviour frequency reflect automatic, habitual responses.

Figure 7.2. Summary of the key findings of the second research aim

Summary of paper 2 and paper 3 findings and contributions. In summary, Paper 2 and Paper 3 make significant contribution to theory as they both reported the effects of dual process models, including constructs representing deliberative processes and constructs representing automatic processes, explaining the past-to-future behaviour relationship. In Paper 2, results revealed significant indirect effects of past to future behaviour via time-1 and time-2 habit. No indirect effects were found via constructs reflecting reasoned action processes. This demonstrates that measures of past behavioural frequency model the effects of habitual action on future behaviour. Furthermore, results may reflect the relative differences in constructs that can predict stable behaviour compared to infrequent or novel behaviours (Kwasnicka et al., 2016; Ouellette & Wood, 1998). In Paper 3 results revealed that intentions consistently mediated the past to future behaviour relationship, whereas measures of habit did not in all but one behaviour/sample. This suggests that in nutrition behaviours, past behaviours effect on future behaviour is modelled via constructs representing reasoned action processes. Furthermore, it was identified in Paper 3 that both goal-directed and counter-intentional habits play a role in directly predicting the nutrition behaviours of middle school children, as well as providing preliminary evidence that multiple automatic constructs may exist and be in competition with each other. Last, a measure of past behaviour frequency was developed that incorporated long-term, recent, and routinised patterns of behaviour. This theory-driven measure was used to capture an accurate representative of participants' past behavioural performance to understand whether reasoned action of automatic processes reflect past behaviours influence on future behaviour.

Lay characterisations of habit. Paper 2 and 3 tested dual process models applied to several health behaviours and found that constructs representing conscious, deliberative processes such as intention, and constructs representing non-conscious, automatic processes such as habit can predict future behaviour and explain the past-to-future behaviour relationship. In particular, Paper 3 investigated simultaneously measures of intention, goal-directed habits, and counter-intentional habits. This was especially novel and has not yet been explored in the behavioural sciences. Of note, Paper 3 reported no significant direct or indirect effects for any measure of habit that was worded using an avoidance orientation (i.e., a habit to restrict or avoid). One explanation for the lack of effects may be that individuals struggle to consistently interpret avoidance-oriented measures of habit. Research has demonstrated that individuals misinterpret goal-directed measures of habit (Gardner & Tang, 2014), which may be amplified in measures using an avoidance orientation. Further, current scientific conceptualisations of habit do not agree on the consistent features, and, as such, may have important ramifications to the way habit is measured, modelled, and intervened upon (Gardner, 2015). Lay representations of habit may help to shed further insights into how habit may be conceptualised, yet, to date, exploring lay representations has been largely ignored. To unpack the features that inform how individuals may interpret measures of habit, and, further, to start to understand the beliefs that inform lay representations of habit, it is necessary to understand how lay people characterise habits. To address this knowledge gap, Paper 4 used qualitative methods to explore how lay people explicitly define habits, the types of behaviours lay people identify as habitual, and how they differentiate habit with the construct of routine. This was achieved in two studies. The first study used an online, open-ended questionnaire to elicit what lay people believe to be the salient features of habit. The second study, in a series of interviews and focus groups, explored an in-depth exploration of a lay representations of habit, including what behaviours participants identify as habitual and if the participants differentiate habit and routine.

Findings of Paper 4 revealed that, when asked to define habits, lay people describe habits as either an outcome or internal mechanism. If lay people believe that there is something inherent about a behaviour that makes it a habit, it may lead to inaccurate expectations when forming habits and when evaluating habit interventions. For example, they may believe that they will always perform the behaviour, across settings and contexts instead of being triggered by a specific cue or set of cues. When habitual behaviour do not immediately occur across contexts in habit interventions, participants may believe the intervention has not worked and negatively evaluate it.

Paper 4 results also revealed that lay people believe habits are characterised by being repetitive or regular, automatic, triggered by stable contextual cues, and can feel emotionally rewarding or comforting. The results of Paper 4, therefore, build on Papers 1, 2, and 3 as it provides evidence that the lay representation of habit is consistent with the scientific conceptualisation that habit is a mechanism of stable behavioural patterns. Paper 2 and 3 aimed to explore whether habit modelled past behaviours effect on future behaviour, which is to say, does habit account for stable behaviour. The results of Paper 4 demonstrate that lay peoples' representation of habit is that of a mechanism that causes behaviour to frequently or regularly persist, consistent with the hypotheses relating to habit in Paper 2 and 3. Furthermore, habit is expected to represent a non-conscious, automatic process. The results of Paper 4 revealed that this maps onto lay representations and experience of habit; participants described habit as occurring automatically and outside of awareness or thought.

The participants in Paper 4 identified habitual behaviours as either simple and discrete, clustered patterns of behaviour, or self-identity characteristics (e.g., "I'm a dog walker”). However, they simultaneously differentiated a habit from a routine by describing habits as discrete simple behaviours, whereas routines as being multi-step patterns of behaviour that are more pliable. The results of Study 4 highlight the similarities and contradictions between how lay people explicitly define habit compared to how they construct habit in everyday language use. Again, this demonstrates that the lay representation of habit incorporates the idea that habit is something that accounts for stable behaviour over time.

Finally, an important and distinct contribution found in Paper 4 that lay people see affect and mood having a dual role in characterising habit. Participants first described how a habit can be cued by an emotion (e.g., feelings of sadness prompt chocolate eating) and describe how enacting a habitual behaviour can be inherently satisfying. The experience of comfort evoked from a habit may be comparable to the process of habituation. Habituation is characterised by the decrease in arousal experienced from repeated exposure to a

Research Aim 3 (Paper 4): *The last aim of the research program was to explore lay representations of habit*

Theoretical Implications

- Lay people characterise habit as automatic, frequent or regular, cued in a stable context, and having the experiences of being emotionally rewarding or comforting
- Lay people believe habits can be enhancing when in line with their goals and debilitating if in opposition to their goals
- Lay people identity habitual behaviours as discrete and simple, clustered pattered of behaviour synonymous with routines, and as a self-identity characteristic. However, also differentiate between habit and routine by characterising routines as multi-step, enacted with greater agency, and less imbued with emotion

Practical Implications

- Measures of habit may be refined to enable consistent and accurate interpretations of habit measures
- Results may allow for clear expectations to be discussed in habit interventions to ensure both the researcher and participants understands what is expected to change
- Results may be used to further refine scientific conceptualisations of habit

stimulus (Cyr & Romero, 2009; Thompson & Spencer, 1966). The role of emotion has not typically been explored in depth in the habit literature. The results of Study 4 highlight that lay people identity that emotion is imbued in the experience of habit, which suggests future research may need to focus on this is richer detail.

Figure 7.3. Summary of the key findings of the third research aim

Summary of paper 4 findings and contributions. In summary, Paper 4 makes a significant contribution to theory as it clarifies how lay people characterise habit across two studies using qualitative methodologies, results of which may be integrated into existing scientific conceptualisations of habit. Results revealed lay people characterise habit as frequent, regular, automatic, cued, and emotionally rewarding, thereby building on Paper 1, 2, and 3 by demonstrating that lay peoples representation of habit is that of a mechanism that determines stable behaviour. However, some contradictions were also found with regards to the complexity of behaviours or behavioural patterns that lay people identified as habitual. These contradictions may relate to the differences between how lay people define habit compared to how they socially construct habit in everyday language. Furthermore, unlike many scientific definitions of habit, lay people identified emotion as being an important component on the experience of habit. Further research needs to investigate the scientific accuracy of this belief.

Practical Implications of the Key Findings

Health behaviour change interventions. The aim of the current thesis has been to understand the effects of theory-based variables that represent non-conscious processes on health behaviours, particularly the effects of past behaviour and habit. The research has made important contributions to theory: providing evidence for the attenuating effect of past behaviour on the effects of constructs from a multi-theory, dual-phase model on health behaviour; providing preliminary evidence that constructs representing both deliberative and automatic processes serve to mediate effects of past behaviour on future behaviour; identifying the lay beliefs people hold in their representations of habit. However, these findings are also important precursors to intervention development. Given research suggesting that interventions based on theory provide more consistent effects on behaviour change than those that are not (McEwan et al., 2019), current findings may also assist in providing formative evidence on which to base health behaviour change interventions. In particular, the current research provides some indication of potentially modifiable constructs that could be targeted in behaviour change interventions (Sheeran, Klein, & Rothman, 2017). This would necessitate matching the constructs with intervention content that would be effective in changing those constructs; this could be done through knowledge of mechanisms of action (see Carey et al., 2018; Connell et al., 2018).

Results of Papers 1 and 3 indicated that constructs representing deliberative, conscious processes, such as intention, autonomous motivation, and planning, were important predictors of nutrition-related behaviours. Furthermore, Paper 2 identified a number of direct effects of the theory of planned behaviour variables on behaviour. These results suggest that it would be prudent for those developing intervention to change health behaviour should focus on increasing motivation to perform a health promoting behaviour, if participants have not yet formed a concrete intention to perform the target behaviour. Given the pervasive effect of attitudes and perceived behavioural control as prominent and consistent predictors of intention, interventions should incorporate change techniques that focus on targeting these constructs (Gardner, Lally, & Rebar, 2020; Hagger & Hamilton, 2020; Hamilton & Johnson, 2020; Warner & French, 2020). This will likely increase an individual's intention to perform the target health behaviour in future (McEachan et al., 2016; Michie et al., 2013; Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016). A meta-analysis of the theory of planned behaviour found that behaviour change techniques linked with the constructs from theory were efficacious in promoting intention and behaviour change (Steinmetz et al., 2016). For example, interventions could use persuasive messages that describe the health benefits of eating fruits and vegetables (to change attitudes), provide examples of vegetable snacks that can be made in less than 5 minutes (to change perceived behavioural control), and prompt rehearsal of making the snacks to provide experiences of success (to change self-efficacy).

Current findings have also raised issues with respect to the 'intention-behaviour gap' by illustrating that relations between intentions and behaviour across all of the behaviours studied are far from perfect. This highlights the necessity of adopting behaviour change techniques that bridge the intention-behaviour gap. Planning is a technique that promotes intention enactment by creating specific context-dependent performance of behaviour (de Bruijn, Wiedemann, & Rhodes, 2014; Hagger & Luszczynska, 2014). Action planning, a planning technique in which individuals specify when, where, how, and how often they will perform the behaviour of interest, is similar to implementation intentions, in which an individual constructs rules regarding contextual features that are intended to cue a specific response (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011). These strategies have been found to be efficacious in translating motivation to action and building the association of specific contextual cues and enactment of the behaviour (Adriaanse et al., 2011; Gollwitzer & Sheeran, 2006).

The current research also found statistically significant effects of habits on behaviour (Papers 2 and 3). Based on these findings, health behaviour change interventions should focus on strategies that target change in context-dependent, cue-response automaticity of the target behaviour to promote behavioural maintenance (Rothman, Sheeran, & Wood, 2009). To date, few studies have tracked habit formation, although in those that have, large variability in the time it takes for the habit to form has been found (e.g., 18 – 254 days) (Lally, van Jaarsveld, Potts, & Wardle, 2010; Mullan, Allom, Fayn, & Johnston, 2014). Moreover, Lally et al. (2010) found that habit formation follows an asymptotic curve, suggesting that the automaticity builds fastest in the beginning stages of habit formation. Interventions should aim to promote context-dependent repetition with a concentration on early few repetitions to promote habit formation quickly (Lally & Gardner, 2013).

Once an individual has the motivation to engage in a behaviour and has started to form a mental association between contextual cues and implementing the behaviour, the continued repetition of the behaviour is necessary for the habit to become strengthened (Lally & Gardner, 2013; Wood & Rünger, 2016). Interventions that seek to build a habit should, therefore, also focus on post-behavioural performance strategies, such as building positive affect. Increasing positive affect, such as satisfaction, has been found to be linked with long-term behavioural maintenance (Baldwin, Rothman, & Jeffery, 2009). Purposely evoking the feeling of satisfaction has been seen as difficult, however, is expected to be experienced after attained a valued anticipated performance (Rothman, 2000) and may strengthen habitual action. Given that lay people also identity affect as an important component of habit, as shown in Paper 4, this is likely an area that needs further exploration.

Another intervention strategy that may be able to increase the strength of habit formation is the use of rewards. Extrinsic rewards may be effective in bolstering motivation to frequently engage with the behaviour in a specific context, thereby increasing the mental association with the cue-response frequency. However, some researchers argue that this may be an unhelpful strategy as external rewards may undermine intrinsic motivation to engage in the behaviour (Deci & Ryan, 2008). The behaviour may only be performed, therefore, in anticipation of the reward instead of the relevant cue. If the reward can be presented in such a way that it does not become the sole focus of goal-attainment, but instead helps signal progress and is informational, then the use of external reward may be able to facilitate habit formation.

Importantly, these strategies could be used for both approach-oriented and avoidance-oriented behaviours. At large, habit formation research has focused on approached-oriented behaviours (i.e., “doing” behaviours such as engaging in physical activity or healthy eating). While avoidance-oriented behaviours include “not-doing” (e.g., avoiding binge-drinking or adding salt to food), it may still be conceptualised as a behaviour and, therefore, likely determined by the same processes as approach-oriented behaviours. Avoidance-oriented habits could also be conceptualised as a form of habit replacement. If an individual needs to engage in an avoidance behaviour (for example, avoiding adding salt to food), it implies they are currently engaging in the opposite approach-behaviour (e.g., adding salt to food), perhaps in a habitual way. The formation of the avoidance-oriented habit would, therefore, likely involve replacing the habit to add salt to the habit of avoiding adding salt.

Taken together, the value of the models tested in the current thesis is that they provide formative data on the constructs reliably related to behaviour that may form multiple potential targets for intervention. In the current models, those targets have been constructs that represent both automatic, non-conscious processes and deliberative, reasoned processes. These constructs represent potentially modifiable targets for behavioural interventions, and there is a need to identify the types of strategies or *behaviour change techniques* (Abraham & Michie, 2008; Michie et al., 2013) necessary to evoke change in those targets. Means to do so may lie in research on mechanisms of action, that is, research demonstrating links between behaviour change techniques and the theory-based constructs they are purported to change (Carey et al., 2018; Connell et al., 2018). Based on current findings, intervention strategies that change determinants of intentions and habit are likely to be optimally effective.

Habit measurement. Results of Paper 4 has practical implications for the way researchers may measure habit. Results of this paper indicate that individuals hold a number of inconsistent beliefs about their habits. Researchers should, therefore, ensure they provide a clear, concise explanation of what they mean by habit as a preamble to a measure of habit. This may clarify for participants the exact meaning of the measure and help them reflect on behaviours that are consistent with what construct the researcher is attempting to tap into. Furthermore, findings from Paper 4 may inform the development of new habit measures. By exploring lay representations of habit, new measures or items for measures, which closely map onto lay people's experience of habit may be developed. For example, given lay people identify behaviours that have different levels of complexity (i.e., discrete simple behaviours and multi-step behaviours), it may be useful for researchers to ensure habit measures specify the exact context of habit instead of being overly broad (e.g., "eating fruit in the kitchen in the morning is something I do with thinking" compared to "eating fruit is something I do without thinking"). This may increase the precision of measurement of items in self-report measures of habit.

Strengths, Limitations, and Suggestions for Future Research

Strengths of the thesis. The research presented in this thesis has a number of strengths. First, the quantitative studies have tested theories across several populations and relevant health behaviours (e.g., fruit and vegetable consumption in long-haul HGV drivers, parental sun safety behaviour of their children 2–5 years old, avoiding sugar sweetened beverages in middle school children). By investigating multiple samples, it provides greater clarity regarding the consistency of the effects. Similarly, it provides greater understanding on the applicability of theories to 'real world' contexts and samples instead of solely on samples that are not necessarily representative (e.g., by only testing university students on a generic behaviour). Another strength of the research in this thesis was the use of a measure of past behaviour that integrates three conceptually distinct elements of past behaviour (i.e., long-term, recent, and routinised patterns of behaviours). This new variable sought to overcome a criticism in the literature that effects of past behaviour on future behaviour had been inflated due to shared-method variance as well as being able to accurately capture whether behavioural automaticity models the effect of past behaviour on future behaviour. Also, this research was one of the first to simultaneously measure both goal-directed and counter-intentional habits, which advanced knowledge on the multiple ways in which habits predict nutrition behaviours. Furthermore, by testing the effects of two measures of habit on behaviour concurrently alongside a measure of intention, the research was able to explore the relative contribution of constructs representing both deliberative processes and automatic processes. Another strength of the thesis is that it includes one of the first qualitative investigations of lay representations of habit, using two studies to elicit and then confirm key characteristics and beliefs of habit. Last, this thesis provides full transparency in materials and data analyses, consistent with good open science practices, with links to open access materials included in the relevant papers.

Limitations of the thesis. Despite the strengths of the research reported in this thesis, it is not without limitations. First, some of the study sample sizes were quite small and some had large attrition rates. This may have been due to recruiting hard-to-reach participants (e.g., long-haul HGV drivers) or some that had limited time (e.g., parents of 2 – 5 years old). While analyses suggested the research had sufficient statistical power, results must still be treated with caution given the possibility of affirmation bias and those likely to be positively predisposed toward the target behaviours. While the research utilised samples of people from populations identified as being at risk of health problems, participants were still typically Western, educated, industrialized, rich, and democratic (WEIRD) (Henrich, Heine, & Norenzayan, 2010), which limits the generalizability of the results. Similarly, while the qualitative research used participants with a broad range of ages, the highly selected recruitment procedures means that participants views may not have been representative of the population. Future research should replicate current findings in representative samples. In addition, the quantitative studies in this research all used a prospective-correlational design. While there were strong theoretical arguments for the sequence of effects, temporal precedence cannot be supported without establishing that change in mediators occur prior to changes in the relevant outcome using longitudinal designs (Kazdin, 2007). Prospective-correlational designs can, however, provide important formative evaluations of conceptual models, building a foundation on which to base future experimental research (Gaynor, 2017; Kazdin, 1999). Finally, this research relied on self-report measures of behaviour, which limits the findings as participants may have provided socially desirable answers or inaccurately reported their behaviour because of poor memory retrieval (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995).

Suggestions for future research. Considering the findings and limitations of the research presented in the thesis, the following section provides suggestions for avenues of future research. There have been advances in habit measurement over the last few decades, with research moving beyond using past behaviour as a proxy for habit (Gardner, Abraham, Lally, & de Bruijn, 2012; Hargadon, 2017; Verplanken, Aarts, Van Knippenberg, & van Knippenberg, 1994; Verplanken & Orbell, 2003). A number of these measures, such as the self-report habit index (Verplanken & Orbell, 2003), have been criticised as they may be subject to methodological artifacts by incorporating items of behavioural frequency (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Labrecque & Wood, 2015; Rebar, Gardner, Rhodes, & Verplanken, 2018). Furthermore, as shown in Paper 3, there has been little research that has explored the validity of adopting or refining these measures for avoidance-orientation habits. Further research could, therefore, use knowledge from Paper 4, by refining measures of habit to further reflect the lay experience and characterisations of habit, to accurately measure habit. These measures need to be able to distinguish between constructs such as habit, routine, automaticity, and other measures of non-conscious processes.

With a recent resurgence of interest in habit in the psychological literature, there have been considerable advances in understanding habit formation and extinction, the relationship between habit and other motivation, self-regulatory, and implicit constructs, as well as interventions that focus on habit (Gardner, 2015; Phipps, Hagger, & Hamilton, 2019; Smith & Graybiel, 2014, 2016; Wood, 2017). However, there is still no unified theory of habit, integrating multiple theoretical perspectives from, for example, social and personality psychology (Wood, 2017), learning theory (Watson & de Wit, 2018), and neuroscience (Smith & Graybiel, 2014). The current research focused on integrating habit into existing theories of social cognition and dual processes (Evans & Stanovich, 2013). These models are useful in understanding specific effects of habit, such as the variance in future behaviour explained by habit relative to other constructs, as well as providing testable hypotheses that guide habit research. However, a unified theory of habit may provide much needed understanding and description of the phenomena of habit, as well as summarise and extend current knowledge to set a broader research agenda across disciplines.

The current research has extended knowledge by testing dual process models, integrating constructs representing both deliberative and automatic processes in the prediction of behaviour. Still, further research is needed to develop behavioural theories, such as exploring the role of other non-conscious processes in predicting and explaining behaviour, such as implicit cognitions and motives. Implicit attitudes, for example, reflect an individual's belief about an object or behaviour, but differ from an 'explicit' attitude as it reflects an evaluation that has developed over time, through repeated experiences of the object or behaviour (Greenwald, Poehlman, Uhlmann, & Banaji, 2009). Implicit beliefs may at times be congruent with explicit beliefs but do not have to be and have been shown to independently predict future behaviour (Greenwald et al., 2009; Perugini, Richetin, & Zogmaister, 2010). Implicit attitudes, like habit, reflect an automatic process and may complement the findings of the current research by further demonstrating the utility of non-conscious processes in explaining behaviour. In particular, there has been preliminary research that has found a moderating effect of implicit beliefs on the effects of behavioural automaticity on health behaviour (Phipps et al., 2019). As implicit beliefs are expected to develop over time, similar to habit, the beliefs may become associated in memory with the contextual features associated with cuing-up a habit. Thus, encountering a specific context may activate both the implicit belief, and, simultaneously the information related to the behaviour response (i.e., the habitual behaviour) (Hagger, 2020).

In addition, the quantitative work conducted in this thesis used correlational, between-group methodologies that provide averaged effects that does not take within participant variability into consideration. Given habits are proposed to be context dependent, there is a need to use single-case and within-participant designs to understand individual differences in the subjective experience of habit. Research could use ecological momentary assessments or other N-of-1 research methods to collect data on each occasion a habit is triggered or inhibited to gain a deeper understanding of the determinants and processes that are associated with these experiences (Conroy, Maher, Elavsky, Hyde, & Doerksen, 2013; Grenard et al., 2013; Liao, Skelton, Dunton, & Bruening, 2016). Using N-of-1 methods could be particularly important for habit and habit formation research. Given habit formation is expected to occur in a personalised context or in response to a person-specific cue, N-of-1 designs allow testing these hypotheses on habit at the individual level. Moreover, N-of-1 studies can determine the heterogeneity of effects in habit formation across different behaviours within the same individual or the same behaviour across different individuals. These methods extend the question of how habits are formed to in what way are they formed for different people in different circumstances. Technological developments (e.g., smartphones, tablets) provide opportunities for researchers to track and intervene on habitual behaviour in real-time.

Finally, findings in this thesis has extended research on the importance of habit as a construct in the prediction of behaviour. Future research, therefore, should focus on the development of simple, evidence-based habit interventions to promote behavioural maintenance. There is preliminary research to suggest that promoting self-regulatory skills that builds cue-response associations are able to assist with habit formation (Hamilton, Fraser, & Hannan, 2019; Judah, Gardner, & Aunger, 2013; Kaushal, Rhodes, Spence, & Meldrum, 2017). However, despite claims that habit is a mechanism of long-term behavioural maintenance, there is relatively little empirical evidence supporting this. To date, much of the research demonstrates that habit strength increases over time, yet little research has explained how habit allows for the maintenance of the behaviour, over a few months (Gardner et al., 2011). Other research suggests, in line with the results of the research in this thesis, that intentions and other constructs reflecting deliberative, conscious processes are equal or better predictors of long-term behaviour change (Bamberg et al., 2003; O’Brien et al., 2015). Future research could focus on using randomised controlled trials, independently using habit formation techniques in one group, goal setting or intention-related techniques in a second group, and combined techniques in a third group to identify the most useful strategies to promote behavioural maintenance.

Conclusion

Given the prevalence of non-communicable, lifestyle related diseases, identifying the modifiable determinants of health behaviours is increasingly important. To date, research in disciplines such as health psychology and behavioural medicine has tended to use theories that have focused on constructs representing conscious, deliberative processes. Measures of past behaviour consistently explain variance in future behaviour, over and above theories of social cognition, and has been argued to represent the effects of non-conscious and automatic processes, such as habit. The overarching aim of this thesis was to investigate the role of past behaviour and habit in health behaviours. The research has achieved this aim and contributed to knowledge in a number of ways. First, Paper 1 corroborated previous research, finding significant attenuation effects of past behaviour within an integrated, multi-theory model of health behaviour. Papers 2 and 3 explored how constructs representing both deliberative and automatic processes model the effect of past behaviour on future behaviour and found different patterns of effects, across the behaviours. For some behaviours, habit mediated the past-to-future behaviour relationship, while for other behaviours intention mediated the relationship. In addition, this thesis is one of the first to test a dual process model that included two habit measures, exploring whether they compete with other in the prediction of behaviour, along with intentions. Last, the research contributed to theory by clarifying lay representations of habit. The investigation found a number of consistent and contradictory beliefs about habit held by lay people.

The results of the research reported in the current thesis also have practical implications. Measures of habit may be refined by incorporating the way in which lay people characterise habit. This may improve the validity and reliability of habit measures. The results can also serve as a foundation for creating efficacious behaviour change interventions. The results of the research suggest that strategies that increase and maintain intention to engage in health behaviours are likely to be important in interventions. Furthermore, habit-based strategies such as using action plans to form mental associations between the desired action and nominated cues in the environment, and the use of approaches to increase satisfaction, may enable long-term behavioural maintenance.

This research had a number of strengths, such as a test of effects across several health behaviours and populations. Furthermore, thesis used mixed methods to investigate the effects of both intention and habit as mediators to the past behaviour on future behaviour. However, the quantitative components of this research relied on prospective-correlational designs, meaning the temporal effects need to be confirmed using experimental designs. Similarly, the reliance on self-report measures of behaviour in WEIRD samples may limit the generalisability of the findings. The knowledge created in this thesis also gives rise to further directions of research. Future research should further focus on theory development, including the creation of a unified theory of habit, integrating cross-disciplinary knowledge. Similarly, further work is needed to clarify the conditions in which behaviours are more likely under either intentional or habitual control, possible using advancements in technology to develop N-of-1 or single-case, experimental designs.

Overall, the findings from the research conducted in this thesis contributes to knowledge by corroborating past behaviours pervasive effect on future behaviour. The thesis has demonstrated that habit can model the effect of past behaviour on future behaviour, suggesting that measures of past behavioural frequency can represent non-conscious, automatic processes. The research similarly demonstrated that constructs representing reasoned action processes have an important role in predicting and explaining future behaviour. The research in this thesis featured one of the first explorations of lay representations of habit and found that lay people similarly believe that habit is a mechanism of stable, persistent behaviour. The thesis provides formative research that can provide a foundation for future research to refine conceptualisations of habit. Furthermore, researchers should take advantage of technological advancements to map the intra-individual patterns of habit formation and inhibition.

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