Construction and Validation of Habit Measures for Fruit and Vegetable Consumption

Christopher John Rompotis
Bachelor of Arts (Honours in Psychology)

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School of Psychology
School of Sport Science, Exercise & Health

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Abstract

Adequate fruit and vegetable consumption is a protective factor against chronic illness, and increasing fruit and vegetable consumption is a public health priority. While public health interventions have modestly improved population fruit and vegetable consumption, only 48.5% and 8.2% of Australian adults currently consume the recommended daily servings of fruit and vegetables, respectively. Social, environmental and economic predictors have been identified as factors that affect fruit and vegetable consumption. However, these predictors are difficult and expensive to modify. Alternatively, psychological predictors may be modifiable and cost-effective mechanisms for increasing fruit and vegetable consumption. Dual-processing frameworks, which models behaviour using reasoned processes (e.g. intentions, self-efficacy and attitudes) alongside automatic and habitual processes, may provide a useful approach in predicting fruit and vegetable consumption. However, previous research has been limited by its focus on reasoned processes at the expense of habitual processes. Consequently, measures of habitual processes require further development. Furthermore, previous research has examined the relationships between psychological predictors and combined fruit and vegetable intake, despite indications that these relationships may differ between the two behaviours. Lastly, there has been a lack of experimental research to support the use of habit-based interventions for improving fruit and vegetable consumption in adults. The present thesis addresses these limitations by exploring the relationships between multi-process habit measures (automaticity, patterned response, stimulus-response bonds and negative consequences for non-performance), measures of cognitive processes (e.g. Theory of Planned Behavior), and
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fruit and vegetable consumption. Furthermore, the effectiveness of an informational intervention based on a multi-process habit framework is assessed.

Experimental chapters in this thesis are presented as a series of papers. Four studies are included which examine measures of habit strength, fruit and vegetable consumption and cognitive processes in Western Australian adults ($N = 619$). In studies one and two, psychometric support is given for a multi-process habit measure of combined fruit and vegetable consumption. Specifically, automaticity of consumption, response patterning (routinisation) and negative psychological consequences for non-consumption are positively related to fruit and vegetable consumption, and stronger in those eating at least five serves of fruit and vegetables per day than those who do not yet consume at least five serves. Study three indicated that the multi-process habit framework was supported for examining fruit consumption. Furthermore, the multi-process habit measures accounted for additional variance in fruit and vegetable consumption above that of automaticity alone. However, when reasoned processes (i.e. Theory of Planned Behavior) were incorporated into the model, habit processes did not significantly predict fruit or vegetable consumption. Study four demonstrated that a habit-based informational intervention resulted in a greater change in fruit consumption than messages based on meal preparation strategies or healthy eating advice. However, habit-based messages were equally effective in improving vegetable consumption when compared to meal preparation strategies and healthy eating advice.

This thesis demonstrates the importance of incorporating a multi-process habit framework alongside traditional measures of cognitive predictors of fruit and vegetable consumption. Additionally, a multi-process habit framework (automaticity, routinisation and negative psychological consequences for non-performance) may account for additional variance in fruit consumption and vegetable consumption than measures of
automaticity alone. Furthermore, habitual and cognitive processes were found to predict fruit consumption and vegetable consumption differentially. Future research and promotion campaigns may benefit from targeting the behaviours separately.
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Preamble

The majority of this thesis is presented as a series of papers. Additional theoretical chapters (Chapters One and Two) introduce the importance of fruit and vegetable consumption and provide an overview of the psychological predictors of consumption. Chapter Three has been submitted for publication and is currently under review. Chapter Four has not been published. Part of Chapter Five has been published in a peer-reviewed journal. Chapter Six is a theoretical chapter that discusses the key findings of the thesis.
Publications and Manuscripts Arising from this Thesis

Paper 1: Submitted (Chapter 3)

Paper 2: Unsubmitted (Chapter 4)

Paper 3: Published (part of Chapter 5)
Statement of Candidate Contribution

For each publication and manuscript included in this thesis, the candidate has completed all study designs, literature reviews, data analyses and interpretations of the findings, and prepared and revised all manuscripts. Co-authors of manuscripts provided guidance during this process and provided comments on draft manuscripts (J Robert Grove and Susan Byrne). All co-authors have provided permission for published works to be included in this thesis.

Christopher John Rompotis (Candidate)

Susan Byrne (Coordinating Supervisor)

J Robert Grove (Co-Supervisor)
Chapter One: General Introduction

1 General Introduction
Chapter One: General Introduction

1.0 Foreword

Public health organizations recommend the adequate consumption of fruit and vegetables to protect against chronic illness and disease. However, few Australian adults currently consume the recommended servings of fruit and vegetables. Consequently, increasing fruit and vegetable consumption is considered a public health priority. Research into the psychological mechanisms that predict fruit and vegetable consumption is needed in order to promote an increased intake within the Australian population. The current thesis contains four empirical studies that provide support for using psychological mechanisms to predict and facilitate fruit and vegetable consumption.

This chapter will provide an overview of the importance of fruit and vegetable consumption for individual health, and will examine the current rates of fruit and vegetable consumption in the Australian context. Furthermore, this chapter will introduce environmental and psychological factors that influence fruit and vegetable consumption. Chapter 2 of the thesis will examine psychological factors in detail. Lastly, the aims and significance of the thesis will be addressed.
Chapter One: General Introduction

1.1 Lifestyle Factors and Chronic Disease

The World Health Organization (WHO) currently estimates that 60% of all deaths globally are the result of chronic disease, specifically, cardiovascular diseases, cancer, chronic respiratory diseases and diabetes (WHO, 2008). In Australia, chronic diseases contribute highly to mortality rates. For example, coronary heart disease is the leading cause of death for men and women, accounting for approximately 15% of all deaths in 2011 (Australian Institute of Health and Welfare, 2014), while cancer is considered the second leading cause of death in Australia (Australian Institute of Health and Welfare, 2014). In addition to lives lost by chronic disease, it also places a large financial burden on the healthcare system (Australian Institute of Health and Welfare, 2012). In 2011-2012, health expenditure in Australia was approximately $140.2 billion, with 70% of the expenditure funded by state and federal governments (Australian Institute of Health and Welfare, 2014). It is therefore in the interest of governments to reduce risk factors that lead to chronic illness in order to decrease lives lost each year and minimize health expenditure.

The WHO (2008) has identified that between thirty to eighty-percent of chronic illnesses could be prevented by reducing four primary lifestyle risk factors (tobacco use, physical inactivity, unhealthy diet, and high levels of alcohol consumption). The Australian Institute of Health and Welfare (2012) identified that, of the four primary lifestyle risk factors, poor diet (and in particular vegetable consumption) had the greatest potential for improvement. It has been estimated that inadequate fruit and vegetable consumption is responsible for approximately 2.7 million deaths per year worldwide (WHO, 2002). In order to reduce the mortality associated with inadequate fruit and vegetable consumption, The World Health Organization and the Department of Health Western Australia recommends the consumption of 600g of fruits and vegetables...
each day for an adult (Miller, Pollard, & Coli, 1997; WHO, 2002). This translates to approximately two serves of fruit and five serves of vegetables each day. However, current estimates suggest that only 48.5% of Australian adults meet fruit consumption guidelines and 8.2% meet the vegetable consumption guideline (Australian Bureau of Statistics, 2013). The following section will examine the relationships between fruit and vegetable consumption, chronic disease, and mental health, to determine the potential benefit of increasing population fruit and vegetable consumption.

1.1.1 Fruit and Vegetable Consumption and Cardiovascular Risk

The WHO (2002) suggested that inadequate fruit and vegetable consumption is estimated to cause 31% of ischaemic heart disease cases worldwide. A consistent inverse relationship between fruit and vegetable consumption and the incidence of cardiovascular disease mortality has been demonstrated in the literature (Bazzano et al., 2002; Boeing et al., 2012; Crowe et al., 2011; Dauchet, Amouyel, Hercberg, & Dallongeville, 2006; Hung et al., 2004; Ness & Powles, 1997). However, the causal link between fruit and vegetable consumption and cardiovascular disease remains unclear. Researchers have suggested that higher levels of fruit and vegetable consumption indirectly affects the risk of cardiovascular disease by lowering blood pressure (Appel et al., 1997; Bazzano, Serdula, & Liu, 2003; Van Duyn & Pivonka, 2000). Alternatively, individuals who consume more fruits and vegetables may have healthier lifestyle behaviours (e.g. regular exercise and lower levels of smoking) that decrease the risk of cardiovascular disease (Bazzano et al., 2002; Dauchet et al., 2006). However, prospective cohort studies have demonstrated inverse relationships between the risk of cardiovascular disease and fruit and vegetable intake after controlling for BMI, smoking, alcohol consumption, physical activity, blood pressure and socio-demographic factors (Bazzano et al., 2002; Crowe et al., 2011). These findings suggest that while the
exact mechanisms are not known, increasing fruit and vegetable consumption is an important strategy in decreasing mortality from cardiovascular disease, independent of other health behaviours.

1.1.2 Fruit and Vegetable Consumption and Cancer

In addition to cardiovascular disease, higher levels of fruit and vegetable consumption have been linked to a lower risk of developing certain cancers. Fourteen percent of gastrointestinal cancer deaths worldwide have been attributed to inadequate fruit and vegetable consumption (WHO, 2009). Epidemiological research suggests that higher levels of fruit and vegetable consumption are associated with a lower risk of developing lung, stomach and oral cancers (Riboli & Norat, 2003; Steinmetz & Potter, 1991).

However, it is unclear if the protective effects extend to those with a balanced diet, as the greatest benefit has been demonstrated among individuals who consume the least amount of fruits and vegetables, or have anti-oxidant deficiencies (Hung et al., 2004; Key, 2011; Terry, Terry, & Wolk, 2001). Similar to cardiovascular disease, the causal mechanisms behind the relationship between fruit and vegetable consumption and cancer risks are unknown. The vitamins and anti-oxidants found in, but not exclusive to, fruit and vegetable consumption have been hypothesized as the mechanism for the protective effect against cancer (Terry et al., 2001). However, a review of research using artificial doses of single-vitamins (e.g. Vitamin C) on cancer risk suggested no protective benefit (Stanner, Hughes, Kelly, & Buttriss, 2004). This suggests that vitamins alone may not be responsible for the protective effect, and that there may be properties unique to whole fruits and vegetables that can protect against cancer. Additionally, the form of fruits and vegetables (i.e. raw versus cooked/preserved) has been hypothesized as an important factor in their protective benefit (Steinmetz & Potter,
Further research is needed to test these hypotheses and explore the causal mechanisms by which fruit and vegetables protect against cancer risk and mortality.

1.1.3 Fruit and Vegetable Consumption and Mental Health

Adequate fruit and vegetable consumption may provide psychological benefits. For example, higher levels of fruit and vegetable consumption have been associated with lower levels of stress (Roohafza et al., 2007; Unusan, 2006). Furthermore, diary studies have suggested that eating 7-8 servings of fruit and vegetables per day can have a positive effect on mood (White, Horwath, & Conner, 2013), and high levels of fruit and vegetable consumption may lead to increases in curiosity and creativity (T. S. Conner, Brookie, Richardson, & Polak, 2015). However, the research examining direct links between fruit and vegetable consumption and mental health is currently limited and these findings should be considered cautiously. Reducing stress and increasing positive affect are important in improving an individuals’ mental health. If increasing fruit and vegetable consumption improves positive affect and reduces stress, then such increases should be encouraged.

1.2 Predictors of Fruit and Vegetable Consumption

Given the protective benefits of fruit and vegetable consumption on chronic illness, researchers have examined predictors of fruit and vegetable intake in order to promote their consumption. In relation to energy-balance behaviours (e.g. fruit and vegetable consumption), the physical, social, and economic environments have been identified as important determinants of behaviour. However, the influence of these environmental predictors may be moderated through psychological factors (Australian Institute of Health and Welfare, 2012; Caspi, Sorensen, Subramanian, & Kawachi, 2012; Kremers et al., 2006; Larson & Story, 2009). The following section will briefly examine the impact of ‘food deserts’, socio-demographic, economic and psychological predictors of
fruit and vegetable consumption. Psychological predictors will be examined in detail in Chapter 2.

### 1.2.1 Food Deserts

Food deserts are geographic areas where affordable and healthy foods are difficult to obtain. Individuals that live within ‘food deserts’ have been suggested to have poorer diets and health outcomes than those with easier access to grocers and nutritious foods (Acheson, 1998). For example, in Detroit, individuals living in areas without ready access to fresh grocers were more likely to suffer or die prematurely from diet-related disease (e.g. cardiovascular disease and cancer), even after controlling for income, education and race (Mari Gallagher Research & Consulting Group, 2007). While food deserts need to be considered when designing urban foodscapes, no consistent relationship between fruit and vegetable consumption and food deserts has been demonstrated (Beaulac, Kristjansson, & Cummins, 2009; Cummins & Macintyre, 2002; Lucan, Hillier, Schechter, & Glanz, 2014; O'Dwyer & Coveney, 2006; T. Pearson, Russell, Campbell, & Barker, 2005; Winkler, Turrell, & Patterson, 2006). In Australia, fruit and vegetable consumption does not appear to vary greatly by geographic location (Australian Institute of Health and Welfare, 2012). That is, the proportion of individuals who do not meet the fruit and vegetable consumption guidelines are similar between major city, inner-regional and other geographic locations. When considered together, these findings suggest that while food deserts may impact upon the quality of an individual’s diet, policies and interventions designed to improve fruit and vegetable consumption specifically may benefit from targeting different predictors, e.g. socio-cultural factors (T. Pearson et al., 2005).
Chapter One: General Introduction

1.2.2 Socio-demographic Factors

Improving the social environment can be effective in promoting fruit and vegetable consumption (European Food Information Council, 2012; T. Pearson et al., 2005). For example, improving the education level of a society may lead to healthier dietary behaviours. Previous research has demonstrated that individuals with post-secondary education purchased greater quantities of fruit and vegetables independent of income and household size (Ricciuto, Tarasuk, & Yatchew, 2006). Family factors and social support also play a substantial role in fruit and vegetable consumption for both children and young adults (Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008). For example, married men tend to consume more fruits and vegetables than unmarried men do (Friel, Newell, & Kelleher, 2005; Kamphuis, van Lenthe, Giskes, Brug, & Mackenbach, 2007). Furthermore, children are more likely to eat fruits and vegetables if their parents do too (Cooke et al., 2004).

In addition to social factors, demographic predictors of fruit and vegetable consumption have been identified. For example, women report consuming more fruit and vegetables than men (Bere, Brug, & Klepp, 2008). However, within the Australian context, vegetable consumption does not seem to differ between the genders (Australian Institute of Health and Welfare, 2012). Age may also affect fruit and vegetable consumption. European research has demonstrated a decline in fruit and vegetable consumption between early childhood to adolescence, with an increase in consumption occurring between early-to-late adulthood (Elfhag, Tholin, & Rasmussen, 2008; Rasmussen et al., 2006). Similarly, in Australia, young adults have the lowest reported fruit and vegetable intake (Australian Bureau of Statistics, 2013). This suggests that research designed to improve fruit and vegetable consumption should consider the age of the target group and the social environment in which the intervention is applied.
While, social and demographic predictors are important to consider in evaluating fruit and vegetable interventions, public health strategies should be designed to target modifiable predictors. Intervention evaluations should consider age, gender and education in their design. However, as they are non-modifiable predictors, researchers should also consider the impact of economic and psychological predictors on fruit and vegetable consumption.

1.2.3 Economic Factors

The economic environment has also been identified as a predictor of fruit and vegetable consumption. Qualitative research into processes that are involved in food selection indicates that the perceived price of healthy foods made eating a nutritious diet difficult (Waterlander, de Mul, Schuit, Seidell, & Steenhuis, 2010). This finding has been replicated in research on fruit and vegetable consumption, with perceived cost being consistently identified as a barrier for consumption (Glasson, Chapman, & James, 2011; Kamphuis et al., 2007; Pollard, Miller, Woodman, Meng, & Binns, 2009). Additionally, empirical research utilising virtual supermarkets has demonstrated that subsidising the costs of nutritious foods by up to 50% results in an increase in fruit and vegetable purchases (Waterlander, Steenhuis, de Boer, Schuit, & Seidell, 2012a, 2012b). Furthermore, when this strategy was applied to real supermarkets, an increase in fruit and vegetable purchases and consumption was demonstrated (Waterlander, de Boer, Schuit, Seidell, & Steenhuis, 2013).

Collectively, these findings suggest that subsidising the cost of fruits and vegetables can be an effective strategy in promoting purchasing and consumption behaviours. However, the implementation and administrative costs of food-pricing interventions require further examination (Wall, Mhurchu, Blakely, Rodgers, & Wilton, 2006; Waterlander et al., 2013). These interventions may be difficult to incorporate on a
large scale, as they require the cooperation of supermarkets and grocers to be effective. Waterlander et al. (2013) suggest that food-pricing strategies may be more impactful when combined with nutrition education interventions. While food-pricing policies and interventions can be effective in changing fruit and vegetable consumption behaviours, there is still a need to evaluate the cost-effectiveness of these interventions on a large scale. Additionally, predictors including nutrition knowledge and attitudes should be considered in order to strengthen the effectiveness of food-pricing interventions.

1.2.4 Psychological Predictors

Multiple psychological predictors of fruit and vegetable consumption have been identified within the literature. A recent review found strong support for knowledge and self-efficacy, and moderate support for intentions, attitudes and beliefs as predictors of fruit and vegetable consumption (Shaikh et al., 2008). That is, the more knowledgeable and confident an individual is about preparing fruit and vegetables, the more likely he/she is to consume larger quantities of fruit and vegetables. Psychological theories that incorporate these processes, e.g. The Theory of Planned Behavior (Ajzen, 1991), have accounted for approximately 30% of the variance in dietary behaviours (Baranowski, Cullen, & Baranowski, 1999; Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). Furthermore, interventions guided by these processes have been cost-effective and led to modest changes in fruit and vegetable consumption (Kothe, Mullan, & Butow, 2012; Thomson & Ravia, 2011). However, there are some individuals who do not act in accordance with their knowledge and intentions (Sheeran, 2002; Webb & Sheeran, 2006). For these individuals, incorporating habitual processes may improve the effectiveness of these interventions.

Dual-processing models of behaviour examine cognitive psychological processes alongside habitual and automatic processes (Chen & Chaiken, 1999; M.
Conner & Armitage, 1998; Gibbons, Houlihan, & Gerrard, 2009; Kremers et al., 2006). However, research into the habitual predictors of fruit and vegetable consumption has been limited. Current habit measures have been criticized for incorporating processes of behavioural frequency that may conflate their relationship with measures of current behaviour (Gardner, Abraham, Lally, & de Bruijn, 2012a, 2012b; Sniehotta & Presseau, 2012). Additionally, researchers have proposed that current habit measures are incomplete and should consider additional processes including the routinisation and the strength of stimulus-response bonds in predicting health behaviours (Grove, Jackson, Longbottom, & Medic, 2013; Grove & Zillich, 2003; Grove, Zillich, & Medic, 2014; Hashim, Golok, & Ali, 2011; Hashim, Jawis, Wahat, & Grove, 2013). Lastly, research from the habit domain has not been adequately translated into health promotion interventions. Researchers have recommended that habit-based behavioural interventions should focus on controlling food cues, giving healthful primes, developing implementation intentions and encouraging the repeated and consistent performance of healthful responses (Rothman, Sheeran, & Wood, 2009). However, habit-based informational interventions have not been utilized to improve fruit and vegetable consumption in adults.

1.3 Summary

Adequate fruit and vegetable consumption has been associated with psychological and physical health benefits. However, Australian adults do not consume the recommended amount of fruit and vegetables. Given the economic impact of chronic illness in Australia, increasing fruit and vegetable consumption is an important priority for a healthier society and a sustainable health care system. Public health interventions should consider strategies that are cost-effective and target modifiable processes. While demographic and economic factors (e.g. cost and gender) have been associated with
fruit and vegetable consumption, these factors are either unmodifiable or resistant to cost-effective alterations. On the other hand, interventions that target psychological processes are cost-effective and hold promise for implementation on a population scale.

Existing research into psychological processes has adopted a restricted focus on conscious processes (e.g. knowledge and intention) at the expense of automatic, habitual processes. There is therefore a need to develop measures of habitual processes and examine their relationships with fruit and vegetable consumption. Additionally, the utility of a habit-based framework in improving fruit and vegetable consumption needs to be examined.

1.4 Thesis Overview

Broadly, the present thesis aimed to develop multi-process measures of fruit and vegetable consumption habits and examine the contribution of these measures alongside pre-existing measures of cognitive processes (e.g. intentions and attitudes) in predicting fruit and vegetable consumption and changing consumption behaviour in young adults. More specifically, the study aimed to: (i) assess a four-process habit measure for combined fruit consumption and vegetable consumption, based on a pre-existing aerobic exercise habit measure in the field, (ii) examine whether multi-process habit measures predicted variance in fruit and vegetable consumption above and beyond cognitive processes (e.g. intentions and attitudes), and (iii) examine whether an informational intervention based on the multi-process habit framework could improve fruit and vegetable consumption in young adults.

To address these aims, four studies were conducted and are presented in the format of journal-article manuscripts. Studies one and two (Chapter 3) aimed to develop a multi-process fruit and vegetable habit measure and evaluate the relationships between the subscales with current and past fruit and vegetable consumption behaviours. Study
three (Chapter 4) examined the predictive validity of the multi-process habit measure by examining fruit and vegetable consumption habits alongside measures of cognitive processes. Study four (Chapter 5) aimed to examine the effectiveness of a habit-based informational intervention in improving fruit and vegetable consumption. The results of this study have been published (Rompotis, Grove, & Byrne, 2014).

This thesis contributes to the body of literature by providing information that can be used to measure fruit and vegetable consumption habits, and provides strategies for use in the design of habit-based informational interventions to increase fruit and vegetable consumption in young adults. The current research is significant in that it:

(i) examined a multi-process habit framework that assessed automaticity, response patterning (routinisation), stimulus-response bonds and negative affect for non-consumption.

(ii) examined fruit consumption and vegetable consumption habits separately. By assessing the behaviours separately, researchers can have an improved understanding of the differential impacts of cognitive and habitual processes on consumption.

(iii) examined the effectiveness of an informational intervention based upon the multi-process habit framework. This is important, as the utility of the framework has been assessed in addition to the predictive validity.

These findings can help identify key predictors of fruit and vegetable consumption and identify processes that should be targeted in order to increase fruit and vegetable consumption. Such strategies may lead to improved levels of fruit and vegetable consumption in young adults, and over time, reduce the burden of chronic illness and economic costs associated with insufficient levels of fruit and vegetable consumption.
2 Literature Review
Chapter Two: Literature Review

2.0 Foreword

This section of the thesis will provide an overview of the psychological processes and behaviour-change models that have been used in the literature to predict fruit and vegetable consumption in adults. This section will also briefly outline the limitations of current models of health behaviour in predicting fruit and vegetable consumption. These limitations will inform the research questions that this thesis aims to address.
2.1 Predictors of Fruit and Vegetable Consumption

Understanding the predictors of fruit and vegetable consumption is important for developing effective behaviour-change interventions. Psychological processes are modifiable, and targeting these may assist researchers and policy makers in designing cost-effective fruit and vegetable consumption interventions. For example, knowledge of fruit and vegetable consumption guidelines has been considered a strong predictor of fruit and vegetable consumption (Guillaumie, Godin, & Vézina-Im, 2010; Shaikh et al., 2008). This finding has led to the development of health campaigns that promote the recommended daily servings of fruit and vegetables to maintain good health (Rekhy & McConchie, 2014). For example, the Western Australian Health Department’s ‘Go for 2&5®’ social marketing campaign has been successful in increasing knowledge of fruit and vegetable guidelines, and led to a subsequent increase in vegetable consumption (Pollard et al., 2008). However, increasing the knowledge of fruit and vegetable guidelines may not be sufficient for changing consumption to meet current recommendations (Bandura, 1998; Rekhy & McConchie, 2014). Despite the increased awareness of fruit and vegetable consumption guidelines, only 48.5% of Australian adults reported consuming 2 or more serves of fruit each day, and only 8.2% reported consuming 5 or more serves of vegetables each day in 2011-2012 (Australian Bureau of Statistics, 2013). An evaluation of additional psychological processes may help extend current campaigns and behaviour-change interventions that promote fruit and vegetable consumption.

An extensive body of research into the predictors of fruit and vegetable consumption has been conducted, with a recent review identifying 25 psychological predictors of consumption (Shaikh et al., 2008). However, examining up to 25 psychological predictors at a time is costly and time consuming. Limiting research to a
small number of the strongest predictors is likely to enable the design of cost-effective research and intervention strategies. Reviews of the psychological predictors of fruit and vegetable consumption have identified the strongest support for attitudes, self-efficacy, social support and habit (Guillaumie et al., 2010; Shaikh et al., 2008). Furthermore, moderate support has been demonstrated for intention and stages-of-change (Shaikh et al., 2008). Utilising theories that encompass these processes is likely to enable researchers to best predict fruit and vegetable consumption and guide behavioural interventions.

2.2 Models of Health Behaviours

Understanding determinants of behaviour, and the processes that underlie behaviour change, is essential to public health research (Noar & Zimmerman, 2005). Research in the health literature has focussed on four behavioural models of behaviour-change: (i) Health Belief Model, (ii) Transtheoretical Model, (iii) Social Cognitive Theory, and (iv) Theory of Planned Behavior (Nigg, Allegrante, & Ory, 2002; Noar & Mehrotra, 2011; Noar & Zimmerman, 2005). These models examine the cognitive and reasoned predictors of health behaviours. However, they do not account for the habitual nature of repeated health behaviours. To address this limitation, additional models of habitual behaviour, and dual-processing models that include cognitive and habitual processes have been proposed. The current section provides an overview of health behaviour theories, with a focus of their ability to predict and improve fruit and vegetable consumption.

2.2.1 Health Belief Model

The Health Belief Model was developed to explain circumstances under which individuals participate in preventative health behaviours, e.g. vaccination against influenza (Rosenstock, 1974). The model proposes that the perceived susceptibility of
an illness, and the consequences of becoming ill, are the primary considerations for adopting preventative health behaviours (Rosenstock, 1966). Specifically, individuals who perceive that they are at risk of an illness of which the consequences are severe, and consider particular health behaviours to be preventative of that illness, are more likely to undertake preventative action. Conversely, individuals who perceive that they are at a low risk of becoming ill are unlikely to be motivated in adopting new health behaviours. In addition to perceived susceptibility and consequences, individuals assess the perceived benefits and barriers to changing their behaviour (Rosenstock, 1966). If the benefits of adopting new health behaviours are considered fewer than the costs of perceived barriers, individuals may be unmotivated to change their behaviour, irrespective of perceived illness susceptibility.

The Health Belief Model has only been found to predict a small amount of variance in the adoption of preventative behaviours. For example, early studies of the Health Belief Model's constructs accounted for up to 9% of the variance in behaviours such as seat-belt use, flu vaccination and weight-loss (Harrison, Mullen, & Green, 1992). Furthermore, only the constructs of perceived susceptibility, barriers and benefits were related to preventative behaviours. A recent review supported these findings, suggesting that benefits and barriers were consistent predictors of behaviour, while perceived severity and susceptibility had no consistent relationship with behaviour (Carpenter, 2010). Given these findings, modelling the perceived benefits and costs of undertaking preventative behaviours may be more parsimonious than evaluating all four of the Health Belief Model’s constructs.

Limited research has examined the relationships between fruit and vegetable consumption and constructs from the Health Belief Model (Dittus, Hillers, & Beerman, 1995). Findings from these studies have demonstrated that constructs from the Health
Belief Model only accounted for approximately 16% of the variance in consumption (Dittus et al., 1995; Guillaumie et al., 2010). Given these findings, an examination of alternative behavioural models is required in order to account for additional variance in fruit and vegetable consumption.

2.2.2 Transtheoretical Model

The Transtheoretical Model proposes that individuals progress through a series of five stages in their readiness for behaviour change (Laforge, Greene, & Prochaska, 1994; J. O. Prochaska & Diclemente, 1984; Velicer, Rossi, Prochaska, & Diclemente, 1996). Three of these stages identify individuals who are not yet performing a desired behaviour and; (i) do not intend to change their current behaviour in the next six months (pre-contemplation), (ii) intend to change their current behaviour in the next six months (contemplation), or (iii) are taking steps to change their current behaviour but have not reached their desired goal yet (preparation). The final two stages identify individuals that are performing a desired behaviour but, (iv) have done so for less than six months (action), or (v) have maintained the behaviour for more than six months (maintenance).

In order to progress through all of the stages, the model incorporates ten processes of change (e.g. consciousness raising and reinforcement management) that are modifiable (J. O. Prochaska & Diclemente, 1984; J. O. Prochaska et al., 1994; Velicer et al., 1996). Furthermore, it has been hypothesised that tailoring these processes to the participants’ current stage will result in an increased readiness-to-change and overall behavioural performance. For example, pre-contemplators should move towards contemplation if they are made aware of the benefits of performing a health behaviour, while those in the action stage are already likely to be aware of associated health benefits. Conversely, increasing positive rewards for performing a health behaviour is
likely to increase the frequency of that behaviour for those already making preparatory changes than those who have not considered performing the behaviour.

Use of the Transtheoretical Model in predicting fruit and vegetable consumption has demonstrated that individuals in the action and maintenance stages-of-change consume more fruits and vegetables, and have higher self-efficacy and perceived benefits of consumption, than those in the pre-contemplation, contemplation and preparation stages (Chee Yen, Mohd Shariff, Kandiah, & Mohd Taib, 2014; Horwath, Nigg, Motl, Wong, & Dishman, 2010; Van Duyn et al., 1998). The stage-of-change construct of the Transtheoretical Model may therefore predict consumption habits and the strength of cognitive processes such as self-efficacy.

While the Transtheoretical Model has been effective in predicting behaviour, the hypothesised utility of the model in guiding behaviour change interventions has not been supported. Recent reviews of Transtheoretical Model-based interventions suggest that they are equally effective in changing behaviour when compared to non-stage based interventions or experimental controls (Bridle et al., 2005; Prestwich et al., 2014). This suggests that incorporating components from the Transtheoretical Model into pre-existing public health interventions may not improve their overall effectiveness (Prestwich et al., 2014). Alternate models of behaviour change may therefore need to be examined in order to inform fruit and vegetable consumption interventions.

2.2.3 Social Cognitive Theory

Social Cognitive Theory was developed to examine the socio-structural and personal determinants of behaviour, including health promotion (Bandura, 1986, 1998). Social Cognitive Theory proposes that motivation, perceived self-efficacy, perceived social reactions and cultural factors all affect the likelihood that an individual will change his/her behaviour (Bandura, 1998). For example, individuals are more likely to perform
behaviours when they believe that: (i) they have the physical capability to do so, (ii) others have confidence in their ability, and (iii) the wider physical environment enables them to do so. Given the Social Cognitive framework, individuals can improve target behaviours by reinforcing successful experiences, organising themselves in groups to receive social support, and by undertaking training to develop skills to commence or maintain their behaviour (Spahn et al., 2010).

Social Cognitive Theory has been successful in examining fruit and vegetable consumption. A review of studies testing Social Cognitive Theory found that the model accounted for 41% of the variance in combined fruit and vegetable consumption (Guillaumie et al., 2010). Furthermore, the review concluded that Social Cognitive Theory predicted a significantly greater amount of variance in combined fruit and vegetable consumption than the Health Belief Model. These findings suggest that Social Cognitive Theory may form a useful model for predicting fruit and vegetable consumption.

Despite the proposed effectiveness of the Social Cognitive Theory in modelling fruit and vegetable consumption, few dietary interventions based on the model’s constructs have been conducted. Of the limited research that has been conducted, the impact of interventions in driving behaviour change has been inconsistent (Burke, Dunbar-Jacob, Orchard, & Sereika, 2005; Glasgow, Toobert, Mitchell, Donnelly, & Calder, 1989; Spahn et al., 2010). Furthermore, there is little evidence that interventions modelled on Social Cognitive Theory are more effective than interventions with no explicit theoretical basis in improving dietary behaviours (Prestwich et al., 2014). While further research is needed to determine the utility of the model in changing behaviour, previous research suggests that Social Cognitive Theory may be of limited value for improving existing dietary interventions.
In addition to the limited evidence for the use of Social Cognitive Theory to guide nutrition interventions, few of the model’s constructs have been associated with fruit and vegetable consumption. For example, while self-efficacy and motivation have been consistently related to higher levels of fruit and vegetable consumption, limited support exists for the relationship between social expectations and consumption (Guillaumie et al., 2010). Models with fewer constructs (e.g. Theory of Planned Behavior) have accounted for similar amounts of variance in fruit and vegetable consumption (Guillaumie et al., 2010). Given these findings, the Theory of Planned Behavior may be a more appropriate framework to predict fruit and vegetable consumption and model behaviour-change interventions.

2.2.4 Theory of Planned Behavior

The Theory of Planned Behaviour posits that intention (or how hard individuals are willing to try to perform a behaviour) directly predicts behaviour (Ajzen, 1991). Intention, in turn, is predicted by an individual’s attitude, perception of social norms and perceived behavioural control (Ajzen, 1991). Individuals that like the taste of fruit and vegetables, and perceive that fruit and vegetable consumption is encouraged by society, are hypothesised to intend to consume fruit and vegetables, as long as they perceive that they have the ability to do so. However, perceived behavioural control is also hypothesised to directly predict behaviour and bypass intention in situations where the behaviour is considered outside of the individual’s ability (Ajzen, 1991). If an individual has favourable attitudes and social expectations, but perceives vegetables as difficult to prepare, then they may not act upon their intention to consume vegetables.

The Theory of Planned Behavior has been widely used in the field of health behaviour and has been successful in modelling fruit and vegetable consumption. A recent review concluded that attitudes, perceived social norms and perceived
behavioural control accounted for 41% of the variance in fruit and vegetable consumption intentions, and the overall model accounted for 45% of the variance in combined fruit and vegetable consumption (Guillaumie et al., 2010). This means that the Theory of Planned Behavior is the top behavioural model that accounts for the most variance in fruit and vegetable consumption.

Despite the strength of the model in predicting fruit and vegetable consumption, interventions utilising the Theory of Planned Behavior to change consumption have been limited and have produced mixed findings (Hardeman et al., 2002; Sniehotta, Presseau, & Araújo-Soares, 2013). For example, a 30-day email intervention based on the Theory of Planned Behavior was successful in increasing fruit and vegetable consumption in young adults (Kothe et al., 2012). However, when a control group was included, the intervention did not result in changes greater than the controls (Kothe & Mullan, 2014). The researchers concluded that the use of interventions based on the Theory of Planned Behavior to change fruit and vegetable consumption behaviours was not supported for young adults (Kothe & Mullan, 2014).

The Theory of Planned Behavior has also been criticised for the predictive validity of its constructs. Intentions and perceived behavioural control have been demonstrated to consistently predict behaviour (McEachan, Conner, Taylor, & Lawton, 2011; Sniehotta et al., 2013), however, perceived social norms have been inconsistent in their ability to predict intentions (Guillaumie et al., 2010). Additionally, the Theory of Planned Behavior has an identifiable intention-behaviour ‘gap’. That is, there are individuals who form strong intentions to perform behaviours but do not enact them even when they perceive that they have the ability to do so (Hardeman et al., 2002; Sheeran, 2002; Sniehotta et al., 2013). In order to account for this gap, the consideration
of automatic and habitual processes of behaviour has been proposed (Collins & Mullan, 2011; Sheeran, 2002).

2.2.5 Habit

The term ‘habit’ has colloquially been used to refer to frequently performed behaviours. However, this definition of ‘habit’ does not provide any explanation as to why some behaviours are frequently performed and is not conducive to the promotion of health behaviours (Gardner, 2015b; Maddux, 1997). Researchers have developed conceptions of ‘habit’ that describes a process in which behaviours are enacted with minimal conscious thought when triggered by associated environmental cues (Maddux, 1997; Ouellette & Wood, 1998; Verplanken, 2006). These features of habitual behaviour provide a framework in which to examine why some behaviours are repeatedly performed. However, research has indicated that habitual behaviours can be inhibited given sufficient self-regulatory resources (Gardner, 2015b; Neal, Wood, & Drolet, 2013), suggesting that habits do not always result in subsequent action. Gardner (2015b) addresses this concern by defining habit as a, “process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations” (p. 280). While there is some debate over whether habit should be defined in relationship to ‘impulse’ (Orbell & Verplanken, 2015), the definition proposed by Gardner (2015b) has been considered a substantive representation of the elements that constitute habitual behaviour (Gardner, 2015a; Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Labrecque & Wood, 2015).

Habits can be involved in the initiation of behaviours (i.e. the behaviour is performed in response to an impulse but requires cognitive effort to perform) and the performance of subsequent action (i.e. the performance of behaviours are enabled and sustained by habit impulses irrespective of whether an impulse initiated the behaviour).
The distinction of processes involved in the initiation and performance of habits may enable researchers to understand the role of habit in health behaviours (e.g. fruit and vegetable consumption) and guide the development of habit-based interventions (Gardner, 2015a, 2015b; Hagger et al., 2015; Lally & Gardner, 2011). Research investigating the initiation and performance of habitual behaviours has identified four main elements: (i) automaticity, (ii) stimulus-response bonds, (iii) patterned response, and (iv) negative psychological consequences for non-performance (Grove et al., 2013; Grove et al., 2014). These processes are examined in relationship to nutritional behaviours below.

Automaticity has been considered the ‘key ingredient’ of habitual behaviours (Gardner, Abraham, et al., 2012b; Gardner & Tang, 2014; Grove et al., 2014). Highly automated impulses to action are considered to be efficient, uncontrollable, unintentional and performed in an unaware manner (Bargh, 1994). Two proposed consequences of automatically generated impulses to action are that they place fewer demands on cognitive capacity, and can bypass conscious intentions unless sufficiently opposed (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977; Wood, Quinn, & Kashy, 2002). These consequences have been demonstrated with nutritional behaviours (including fruit consumption), such that repeatedly eating a piece of fruit for lunch each day, over a number of repetitions, resulted in stronger self-reported automaticity (Lally, van Jaarsveld, Potts, & Wardle, 2010). Additionally, self-reported automaticity has been shown to moderate the intention-behaviour gap (Gardner, Abraham, et al., 2012b). That is, when individuals felt that their impulse to consume fruit was highly automated, their conscious intention to consume fruit was a weaker predictor of its subsequent consumption.
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The development of strong stimulus-response bonds has been considered as another core component of establishing impulses to action (Grove et al., 2013; Grove et al., 2014; Verplanken & Aarts, 1999). Impulses to action are established by repeatedly pairing the successful execution of a behaviour with consistent environmental cues (Verplanken & Aarts, 1999; Verplanken & Orbell, 2003). When this process has been repeated sufficiently, encountering associated cues are proposed to trigger the impulse to initiate or perform the behaviour spontaneously and without conscious awareness (Neal, Wood, & Quinn, 2006; Verplanken & Orbell, 2003). Research has demonstrated that this impulse to action can overcome opposing motivational influences, such as the enjoyment of food. Neal, Wood, Wu, and Kurlander (2011) found that habitual popcorn eaters consumed similar amounts of stale and fresh popcorn in a context-consistent setting (e.g. cinema), despite reporting a lower liking of the stale popcorn. However, when the behaviour was enacted in a context-inconsistent setting (e.g. meeting room), the habitual popcorn eaters consumed significantly less stale than fresh popcorn. Given these findings it worth considering the contexts and situations in which fruits and vegetables are commonly consumed in order to examine how these stimulus-response bonds predict their subsequent consumption.

Habitual impulses have been described as schematic representations of action (Gardner, 2015b) and are consistent with social psychological research (e.g. action slips and heuristic modelling) which suggests that actions can become automated to such an extent that they tend to follow predictable scripts in which events in an action sequence guides subsequent action components if left unopposed (Ewart, 1991; Gardner, 2015b; Grove et al., 2014; Ronis, Yates, & Kirscht, 1989). That is, once automated, habitual behaviours tend to be performed in the same way, in the same place and at the same time unless the action sequence is interfered with (M. Conner, Norman, & Bell, 2002;
van't Riet, Sijtsema, Dagevos, & de Bruijn, 2011). This schematic representation has been supported in relationship to nutrition behaviours. Habitual popcorn eaters have been shown to bypass motivational influences (e.g. taste) when the action sequence of their consumption was left unaltered (Neal et al., 2011). However, when they were forced to eat with their non-dominant hand (i.e. effectively interfering with their action sequence), habitual popcorn eaters consumed less stale than fresh popcorn, even when they were within a context-consistent setting (e.g. cinema). Given the role of response patterning in initiating and maintaining habitual nutrition behaviours, it may therefore be beneficial to examine the role that the location, time and structure of fruit and vegetable behaviours has on their consumption.

Additionally, researchers have proposed that habitual behaviours are linked to psychological well-being, with a failure to enact these behaviours resulting in negative psychological consequences (DeCaro & Worthman, 2011; Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Luo & Cooper, 1990). Custers and Aarts (2005) suggested that the unconscious desire to complete tasks, even if mundane (e.g. completing a puzzle) can be initiated by associating them with positively framed words (e.g. good, pleasant and enjoyable). If these positive associations become implicit towards a behaviour then it may be performed regularly and initiated automatically in the future to achieve positive mood states. This has been demonstrated in relationship to fruit and vegetables where individuals with strong positive implicit associations towards consuming fruit (e.g. pleasant, happiness) reported consuming larger quantities of fruit and had stronger self-reported automaticity in relationship to their consumption than those with weak positive implicit associations (de Bruijn, Keer, Conner, & Rhodes, 2012). Consequently, the failure to enact upon these unconsciously motivated impulses may result in negative affect. Fruit and vegetable intervention studies have
demonstrated that higher levels of anticipated regret for failing to eat fruits and vegetables predicted significant increases in fruit and vegetable consumption (Kellar & Abraham, 2005; Steptoe, Perkins-Porras, Rink, Hilton, & Cappuccio, 2004). If additional associations such as health and meal satisfaction are implicit to fruit and vegetable consumption, then perhaps the inability to perform these behaviours will result in negative affective states (e.g. feeling unhealthy or sick).

On a practical level, strategies based on these habit processes have resulted in positive changes in nutrition behaviours. For example, an informational intervention that incorporated a habit-based strategies, resulted in significantly more weight-loss after 8 weeks than a control group (Lally, Chipperfield, & Wardle, 2008). Similarly, a telephone-based intervention that included strategies to increase meal routinisation, resulted in increased fruit and vegetable consumption 18 months post-intervention (Fletcher et al., 2013; Wyse, Campbell, Brennan, & Wolfenden, 2014). These findings indicate that designing interventions that include habit formation principles may be an effective way to increase fruit and vegetable consumption.

Despite the relationships between these habit processes and fruit and vegetable consumption, few health behaviours may truly be entirely habitual (Maddux, 1997). That is, while stimuli in the environment can automatically trigger impulses to action that lead to behaviour, there is still some level of awareness of the behaviour being initiated. Therefore, models of behaviour that account for the extent to which health behaviours (such as fruit and vegetable consumption) are influenced by conscious and habitual processes may enable researchers to better predict consumption behaviours and guide behaviour-change interventions (Sheeran, Gollwitzer, & Bargh, 2013).
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2.2.6 Dual-processing Theory

Dual-processing models propose that information can be processed through an automated system that is efficient and requires minimal attention, or a controlled system that is resource intensive and requires large amounts of attention (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). In terms of health behaviour, dual-processing models propose that interactions between reasoned cognitive processes (e.g. intentions and risk perceptions) and nonconscious implicit processes (e.g. habits) predict behaviour more comprehensively than cognitive or implicit models individually (Ronis et al., 1989; Sheeran et al., 2013). If dual-processing models better account for health behaviours, then research incorporating habit constructs alongside cognitive theories (e.g. Theory of Planned Behavior) should predict significantly more variance in fruit and vegetable consumption than cognitive theories alone.

Research has supported the use of dual-processing frameworks for predicting fruit consumption, with habit strength contributing additional variance in consumption over and above predictors from the Theory of Planned Behavior (Brug, de Vet, de Nooijer, & Verplanken, 2006). Furthermore, habit strength has been shown to moderate the intention-behaviour relationship, such that when individuals have weak consumption habits, intention is a stronger predictor of consumption (de Bruijn, 2010; de Bruijn et al., 2007; Menozzi & Mora, 2012), however, when individuals have strong consumption habits, intention is no longer a significant predictor of fruit consumption. The relative contribution of each pathway should therefore be considered when investigating factors that affect fruit and vegetable consumption.

2.3 Limitations

Despite the relationships between psychological factors and fruit and vegetable consumption, reviews in this area have identified limitations of previous research. These
limitations include: (i) incomplete measures of habitual behaviour, (ii) a lack of studies examining how psychological predictors relate to fruit and vegetable consumption separately, and (iii) a lack of experimental research utilising habit-based frameworks.

2.3.1 Issues with Habit Measures

Previous research has used past behavioural frequency as a proxy for habit strength (Neal et al., 2011; Ouellette & Wood, 1998). However, assessing past behaviour does not examine the underlying processes that predict and drive behaviour change. As habitual behaviours include additional features such as automaticity, response patterning (routinisation), and strong stimulus-response bonds, measures that tap into these constructs are likely to produce a comprehensive and theoretically sound examination of habit strength. To address the limitations of measures of past behavioural frequency, the Self Report Habit Index has incorporated additional items that assess behavioural automaticity and self-identity (Verplanken & Orbell, 2003). The Self Report Habit Index has demonstrated a high level of internal consistency and studies using the measure have demonstrated strong correlations between habit strength and nutrition behaviours (Gardner, de Bruijn, & Lally, 2011). However, the measure has been criticised for including items of past behavioural frequency, which may conflate correlations with measures of current behavioural frequency, and for incorporating items of self-identity which may not be important for developing habitual behaviours (Gardner, Abraham, et al., 2012a; Gardner, de Bruijn, & Lally, 2012; Sniehotta & Presseau, 2012). Additionally, an automaticity subscale (the Self Report Behavioral Automaticity Index) has been shown to be a parsimonious and valid alternative to the Self Report Habit Index (Gardner, Abraham, et al., 2012b). However, these measures have not incorporated items examining other features of habitual behavior (i.e. strength...
of stimulus-response bonds, routinisation of the behaviour, and the negative psychological affect associated with failing to perform habitual behaviours).

In the exercise domain, measures of habit strength have addressed these limitations by incorporating contextual cueing alongside automaticity (Tappe & Glanz, 2013), or examining a four-process habit framework that incorporates automaticity, strength of stimulus-response bonds, routinisation of exercise and negative affect for exercise non-performance (Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). While the relationship between the strength of stimulus-response bonds and exercise behaviour has been inconsistent (Grove et al., 2014; Tappe & Glanz, 2013), routinisation of exercise, automaticity, and negative affect for non-performance have been significantly correlated with exercise frequency, intensity and duration (Grove et al., 2014; Tappe & Glanz, 2013). Incorporating additional processes alongside automaticity into a measure may help to further our understanding of the habitual processes involved in health behaviours, however, no measures to date have examined a four-process habit framework in predicting fruit and vegetable consumption. Given previous research linking the four habit-processes to fruit and vegetable consumption (see Section 2.2.5), we believe that an investigation of a multi-process habit measure for fruit and vegetable consumption is warranted.

A further criticism of previous habit measures has been their reliance on self-report. Self-report measures of habit (e.g. the SRHI and SRBAI) requires individuals to report on inaccessible aspects of performance outside of their conscious awareness (Hagger et al., 2015; Labrecque & Wood, 2015). It has been suggested that self-report habit measures likely reflect inferences about one’s behaviour based on the consequences of the habit (e.g. fruit consumption habit inferred from an apple core) rather than a report of the habit itself (Sniehotta & Presseau, 2012). To examine the
experience of individuals when completing self-report habit measures, Gardner and Tang (2014) utilized a think-aloud protocol. Their findings suggested that approximately 10% of responses to these measures were problematic (primarily in relationship to comprehension of items and alcohol habits). Despite these issues for some of the respondents, they acknowledged that self-reporting habit and the automaticity of past experiences may not always incur difficulties for participants, particularly when behaviours are specified carefully. As an alternative to self-report measures, Gardner (2015b) proposed that the ‘gold standard’ measure of habit should be associative measures (e.g. the Implicit Association Test; IAT) as they assess cue-response associations directly. However, Orbell and Verplanken (2015) posit that implicit measures which assess automaticity without reference to stimulus-response bonds or behavioural scripts may instead detect processes such as motivational forces and familiarity rather than ‘habit’ itself. Additionally, associative measures require administration in controlled settings and are unsuitable for large scale survey designs (Gardner, 2015b). Given the relatively unproblematic nature of completing self-report habit measures when responding to carefully specified behaviours, and the unsuitability of associative measures in large survey designs, the present thesis will be focusing on the relationships between self-report habit measures and fruit and vegetable consumption behaviours.

2.3.2 Differential Relationships of Psychological Predictors with Fruit Consumption and Vegetable Consumption

Public health campaigns have primarily promoted fruit and vegetables as a single food group rather than treating them separately (Glasson et al., 2011). While fruit and vegetables have similar nutrient profiles and health benefits, psychological processes might not predict both behaviours equally. For example, while intrinsic motivations for
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eating a healthy diet predicts both fruit and vegetable consumption (Trudeau, Kristal, Li, & Patterson, 1998), preparation time tends to be a larger barrier for vegetable than fruit consumption (Glasson et al., 2011), social influence is a more reliable predictor of fruit consumption (Guillaumie et al., 2010), and interventions that address the impact of attitudes on a healthy diet may be more beneficial for fruit consumption (Trudeau et al., 1998). Cooking habits may also differ between the two behaviours as fruits are typically consumed raw for breakfast, lunch and snacks, while vegetables are typically cooked and consumed at meals (Wansink & Lee, 2004). Additionally, while dual-processing frameworks that have incorporated habit measures alongside measures of the Theory of Planned Behavior constructs to examine fruit consumption (Brug et al., 2006; de Bruijn, 2010; de Bruijn et al., 2007; Menozzi & Mora, 2012), and combined fruit and vegetable consumption (Allom & Mullan, 2012; Wiedemann, Gardner, Knoll, & Burkert, 2014), no studies, to our knowledge, have utilized dual-processing framework to examine vegetable consumption.

Given that differences in the relationships between reasoned processes and fruit and vegetable consumption have been identified, there is warrant to examine how dual-processing frameworks predicts the behaviours when assessed together and individually to determine if habit frameworks are sensitive to the differences between the behaviours. For example, if cooking behaviour and preparation time differs between fruit and vegetables (Wansink & Lee, 2004), then vegetables may be more difficult than fruit to automate and perform in a patterned (routinized) manner. However, if the intrinsic motivation (e.g. to stay healthy or to feel better) to eat a healthy diet predicts fruit and vegetable consumption similarly (Trudeau et al., 1998), then individuals may report experiencing similar negative psychological consequences when they are unable to consume them. If differences are identified between a unified habit measure of fruit
and vegetable consumption and individual habit measures of fruit/vegetable consumption, then understanding these differences will enable researchers to tailor more effective health interventions for fruit consumption and vegetable consumption (Wansink & Lee, 2004).

### 2.3.3 Lack of Habit-based Interventions

Substantial proportions of daily eating behaviours are habitual and require minimal conscious effort to perform (van't Riet et al., 2011). Research into the habitual nature of eating behaviours has led to a series of recommendations for the design of behavioural interventions. Specifically, it has been recommended that behavioural interventions should: (i) encourage stimulus control (control situations in which the behaviour is performed), (ii) encourage performing the behaviour in a consistent manner (routine), and (iii) reward successful performances of the behaviour by promoting positive affect (Lally & Gardner, 2011; van't Riet et al., 2011; Verplanken & Wood, 2006). Despite these recommendations, few interventions have incorporated habit processes in their design (van't Riet et al., 2011). Furthermore, interventions targeting habit processes have been used to change multiple behaviours simultaneously (e.g. weight-loss through targeting dietary behaviour and physical activity) or have incorporated additional non-habit based strategies, making it difficult to determine if habit-based strategies result in improved nutrition behaviours (Lally et al., 2008; Wyse et al., 2014).

To our knowledge, no informational intervention has solely utilised a habit-based framework to promote fruit and vegetable consumption in adults. Additional research using this framework is required to examine the utility of habit-based interventions in promoting fruit and vegetable consumption.

### 2.4 Summary
In order to improve public health interventions of behaviour change, strategies should focus on modifiable and empirically supported predictors. Reviews have identified self-efficacy, intentions, attitudes, and stages-of-change as consistent predictors of fruit and vegetable consumption (Shaikh et al., 2008). Non-conscious, habitual processes have also been demonstrated to predict fruit, and combined fruit and vegetable consumption (Allom & Mullan, 2012; Gardner et al., 2011). While cognitive models such as the Health Belief Model, Transteoretical Model, Social Cognitive Theory, and the Theory of Planned Behavior have traditionally been used to model fruit and vegetable consumption (Noar & Mehrotra, 2011), a dual-processing approach may account for additional variance in consumption (de Bruijn, 2010; de Bruijn et al., 2007).

Reviews of the literature have identified limitations in health behaviour and habit research. Current self-report habit measures only include items assessing the automaticity process, or include items of behavioural frequency that may conflate habit-behaviour relationships. Habit measures in this area may benefit from the inclusion of items assessing fruit and vegetable routinisation, stimulus-response bonds and negative affect associated with their non-consumption. Furthermore, while dual-processing models of fruit and combined fruit and vegetable consumption habits have been assessed in adults, no research has examined this framework in relation to vegetable consumption separately.

Predictors of behaviour are only useful in public health research if they can be used to develop population-based interventions. While previous studies have incorporated habit strategies into their design, no studies to date have examined the effectiveness of an intervention utilising a multi-process habit framework to increase fruit and vegetable consumption in adults.
3 Studies 1 & 2: The Validation of a Multi-process Fruit and Vegetable Habit Measure

This chapter is presented in the format of a journal article manuscript.

3.0 Foreword

This chapter explores relationships between four habit processes (automaticity, patterned response, stimulus-response bonds and negative consequences for non-performance) and measures of combined fruit and vegetable consumption. Initially, the chapter explores whether a measure based on these four processes is psychometrically sound. Additionally, the chapter examines the relationships between these processes and measures of current/previous fruit and vegetable consumption.
3.1 Abstract

Previous research has identified four underlying processes (response patterning, stimulus-response bonds, automaticity, and negative consequences for non-performance) of habitual behaviour in the exercise domain. Two studies ($N = 357$) are reported wherein these processes are examined in relation to fruit and vegetable consumption. Exploratory and confirmatory factor analyses were used to examine the structure of a four-component fruit and vegetable habit measure, and these components were then examined in relation to past and present consumption. Three processes (response patterning, automaticity, and negative consequences for non-performance) demonstrated good construct validity and targeting these processes may help to promote long-term fruit and vegetable consumption.
3.2 Background

Adequate consumption of fruits and vegetables may protect against chronic illness, cancer and obesity (Alinia, Hels, & Tetens, 2009; Hung et al., 2004; Riboli & Norat, 2003). However, few Australian adults (~5.50%) currently consume the recommended two serves of fruit and five serves of vegetables each day (Australian Bureau of Statistics, 2013). To promote higher levels of fruit and vegetable consumption, processes such as intention, self-efficacy and taste have been examined (Guillaumie et al., 2010). While these processes have been useful in predicting fruit and vegetable consumption (Guillaumie et al., 2010), there is still a considerable amount of unexplained variance in consumption behaviour (Sheeran, 2002). Some researchers have suggested that as behaviours become habitual, processes such as intention are less reliable predictors of behaviour (Danner, Aarts, & de Vries, 2008). Therefore, processes related to the initiation and maintenance of habits warrants examination in predicting nutrition behaviours (M. Conner et al., 2002; Guillaumie et al., 2010; Sheeran, 2002; van't Riet et al., 2011; Wood et al., 2002).

Habitual behaviours are enacted automatically and without conscious awareness when preceded by associated cues (Maddux, 1997; Verplanken & Orbell, 2003). To date measures of behavioural habits have focussed on automaticity (unintentionality, uncontrollability, lack of awareness and efficiency) and past behavioural frequency (Gardner et al., 2011; Ouellette & Wood, 1998; Verplanken & Aarts, 1999; Verplanken & Orbell, 2003). However, as automaticity is driven by the consistent repetition of a behaviour within a stable context (Lally et al., 2010), measures of habit may benefit from the consideration of additional processes. For example, some researchers have proposed that habitual health behaviours can be facilitated by response patterning and may also be characterised by negative psychological affect (e.g. feelings of guilt) if they
are not performed (Grove et al., 2013; Grove et al., 2014; Hashim et al., 2011). Further examination of these processes in relation to specific health behaviours are needed in order to achieve a more comprehensive understanding of habit development and maintenance processes.

The repetitive performance of behaviour in relation to consistent cues (i.e. establishment of strong stimulus-response bonds) is a necessary condition for establishing automatic behaviours (Neal et al., 2006; van't Riet et al., 2011). Nutrition behaviours, in particular, tend to be repeated regularly, and the environment can therefore become an important trigger to eating (van't Riet et al., 2011). For example, research has demonstrated that habitual popcorn eaters consumed equal amounts of stale and fresh popcorn when they were in an associated context (e.g. cinema), while those in a disassociated context (e.g. meeting room) ate significantly less stale than fresh popcorn (Neal et al., 2011). The authors concluded that habitual eating was not dependent on motivational states or enjoyment of the food but, instead, was enacted with minimal awareness when triggered by an associated cue (Neal et al., 2011). Examination of the specific contexts and cues that precede and trigger behavioural responses is therefore warranted when modelling habit formation and execution.

Habitual behaviours tend to be performed in a patterned manner. That is, they tend to be performed in the same way, at the same times of the day, in the same locations, and in the same order each time (M. Conner et al., 2002; van't Riet et al., 2011; Wood et al., 2002). Performing simple nutrition behaviours, such as eating a piece of fruit with lunch each day can, over a large number of repetitions, enable the subsequent consumption of fruit during lunch to become automatic (Lally et al., 2010). Including measures of the extent to which individuals perform a particular behaviour
(e.g. eating fruit or consuming vegetables) in a patterned manner may therefore provide important information about the extent to which that behaviour has become habituated.

Lastly, habitual behaviours (especially in the health domain) tend to result in negative psychological consequences if they are not performed. The strength of habitual behaviours increases when repetition is associated with satisfactory experiences or positive reinforcements (van't Riet et al., 2011). Previous research has demonstrated that linking a specific goal with implicit positive affect may enable the automatic execution of that particular behaviour (Custers & Aarts, 2005; van't Riet et al., 2011). Therefore, when a habitual health behaviour is interrupted or fails to occur, feelings of guilt, uneasiness, or being “out of sorts” may be experienced (Grove et al., 2013; Grove et al., 2014; Verplanken & Orbell, 2003).

To date, measures of habit strength have largely focussed on assessing past behavioural frequency and the extent to which behaviours are automatically enacted (Gardner et al., 2011; Verplanken & Orbell, 2003). While automaticity is a key ingredient of habitual behaviour, researchers have recommended that habit measures should not incorporate items of behavioural frequency (Gardner, Abraham, et al., 2012a). Furthermore, no research to date has examined the reliability and validity of a multi-component fruit and vegetable habit measure (response patterning, automaticity, stimulus-response bonds and negative consequences).

Therefore, the aims of the present study were to extend previous habit research by: (i) assessing whether automaticity, strong stimulus-response bonds, negative consequences for non-performance and patterned response are identifiable factors in relation to fruit and vegetable consumption; (ii) modelling the relationships among these proposed factors; and (iii) assessing the relationships between these factors and self-reports of past and current fruit and vegetable consumption.
3.3. Study 1 Methodology

3.3.1 Participants and General Procedure

University undergraduate students \((n = 147)\) participated in the study. The average age of the participants was 19.90 years \((SD = 1.98)\), and the sample consisted of an approximately equal number of males and females (69 males and 78 females). Four participants did not report their BMI. The remaining participants had an average BMI of 22.40 \((SD = 2.88)\). Participants were provided with information about the study during a class session and all participants provided consent prior to completing the measures.

3.3.2 Measures

Participants completed a questionnaire that consisted of: (i) demographic items (age, gender, height and weight); (ii) history of fruit and vegetable consumption; (iii) current fruit and vegetable consumption and frequency of consumption; and (iv) items designed to assess automaticity, strength of stimulus-response bonds, patterning of action, and negative consequences for non-performance in relation to the consumption of fruits and vegetables.

**Fruit and Vegetable Consumption Measures**

Fruit and vegetable consumption items were adapted from those used in previous research to examine aerobic exercise (Grove et al., 2014). For each item participants were asked to think about occasions on which they ate four or more servings of fruit and/or vegetables within 24 hours, and were given examples of fruit and vegetable servings based on the Western Australian Department of Health’s “Go for 2&5” website (www.gofor2and5.com.au). The decision to use four or more servings of fruits and/or vegetables as a behavioural criterion was based on a report suggesting that the average Australian adult consumes 1.6 serves of fruit and 2.4 serves of vegetables each day (Queensland Health, 2011).
In order to assess their history of fruit and vegetable consumption, participants were asked to classify themselves into one of five categories (based on the stages-of-change component of the Transtheoretical Model) of fruit and vegetable consumption over the past six months (J. O. Prochaska & DiClemente, 1984). Participants classified themselves into; pre-contemplation (“I don’t eat that amount of fruits and/or vegetables, and I probably won’t start in the next six months”), contemplation (“I don’t eat that amount of fruits and/or vegetables, but I’m thinking about starting in the next six months”), preparation (“I sometimes eat that amount of fruits and/or vegetables but I don’t do so consistently”), action (“I do eat that amount of fruits and/or vegetables on a regular basis, but I started doing so less than six months ago”), or maintenance (“I do eat that amount of fruits and/or vegetables, and I started doing so more than six months ago”).

Frequency of current fruit and vegetable consumption was assessed by asking participants, “On average, how many days per week do you eat that amount of fruits and/or vegetables?” with responses ranging from “only rarely” to “every day” on an eight-point scale. Quantity (amount) of fruit and vegetable consumption was assessed by asking, “On average, how many servings of fruit and/or vegetables do you eat in a day?” on an eight-point scale with responses ranging from “0” to “9 or more”. These measures are similar to those used in previous fruit and vegetable studies (Laforge et al., 1994; J. J. Prochaska & Sallis, 2004).

**Habit Items**

Twenty-six items were included to assess the four proposed habit processes: automaticity, strong stimulus-response bonds, patterning of action, and negative consequences for non-performance. These items were adapted from previous habit measures (Grove et al., 2014; Verplanken & Orbell, 2003). Items designed to measure
the patterned response factor included, “I eat fruit in the same meals each day”.
Automaticity items were designed to reflect the spontaneity and lack of awareness of
fruit and vegetable consumption (e.g., “When I eat fruits and vegetables, I do not always
remember choosing them in my meal”). Items designed to measure negative
consequences for non-performance included, “I feel unhealthy if I don’t eat fruits and
vegetables”. Stimulus-response bond items assessed whether external cues influenced
the desire to consume fruits and vegetables (e.g., “Certain surroundings just make me
want to eat more fruits and vegetables”). Item responses were made on a six-point
Likert-type scale ranging from “not true for me” (1) to “very true for me” (6).

3.3.3 Statistical Analyses
The Statistical Package for the Social Sciences version 20.0 (SPSS 20) was used to
conduct all analyses. The number of missing values was small (<1%), so mean
imputation was used to replace these values. Six participants were identified as
multivariate outliers (Mahalanobis scores that exceeded the p < .001 critical value) and
were excluded from subsequent analyses.

Exploratory factor analysis was conducted to examine the latent structure of the
habit process items. Principal-axis factoring with oblique rotation (direct oblimin) was
chosen as the extracted factors were expected to be related to each other. Factor
retention was decided using multiple criteria (Stellefson, Hanik, Chaney, & Chaney,
2009): factors with eigenvalues greater than 1 (Guttman, 1954); inspection of the scree
plot for factors above the point of inflexion or “elbow” (Cattell, 1966); Velicer’s
Minimum Average Partial (MAP) analysis (Velicer, 1976), available from
http://people.ok.ubc.ca/brioconn/nfactors/nfactors.html; and theoretical relevance. Items
were considered viable for retention when they had a primary loading greater than .40
with cross-loadings less than .30. Items that failed to meet these criteria were removed.
in an iterative process. Cronbach’s alpha was used to assess internal consistency, with coefficients >.60 considered adequate and coefficients >.80 considered highly reliable (Nunnally & Bernstein, 1994).

Pearson-point correlations were calculated to determine relationships between the latent habit dimensions and the consumption measures. Correlation coefficients of .10, .30, and .50 were considered small, medium and large, respectively (Cohen, 1992). MANOVA was used to examine differences in factor scores in relation to history of fruit and vegetable consumption (stage-of-change classification).

3.4 Study 1 Results

3.4.1 Exploratory Factor Analysis

Seven items failed to meet the criteria for sufficient loading (> .40) on the primary factor and minimal loading (< .30) on other factors. The remaining 19 items (presented in Table 3.1) accounted for 56.75% of the total variance. Simultaneous consideration of the MAP analysis, scree plot output, and conceptual clarity issues suggested that these items represented four latent factors. All items had adequate communalities ranging from .33 to .80 ($M = .57$), and the respective factors were internally consistent ($\alpha = .65 - .90$). The four identified factors were labelled automaticity, patterned response, negative consequences for non-performance and stimulus-response bonds.

3.4.2 Habit Factors and Current Fruit and Vegetable Consumption

To examine the inter-relationships of the four processes as well as their relationship with dietary behaviours, each factor was summed and correlated with self-reports of current fruit and vegetable consumption. All factors showed a significant relationship with at least one other factor (Table 3.2). Furthermore, the negative consequences for non-performance, automaticity and patterned response factors showed significant positive correlations with self-reported weekly frequency of fruit and vegetable
Chapter Three: Validation of a Multi-process Fruit and Vegetable Habit Measure

collection. The automaticity and negative consequences factors also showed significant positive correlations with the amount of fruits and vegetables consumed per day.

3.4.3 Stages-of-change and Habit

The majority of participants reported being in the preparation or maintenance stages-of-change with few being in the pre-contemplation, contemplation, and action stages. In order to examine differences in habit factor scores between individuals in the earlier stages of change with those in the later stages, response categories were recoded such that individuals in the pre-contemplation, contemplation and preparation stages of change were combined (PC/C/P). These individuals were combined, as they were not yet consuming at least four or more servings of fruits and/or vegetables on a daily basis (40.43%). Participants in the action and maintenance (A/M) phases were combined in a similar manner as they had commenced, or were maintaining the consumption of four or more servings of fruits and/or vegetables on a daily basis (59.57%). A MANOVA revealed a significant multivariate effect for stage-of-change, $\lambda = .83, F(4, 136) = 7.11, p < .001, \eta_p^2 = .17$. Subsequent examination of univariate results confirmed significantly higher responses by the A/M group on the negative consequences, $F(1, 139) = 10.15, p = .002, \eta_p^2 = .07$, and automaticity, $F(1, 139) = 13.15, p < .001, \eta_p^2 = .09$, processes. No differences between the groups were found on the patterned response, $F(1, 139) = 2.51, p = .115, \eta_p^2 = .02$, or stimulus-response bond, $F(1, 139) = .01, p = .921, \eta_p^2 < .001$, processes (Figure 3.1).
Table 3.1: Rotated factor loadings for the 19 item habit measure (N = 141)

<table>
<thead>
<tr>
<th>Item</th>
<th>NEG</th>
<th>AUT</th>
<th>SRB</th>
<th>PAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I don’t eat fruits and vegetables, I feel irritable</td>
<td>.83</td>
<td>.01</td>
<td>.04</td>
<td>-.03</td>
</tr>
<tr>
<td>I feel sick if I don’t eat fruits and vegetables</td>
<td>.79</td>
<td>.05</td>
<td>-.04</td>
<td>.08</td>
</tr>
<tr>
<td>I feel guilty if I don’t eat fruits and vegetables</td>
<td>.78</td>
<td>-.08</td>
<td>-.03</td>
<td>-.12</td>
</tr>
<tr>
<td>If I don’t eat fruits and vegetables, I find it hard to concentrate</td>
<td>.78</td>
<td>.04</td>
<td>.02</td>
<td>.01</td>
</tr>
<tr>
<td>I feel unhealthy if I don’t eat fruits and vegetables</td>
<td>.73</td>
<td>-.04</td>
<td>-.05</td>
<td>.01</td>
</tr>
<tr>
<td>I feel tired if I don’t eat fruits and vegetables</td>
<td>.72</td>
<td>-.08</td>
<td>-.01</td>
<td>.06</td>
</tr>
<tr>
<td>If a meal doesn’t include fruits or vegetables, I find it unsatisfying</td>
<td>.54</td>
<td>.06</td>
<td>-.07</td>
<td>.09</td>
</tr>
<tr>
<td>When I eat fruits and vegetables, I do not always remember choosing them in my meal</td>
<td>-.03</td>
<td>.75</td>
<td>-.02</td>
<td>-.12</td>
</tr>
<tr>
<td>When I start eating fruits and vegetables I do so spontaneously and automatically</td>
<td>.14</td>
<td>.72</td>
<td>.05</td>
<td>-.07</td>
</tr>
<tr>
<td>I often eat fruits or vegetables and only later realize I am doing so</td>
<td>.01</td>
<td>.66</td>
<td>-.17</td>
<td>.18</td>
</tr>
<tr>
<td>When I eat fruits and vegetables, I do not consciously remember deciding to do so</td>
<td>-.03</td>
<td>.66</td>
<td>.08</td>
<td>.02</td>
</tr>
<tr>
<td>I often eat fruits or vegetables as a snack without consciously realizing it</td>
<td>.04</td>
<td>.62</td>
<td>-.16</td>
<td>.10</td>
</tr>
<tr>
<td>Seeing other people eat fruit and vegetables motivates me to eat more fruits and vegetables</td>
<td>.03</td>
<td>-.01</td>
<td>-.83</td>
<td>-.04</td>
</tr>
<tr>
<td>When I see someone else eating a piece of fruit or a vegetable, I feel like eating them too</td>
<td>-.07</td>
<td>.02</td>
<td>-.75</td>
<td>-.03</td>
</tr>
<tr>
<td>Certain surroundings just make me want to eat more fruits and vegetables</td>
<td>.08</td>
<td>.02</td>
<td>-.73</td>
<td>-.03</td>
</tr>
<tr>
<td>Some situations give me a desire to eat fruits and vegetables</td>
<td>.01</td>
<td>.10</td>
<td>-.68</td>
<td>.01</td>
</tr>
<tr>
<td>Seeing fruit and vegetable advertisements gives me the desire to eat more fruits and vegetables</td>
<td>.05</td>
<td>-.08</td>
<td>-.67</td>
<td>.06</td>
</tr>
<tr>
<td>I eat vegetables in the same meals each day (e.g. salad with dinner or a carrot for a snack)</td>
<td>-.13</td>
<td>.01</td>
<td>.01</td>
<td>.91</td>
</tr>
<tr>
<td>I eat fruit in the same meals each day (e.g. a banana with breakfast or an apple for a snack)</td>
<td>.14</td>
<td>-.02</td>
<td>.01</td>
<td>.54</td>
</tr>
</tbody>
</table>

Notes: NEG = Negative consequences for non-performance; AUT = Automaticity; SRB = Stimulus-response bonds; PAT = Patterned response. Items in bold have factor loadings > |.30|. 
Table 3.2: Descriptive statistics for habit factors and correlations with reported fruit and vegetable consumption (Study 1)

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>NEG</th>
<th>AUT</th>
<th>SRB</th>
<th>PAT</th>
<th>WEEK</th>
<th>DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative consequences for non-performance (NEG)</td>
<td>23.13 (8.10)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automaticity (AUT)</td>
<td>17.28 (4.99)</td>
<td>.38**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulus-responds bonds (SRB)</td>
<td>20.63 (5.23)</td>
<td>.54**</td>
<td>.39**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patterned response (PAT)</td>
<td>8.20 (2.32)</td>
<td>.19*</td>
<td>.14</td>
<td>.14</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of weekly fruit and vegetable consumption (WEEK)</td>
<td>5.10 (1.73)</td>
<td>.29**</td>
<td>.38**</td>
<td>.02</td>
<td>.19*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Daily amount of fruit and vegetable consumption (DAY)</td>
<td>4.55 (1.20)</td>
<td>.27**</td>
<td>.25**</td>
<td>-.004</td>
<td>.13</td>
<td>.64**</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes:* indicates correlations are significant at p <.05; ** indicates that correlations are significant at p < .01.
Figure 3.1: A comparison of habit factor scores across stages-of-change with 95% CI (Study 1; N = 141). PC/C/P = Pre-contemplation/Contemplation/Preparation; A/M = Action/Maintenance. Negative = Negative consequences for non-performance; S-R bonds = Stimulus-response bonds.

3.5 Study 2 Aims

The aims of the study were to: (i) cross-validate the measurement model developed in Study 1 using an independent sample of respondents; (ii) replicate the relationships between the proposed processes; and (iii) replicate the relationships of the processes with a history of fruit and vegetable consumption (stage-of-change) and self-reports of current fruit and vegetable consumption.

3.6 Study 2 Methodology

3.6.1 Participants and General Procedure

After approval was received from the University Research Ethics Committee, an advertisement was circulated via an electronic bulletin board seeking participants over
the age of 18 years for a study on fruit and vegetable consumption. Participants had the opportunity to complete the measures used in Study 1 through the Survey Monkey website (www.surveymonkey.com) or via pen-and-paper by contacting the project coordinator. Two-hundred and twenty participants met the study criteria. The average age of the participants was 26.89 years ($SD = 12.13$), and the sample was predominantly female (61 males and 159 females). Five participants did not report their BMI. The remaining participants had an average body mass index of 22.40 ($SD = 3.41$).

3.6.2 Statistical Analyses

The proportion of missing data was negligible (<3%), so mean substitution was used to replace these values. Four participants were identified as multivariate outliers and removed from subsequent analyses.

Confirmatory factor analysis was conducted using AMOS 20.0. To assess the uni-dimensionality of each habit process, one-factor congeneric models were conducted for the automaticity, negative consequences for non-performance and stimulus-response bonds factors. A one-factor congeneric model was not conducted for the patterned response factor due to having less than three items. A non-significant chi-square value indicates good model fit. However, as the chi-square value can be influenced by sample size, additional fit indices were used to evaluate the fit of each factor and the overall measurement model. Based on previous recommendations (Hu & Bentler, 1998), we assessed the Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Standardised Root Mean Square (SRMR) and Root Mean Square Error of Approximation (RMSEA) as they are robust to smaller sample sizes ($N < 250$). Values > .95 and > .90 were considered good and acceptable fits respectively for the TLI and CFI indices, while values of < .05 and < .08 were considered good and acceptable fits respectively for the SRMR. Values of < .05 and < .10 were considered good and acceptable fits respectively
for the RMSEA indices (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999). SPSS 20.0 was used to conduct Pearson-point correlations, multiple regression and MANOVA procedures.

3.7 Results

3.7.1 Confirmatory Factor Analysis

The automaticity, negative consequences for non-performance and stimulus-response bonds factors exhibited poor initial fit with their hypothesized models. An iterative process, alongside consideration of the theoretical relevance of each factor, was therefore used to eliminate items that were found to contribute poorly to the model-fit indices. The final composite for each process consisted of four items, and inspection of indices confirmed that these items were a good to excellent fit with their proposed subscale. All four of the habit processes demonstrated adequate to good internal consistency (Table 3.3).

<table>
<thead>
<tr>
<th>Table 3.3: One factor congeneric models of the four proposed habit factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit Factor</td>
</tr>
<tr>
<td>Automaticity</td>
</tr>
<tr>
<td>Negative</td>
</tr>
<tr>
<td>SRB</td>
</tr>
<tr>
<td>Patterned Response$^a$</td>
</tr>
</tbody>
</table>

Note: * indicates $p = .05$. $^a$A one-factor congeneric model was not performed due to the factor having less than three items. CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; SRMR = Standardised Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; Negative = Negative consequences for non-performance; SRB = Stimulus-response bonds.

Due to the non-significant correlations between the stimulus-response bonds factor and both of the fruit and vegetable consumption measures in Study 1, three models were considered: a uni-dimensional model; a four-factor higher-order model; and a three-factor higher-order model in which stimulus-response items were excluded. The uni-dimensional, $\chi^2 (77) = 561.38, p < .001$, CFI = .58, TLI = .50, SRMR = .12,
RMSEA (90% CI) = .17 (.16-.18), and four-factor higher-order model, $\chi^2 (73) = 207.80$, $p < .001$, CFI = .88, TLI = .85, SRMR = .08, RMSEA (90% CI) = .09 (.08-.11), demonstrated poor-fit to the data. The three-factor higher-order model showed superior fit over the four-factor higher-order model, $\Delta \chi^2 = 130.80$, $\Delta df = 41$, $p < .001$, with all indices suggesting an acceptable fit, $\chi^2 (32) = 77.00$, $p < .001$, CFI = .94, TLI = .92, SRMR = .07, RMSEA (90% CI) = .08 (.06-.10). Additionally, the three-factor higher-order model demonstrated an acceptable fit when modelling fruit and vegetable frequency and consumption, $\chi^2 (51) = 135.84$, $p < .001$, CFI = .92, TLI = .90, SRMR = .09, RMSEA (90% CI) = .09 (.07-.11). The three-factor higher-order model is presented in Figure 3.2.

**Figure 3.2:** The three-factor higher-order model (Study 2; $N = 216$). Values adjacent to double-headed arrows represent factor correlations while values above single-headed arrows represent standardised factor loadings. All values are significant to $p < .05$. Numbers above the items represent squared multiple correlations. Aut = Automaticity; Neg = Negative consequences for non-performance; Patt = Patterned Response; Week = Frequency of weekly fruit and vegetable consumption; and Day = Daily amount of fruit and vegetable consumption.
3.7.2 Habit Factors, Current Fruit and Vegetable Consumption and Stages-of-change

All three habit processes showed significant, modest to moderate positive relationships with one another (Table 3.4). The three habit processes also demonstrated significant, modest to moderate positive correlations with self-reported weekly and daily fruit and vegetable consumption. In order to assess the contribution of the habit processes on the fruit and vegetable frequency measures, multiple regression analyses were conducted and indicated that all three habit processes (automaticity, patterned response and negative consequences for non-performance) were significant predictors of daily and weekly fruit and vegetable consumption (Tables 3.5 and 3.6), and accounted for approximately 25-26% of the variance in these consumption behaviours.

A MANOVA procedure was again used to assess whether scores on the subscales increased as a result of the individual’s history of fruit and vegetable consumption. Similar to Study 1, participants who reported being in the pre-contemplation, contemplation and preparation stages-of-change (40.28%) were combined into a single category while those in the action and maintenance stages (59.72%) were combined into a second category. Findings from this analysis revealed a significant multivariate effect for stage-of-change, $\lambda = .79, F(3, 212) = 18.53, p < .001$, $\eta_p^2 = .21$. Subsequent examination of univariate results confirmed significantly higher responses by the A/M group on all three processes, $F(1, 214) = 26.22, p < .001$, $\eta_p^2 = .11$, for negative consequences for non-performance; $F(1, 214) = 30.13, p < .001$, $\eta_p^2 = .12$, for automaticity; and $F(1, 214) = 20.41, p < .001$, $\eta_p^2 = .09$, for patterned response (Figure 3.3).
### Table 3.4: Descriptive statistics for habit factors and correlations with reported fruit and vegetable consumption (Study 2)

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>NEG (SD)</th>
<th>AUT</th>
<th>PAT</th>
<th>WEEK</th>
<th>DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative consequences for non-performance (NEG)</td>
<td>15.11 (5.31)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automaticity (AUT)</td>
<td>14.03 (4.58)</td>
<td>.40**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patterned response (PAT)</td>
<td>7.64 (2.78)</td>
<td>.26**</td>
<td>.13</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of weekly fruit and vegetable consumption (WEEK)</td>
<td>5.36 (2.23)</td>
<td>.39**</td>
<td>.36**</td>
<td>.27**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Daily amount of fruit and vegetable consumption (DAY)</td>
<td>4.68 (1.49)</td>
<td>.45**</td>
<td>.28**</td>
<td>.28**</td>
<td>.78**</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: ** indicates that correlations are significant at p < .01.

### Table 3.5: Fruit and vegetable frequency regression analysis. Fruit and vegetable frequency (DV) with the habit processes as predictors.

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>r²</th>
<th>F-change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automaticity</td>
<td>.26**</td>
<td>.45</td>
<td>F (3, 212) = 23.71, p &lt; .01</td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.25**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patterned response</td>
<td>.18**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ** indicates p < .01. β represents standardized coefficients.

### Table 3.6: Fruit and vegetable quantity (amount) regression analysis. Fruit and vegetable quantity (DV) with the habit processes as predictors.

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>r²</th>
<th>F-change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automaticity</td>
<td>.14*</td>
<td>.26</td>
<td>F (3, 212) = 24.39, p &lt; .01</td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.35**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patterned response</td>
<td>.18**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * indicates that p < .05, ** indicates p < .01. β represents standardized coefficients.
Chapter Three: Validation of a Multi-process Fruit and Vegetable Habit Measure

Figure 3.3: A comparison of habit factor scores across stages-of-change with 95% CI (Study 2; \( N = 216 \)). PC/C/P = Pre-contemplation/Contemplation/Preparation; A/M = Action/Maintenance. Negative = Negative consequences for non-performance.

3.8 Discussion

The current studies aimed to examine whether a four-process habit model proposed for aerobic exercise (Grove et al., 2014) could be extended to fruit and vegetable consumption. A further aim of the studies was to examine the relationships between the processes and fruit and vegetable consumption. It was expected that individuals who reported stronger fruit and vegetable habits, as measured by the four habit processes (negative consequences for non-performance, automaticity, stimulus-response bonds and patterned response), would report higher levels of fruit and vegetable consumption and have a longer history of consumption.

The findings of these two studies suggest that the proposed four-process model was not appropriate in examining combined fruit and vegetable consumption. However,
a model consisting of three processes (negative consequences for non-performance, automaticity and patterned response) demonstrated acceptable fit to the data. Furthermore, these three processes significantly correlated with, and accounted for significant variance (25-26%) in the fruit and vegetable consumption measures, suggesting that individuals who reported eating fruit and vegetables in a routinized manner, with minimal conscious awareness, and who experienced negative affect when failing to do so, also reported eating fruits and vegetable more regularly and in greater quantities. Additionally, responses on these three processes were significantly greater in individuals with a longer history of fruit and vegetable consumption.

These findings may provide important clues about the specific psychological processes that should be targeted to effectively change fruit and vegetable eating habits. Our data supports previous findings that nutritional habits (specifically fruit and vegetable consumption) might be facilitated by strategies that encourage consumption in stable settings (e.g. same meals each day). Previous research into habit formation found that performing a specific activity within a stable context (e.g. ‘eating a piece of fruit with lunch’) each day for 12 weeks resulted in an increase in behavioural automaticity for many of the participants (Lally et al., 2010). Similarly, the present findings suggest that self-reported patterned response (i.e. meal stability) correlated positively with fruit and vegetable consumption and overall habit strength.

Previous research has suggested that habit strength increases when behavior is reinforced by satisfactory experiences (Aarts, Verplanken, & van Knippenberg, 1998; van't Riet et al., 2011; Wood & Neal, 2007). For example, habit strength has been associated with increased positive implicit affect (e.g. feeling happy or pleasant) in relationship to fruit consumption (de Bruijn, 2010). Additionally, experimental research has demonstrated that a short-term increase in anticipated regret, following an eight-
week behavioural and nutritional intervention, predicted a significant increase in fruit and vegetable consumption after 12 months (Steptoe et al., 2004). The present research supports these findings by suggesting that failing to consume fruits and vegetables, resulted in greater feelings of guilt, unhealthiness and meal dissatisfaction for participants who consumed fruits and vegetables regularly. Future research aimed at developing fruit and vegetable consumption habits may therefore benefit from the consideration of strategies that emphasise the implicit affective benefits of fruit and vegetable consumption (e.g. feelings of health and meal satisfaction) in order to minimize negative affective states associated with the failure to consume them (e.g. guilt).

The stimulus-response bond process was not significantly correlated with fruit and vegetable consumption and individuals with a longer history of fruit and vegetable consumption did not report stronger stimulus-response bonds than those who had a shorter history of consumption. These findings suggest that the stimulus-response bonds process, as defined here, was unrelated to the consumption of fruits and vegetables. While stimulus-response bonds are involved in the development of habitual behaviours (Maddux, 1997), already established habits may be executed automatically with a greater flexibility of context (Tappe & Glanz, 2013). Previous research has suggested that it may be difficult to adequately capture contextual cues that precede some behaviours using self-report measures (Tappe & Glanz, 2013). Thus, the specific items used in the present study to examine cueing processes (i.e. stimulus-response bonds) associated with fruit and vegetable consumption may not have been the most appropriate to capture these processes. Future studies may benefit from the investigation of participant-driven cues for fruit and vegetable consumption. These might be uncovered with the use of behaviour diaries.
3.8.1 Limitations

Although encouraging with respect to defining the structure of fruit and vegetable consumption habits, these findings should be considered alongside some potential limitations. Both of these studies utilised cross-sectional designs. While a large body of health behaviour research has focussed on cross-sectional designs (M. Conner et al., 2002; Gardner, 2015b), experimental designs should be used to determine whether increases in the negative consequences for non-performance, automaticity and patterned-response processes lead to a longer history of repetition and fruit and vegetable consumption or if increased consumption and history of repetition lead to a strengthening of these processes.

Following the exploratory factor analysis procedure, the patterned-response process was subsequently examined using just two items. While these items demonstrated adequate internal consistency, examining additional ways in which consumption can be patterned (e.g. eating the same varieties of fruits and vegetables each time and in the same locations each day) may help strengthen the internal consistency and comprehensiveness of this subscale (Field, 2009).

The multi-process habit model proposed in these studies includes factors that have been argued to be antecedents (e.g. patterned response) and maintenance factors (e.g. negative consequences for non-performance) of habits as opposed to core constructs. However, similar to Grove et al. (2014), we argue that the present research suggests that a model of habits that incorporates items that reflect their development, execution and maintenance may provide a comprehensive framework that can assist in identifying how habit processes interrelate. These interrelationships may eventually assist in the design and implementation of interventions to improve nutrition behaviours.
3.8.2 Conclusion

These two studies provide initial psychometric support for a three-process habit model (automaticity, patterned response and negative consequences for non-performance) for fruit and vegetable consumption. These studies also provide clues as to the processes that underlie habitual behaviours and may help drive interventions. While experimental research is required, targeting processes such as the psychological benefits for consuming fruits and vegetables and the patterned/routinized nature in which consumption occurs may allow for fruit and vegetable consumption to become habitual and promote long-term behaviour change.
4 Study 3: Differential Relationships between Habit Processes and Fruit and Vegetable Consumption

This chapter is presented in the format of a journal article manuscript.

Chapter Four: Differential Relationships Between Fruit and Vegetable Habits

4.0 Foreword

Chapter Three examined the factor structure of a four-process fruit and vegetable habit measure, as well as the relationships between those processes and fruit and vegetable consumption. Significant relationships were found between three of the processes (patterned response, automaticity and negative consequences for non-performance) and fruit and vegetable consumption. However, the internal consistency of the patterned response measure may have been limited by the use of only two items. Additionally, some researchers (Glasson et al., 2011) have proposed that fruit consumption and vegetable consumption should be considered separately in health promotion programs. While relationships between deliberative, conscious processes have been examined with fruit and vegetables consumption as individual behaviours, no research to date has examined whether habitual processes differ between the two.

The present chapter explores whether the three habit processes identified in Chapter 3 extend towards fruit consumption and vegetable consumption as separate behaviours. Additionally, the present chapter examines the factor structure and validity of the processes identified in Chapter 3 alongside an additional measure of automaticity, the Self-Report Behavioral Automaticity Index (Gardner, Abraham, et al., 2012b), and processes from the Theory of Planned Behavior (Ajzen, 1991).
4.1 Abstract

Previous research (Chapter 3) supported the construct validity and reliability of a three-process (automaticity, patterned response and negative consequences for non-performance) fruit and vegetable habit measure. However, some researchers have suggested that fruit consumption and vegetable consumption should be examined separately. Additionally, it is unknown if these nutrition-specific habit measures add explanatory power beyond current habit and cognitive measures (e.g. processes from the Theory of Planned Behavior). To address these limitations, the present study examined whether differential relationships exist between the three habit processes, fruit consumption, and vegetable consumption.

One-hundred and six participants completed a three-process fruit/vegetable habit measure, measures of fruit/vegetable consumption, an automaticity measure, and measures of The Theory of Planned Behavior processes. Confirmatory Factor Analyses demonstrated that a three-process measure (automaticity, patterned response and negative consequences for non-performance) was structurally sound for fruit but not vegetable consumption. Regression analyses for fruit consumption revealed that the patterned response factor of the habit measure predicted variance beyond that accounted for by automaticity. Similar analyses for vegetable consumption revealed that negative consequences for non-performance predicted variance beyond that of automaticity. The findings of this study suggested that a three-process habit measure is appropriate in examining fruit consumption; that habit processes differ in their relationships between fruit and vegetable consumption; and that these habit elements add explanatory power to the prediction of both fruit and vegetable consumption beyond that of automaticity alone.
Chapter Four: Differential Relationships Between Fruit and Vegetable Habits

4.2 Background

Health behaviours (e.g. exercise and fruit and vegetable consumption) may be performed habitually, that is, with minimal conscious thought (Ouellette & Wood, 1998). Habitual behaviours are those performed in a routine manner and in consistent contexts, such that, they are automatically enacted when triggered by an associated environmental cue (Lally et al., 2010; Verplanken & Aarts, 1999). As behaviours become habitual, conscious decision-making processes, such as intention, become less predictive of subsequent behavioural performance (Chatzisarantis & Hagger, 2007; Gardner et al., 2011). Interventions based on intention and motivation may be insufficient to enact long-term behaviour change, especially when motivation to perform the desired behaviour diminishes. There is therefore a need to examine processes that are involved in habitual behaviours, and to develop measures that capture these processes (Rothman et al., 2009; Verplanken & Wood, 2006; Wood, Tam, & Witt, 2005).

Research into underlying habit processes has focussed on three components; (i) automaticity, (ii) behavioural frequency, and (iii) relevance to self-identity (Verplanken & Orbell, 2003). In order to examine these habit processes, a 12-item self-report measure was constructed (Self-Report Habit Index; SRHI) and has been used across a variety of health behaviours (Gardner et al., 2011; Verplanken & Orbell, 2003). While this measure has demonstrated good psychometric properties (Gardner et al., 2011), the conceptual validity of the measure has questioned. For example, self-identity may not be a necessary component of health related habits (Gardner, Abraham, et al., 2012b; Gardner, de Bruijn, et al., 2012; Sniehotta & Presseau, 2012). Furthermore, the inclusion of behavioural frequency within the measure itself may conflate the relationship between the measure and outcomes that are often assessed using a measure
of behavioural frequency (Gardner, Abraham, et al., 2012a; Gardner, de Bruijn, et al., 2012; Sniehotta & Presseau, 2012). To overcome these conceptual limitations, an automaticity subscale of the SRHI was constructed. This automaticity subscale, the Self-Report Behavioral Automaticity Scale (SRBAI), has demonstrated good construct validity and reliability in predicting a variety of health behaviours and has been considered as conceptually sound (Gardner, Abraham, et al., 2012b).

While the SRBAI is an important step forward in measuring behavioural habits, researchers have proposed that the assessment of additional processes may enable a more comprehensive understanding of habit development and execution (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). For example, habitual behaviours tend to be repeated in a routine or patterned manner, and disrupting the pattern can bring the behaviour back into conscious awareness (Lally et al., 2010; Neal et al., 2011). Additionally, positive habitual behaviours may result in negative psychological consequences (e.g., feelings of guilt or being unhealthy) if they are not performed (Custers & Aarts, 2005; van't Riet et al., 2011). Measures based on these habit processes (automaticity, patterned response and negative consequences for non-performance) have been shown to be structurally sound and valid when predicting fruit and vegetable consumption (Chapter 3) and exercise behaviours (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). The researchers suggested that a multi-process habit measure might be used to understand the mechanisms by which habits are formed and guide interventions. However, further research is still required to refine the fruit and vegetable measure before it can be used to guide interventions.

The patterned response subscale of the three-process fruit and vegetable habit measure contained only two items that examined meal stability. While this process
displayed adequate internal consistency (Chapter 3), adding additional items that measure the routinisation of consumption (e.g. same time of day and same types of fruits/vegetables) may increase the internal consistency and comprehensiveness of the subscale (Tavakol & Dennick, 2011; van't Riet et al., 2011; Wood et al., 2002).

Additionally, the psychometric properties of the measure have been confined to examining fruit and vegetable consumption as an individual behaviour. While this is consistent with fruit and vegetable marketing strategies and previous research in the field (Laforge et al., 1994; Neumark-Sztainer, Story, Resnick, & Blum, 1996; Sjoberg, Kim, & Reicks, 2004; Unusan, 2006), the psychosocial processes that drive fruit and vegetable consumption may differ (Brug, Glanz, & Kok, 1997; Glasson et al., 2011; Horacek et al., 2002; Moser, Green, Weber, & Doyle, 2005; Trudeau et al., 1998; Van Duyn et al., 2001). For example, research has demonstrated that cost tends to be a barrier for fruit consumption, while a lack of time tends to be a barrier for vegetable consumption (Glasson et al., 2011; Pollard, Miller, et al., 2009). However, little is known as to whether the habitual processes that underlie the two behaviours differ, as research has focused on examining either fruit consumption or combined fruit and vegetable consumption (Allom & Mullan, 2012; Gardner, Abraham, et al., 2012b; N. Pearson, Atkin, Biddle, & Gorely, 2010).

The construct validity of the three habit processes also requires further examination. A measure is considered to have good construct validity when its subscales are highly correlated to theoretically similar measures and correlate less strongly with theoretically dissimilar constructs (Field, 2009). There is therefore a need to examine relationships between the proposed habit processes and theoretically similar and dissimilar measures. For example, if the automaticity process of the three-factor measure captures the lack of awareness and spontaneity of fruit/vegetable consumption,
then it should strongly correlate with a similar habit measure, e.g. the SRBAI. Likewise, previous research has shown that fruit automaticity is positively and strongly correlated with an individual’s intent to consume fruit and his/her perceived control that he/she can consume fruit adequately (de Bruijn, 2010). Therefore, the fruit and vegetable automaticity subscales of the multi-process habit measure should correlate strongly with measures of intention and perceived behavioural control. However, this correlation is expected to be smaller than that between the automaticity subscale and the SRBAI.

Lastly, while previous studies have demonstrated a good factor structure for a three-process fruit and vegetable habit measure, it is unclear as to whether the additional processes (i.e. patterned response and negative consequences for non-performance) contribute to predicting fruit and vegetable consumption above that already accounted for by automaticity and established measures in the field, e.g. measures of intention and attitudes based on The Theory of Planned Behavior. If the patterned response and negative consequences for non-performance processes do not account for additional variance in consumption beyond measures of automaticity, then it would be parsimonious to use a single automaticity subscale that reduces the time burden for participants. If however, the processes do account for additional variance in consumption beyond established measures in the field, then future examination of the processes may be warranted.

4.2.1 Aims

The aims of the study were to: (i) examine the structure of a three-process habit measure for fruit and vegetable consumption separately; (ii) examine the construct validity of the three-process measures; and (iii) examine the additional variance accounted for by the three habit processes beyond that of automaticity and measures of variables from the Theory of Planned Behavior. It was hypothesized that: (i) three-process habit measures
for fruit and vegetable consumption would be structurally sound; (ii) the automaticity process of the measure for both fruit and vegetable habits would be strongly correlated with an established measure of automaticity; and (iii) the habit processes would predict additional variance in fruit/vegetable consumption above that of automaticity and variables from the Theory of Planned Behavior.

4.3 Methods

4.3.1 Participants and General Procedure

Participants consisted of staff at The University of Western Australia and members of the Western Australian public ($N = 106$). They were recruited via email and an online bulletin board. Participants were provided with a link to an electronic information sheet, consent form and online questionnaire using LimeSurvey (www.limesurvey.com). After providing consent, participants completed an online questionnaire. The University of Western Australia Human Research Ethics Committee approved the study.

4.3.2 Measures

Demographic Measures

Demographic information including age, sex, body mass index, vegetarian/vegan status, highest level of education, combined household income and primary purchaser status was assessed for each participant. Vegetarian/vegan and primary grocery purchaser status were examined on a binary scale (yes/no). Highest level of education was examined on a four point scale (1 = year 10 or equivalent to 4 = apprenticeship or trade qualification). Combined household income was also examined on a four point scale (1 = <$15,000, to 4 = >$50,000).

Fruit/Vegetable Consumption Measures

For the following items, a serving of fruit was defined as, “one medium piece, two small pieces of fruit, or one cup of diced fruit.” A serving of vegetables was defined as, “half
a cup of cooked vegetables, one small potato or one cup of salad vegies.” These serving definitions were identical to those used in previous studies on fruit and vegetable consumption in Western Australian adults (Pollard et al., 2008).

Participants were asked, “On average, how many days per week do you eat fruit/vegetables?” with possible responses ranging from none to every day. Participants were then asked, “When you eat fruit/vegetables, how many servings a day do you usually eat?” These items were multiplied and then divided by seven to give an average daily consumption of fruits/vegetables. These items have been used in previous studies examining the Western Australian population and validated against a 24-hr food recall measure (Marks, Webb, Rutishauser, & Riley, 2001; Pollard et al., 2008).

Participants were asked to think about occasions when they ate 2 or more servings of fruit or 5 or more servings of vegetables within 24 hours and then to classify themselves into one of five stages of change. These item response categories were based on the stage-of-change model (J. O. Prochaska & Diclemente, 1984).

Self-Report Behavioral Automaticity Index

The Self-Report Behavioral Automaticity Index (SRBAI) was used to examine the level of automaticity associated with the consumption of fruit/vegetables (Gardner, Abraham, et al., 2012b). Each statement began with, “Eating fruit/vegetables is something” followed by four items; (i) I do automatically, (ii) I do without having to consciously remember, (iii) I do without thinking, and (iv) I start doing before I realise I’m doing it. Responses were made on a seven point scale with (1) indicating that participants totally disagreed with the statement and (7) indicating that participants totally agreed with the statement.

Fruit/Vegetable Habit Processes
Participants were instructed to read each of the habit items and select the number that indicated how much they agreed with the statement on a six-point scale. A score of one for an item indicated that they thought the statement was not reflective of them while a score of six indicated that the statement was very reflective of them. The habit items were identical to those used in Studies 1 and 2 (Chapter 3), with additional patterned response items taken from existing habit measures (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2013) and factors identified in the literature (e.g. same time of day and same location each day).

Automaticity was assessed with four items; (i) When I eat fruit/vegetables, I do not consciously remember deciding to do so, (ii) When I start eating fruit/vegetables, I do so spontaneously and automatically, (iii) I eat fruit/vegetables as a snack without consciously realising it, and (iv) When I eat fruit/vegetables, I do not always remember choosing them in my meal.

Pattern response was assessed using five items; (i) I eat fruit/vegetables in the same locations each day (e.g. home, work), (ii) I eat fruit/vegetables in the same meal each day (e.g. a banana with breakfast or an apple for a snack/salad with dinner or a carrot for a snack), (iii) I eat the same fruit/vegetables each day (e.g. an apple or a banana/carrots or peas), (iv) I eat fruit/vegetables in a similar pattern each day, and (v) I eat fruit/vegetables in the same way each time.

Negative consequences for non-performance was measured using four items; (i) If I don’t eat fruit/vegetables, I feel guilty, (ii) If I don’t eat fruit/vegetables, I feel unhealthy, (iii) If I don’t eat fruit/vegetables, I feel sick, and (iv) If a meal doesn’t include fruit/vegetables, I find it unsatisfying.

Fruit/Vegetable Theory of Planned Behaviour Processes
For the Theory of Planned Behaviour processes, items were modelled off previous research examining the relationships between the processes and fruit consumption habits (de Bruijn, 2010). All responses were given on a five-point scale.

Intention was computed as the average of the items, “I intend to eat at least two servings of fruit/five servings of vegetables per day” and, “I am sure I will eat at least two servings of fruit/five servings of vegetables per day” with possible responses ranging from, 1= No, definitely not, to 5= Yes, definitely.

Instrumental attitude was calculated as the average of the items, “I would consider eating at least two servings of fruit/five servings of vegetables per day to be,” 1 = Very bad, to 5 = Very good and, “I would consider eating at least two servings of fruit/five servings of vegetables per day to be,” 1 = Very unhealthy, to 5 = Very healthy.

Affective attitude was calculated as the average of the items, “I would consider eating at least two servings of fruit/five servings of vegetables per day to be,” 1 = Very unpleasant, to 5 = Very pleasant and, “I would consider eating at least two servings of fruit/five servings of vegetables per day to be,” 1 = Very tasteless to 5 = Very tasteful.

Subjective norm was calculated as the average of the items, “My parents believe I should eat at least two servings of fruit/five servings of vegetables per day”, “My friends believe I should eat at least two servings of fruit/five servings of vegetables per day”, “My partner believes I should eat at least two servings of fruit/five servings of vegetables per day” and “My colleagues believe I should eat at least two servings of fruit/five servings of vegetables per day,” with 1 = No, definitely not, to 5 = Yes, definitely.

Perceived behavioural control was calculated as the average of the items, “I find eating at least two servings of fruit/five servings of vegetables per day,” 1 = Very difficult, to 5 = Very easy and, “I am sure I will succeed in eating at least two servings
of fruit/five servings of vegetables per day,” 1 = No, definitely not, to 5 = Yes, definitely.

4.3.3 Statistical Analyses

The Statistical Package for the Social Sciences version 20.0 (SPSS 20) was used to conduct data screening, correlational, regression and ANOVA analyses. A cutoff of $p < .05$ was used in order to establish statistical significance. Descriptive statistics were conducted for all variables in order to obtain means (M), standard deviations (SD), ranges and frequencies. The data were initially screened for missingness and normality.

One-hundred and six participants completed at least 50% of the items in the online survey and included in the present study. Missing data from these participants ranged from 0-7% for the habit processes and up to 40% for the subjective norm process. Missingness was therefore handled in two ways; (i) to assess the structural fit of the habit factors, the estimate means and intercepts through the maximum likelihood feature of AMOS 20.0 was used and, (ii) for the remaining analyses, power was maximised by imputing missing values using the multiple linear regression missing data feature of SPSS 20. This method computes multiple linear regression estimates and adds residuals from a similar randomly selected complete case, or with a random normal deviate. When missing values are >10%, multiple linear regression with standard error estimation has been shown to be superior to mean imputation (Marshall, Altman, Royston, & Holder, 2010).

Univariate outliers (defined as scores greater than 3.3 standard deviations from the item mean) were trimmed and replaced with a score 3.3 standard deviations away from the item mean in order to maximise power. This affected no more than 3% of responses on any item. No multivariate outliers (Mahalanobis scores that exceeded the $p < .001$ critical value) were detected. Variables from the Theory of Planned Behavior, and
fruit consumption were identified as being significantly skewed. These variables were
square root transformed prior to regression analyses once normality was improved.

Confirmatory factor analysis was conducted using AMOS 20.0. To assess the
uni-dimensionality of each habit process, one-factor congeneric models were conducted
for the automaticity, negative consequences for non-performance and patterned
response processes. A non-significant chi-square value indicates good model fit.
However, as the chi-square value can be influenced by sample size, additional fit
indices were used to evaluate the fit of each factor and the overall measurement model.
Based on previous recommendations (Hu & Bentler, 1998), we assessed the Tucker-
Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of
Approximation (RMSEA) as they are robust to smaller sample sizes (N< 250). Values >
.95 and >.90 were considered good and acceptable fits respectively for the TLI and CFI
indices. Values of <.05 and <.10 were considered good and acceptable fits respectively
for the RMSEA indices (Hooper et al., 2008; Hu & Bentler, 1999).

SPSS 20.0 was used to conduct MANOVA to explore the differences in factor
responses across stages-of change. To test the additive effects of the habit processes,
hierarchical regression analyses were conducted with fruit/vegetable consumption as the
dependent variable and intention and the habit processes (patterned response,
automaticity and negative consequences for non-performance) in step 1 and
affective/instrumental attitude, subjective norm and perceived behavioral control in step
2.

4.4. Results

4.4.1 Participant Demographics

Demographic information of the sample is presented in Table 4.1. Participants were
predominantly female and were considered on the border of being average weight and
overweight. They were also likely to be university educated, primary grocery purchasers, non-vegetarian, and have a combined household income >$50,000 pa. Less than half (44.34%) of the participants reported consuming at least two serves of fruit per day and few (20.75%) reported consuming the recommended five or more serves of vegetables each day.

Table 4.1: Study 3 Descriptive characteristics (n = 106)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (M, SD)</td>
<td>40.29 (13.33)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>%Female</td>
<td>64.20%</td>
</tr>
<tr>
<td>BMI (M, SD)</td>
<td>25.21 (4.93)</td>
</tr>
<tr>
<td>Primary Purchaser</td>
<td></td>
</tr>
<tr>
<td>%Yes</td>
<td>69.80</td>
</tr>
<tr>
<td>%No</td>
<td>22.60</td>
</tr>
<tr>
<td>%Missing</td>
<td>7.50</td>
</tr>
<tr>
<td>Vegetarian/Vegan</td>
<td></td>
</tr>
<tr>
<td>%Yes</td>
<td>9.40</td>
</tr>
<tr>
<td>%No</td>
<td>84.00</td>
</tr>
<tr>
<td>%Missing</td>
<td>6.60</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td></td>
</tr>
<tr>
<td>%Year 10</td>
<td>.90</td>
</tr>
<tr>
<td>%Year 12</td>
<td>6.60</td>
</tr>
<tr>
<td>%University</td>
<td>83.00</td>
</tr>
<tr>
<td>%Apprenticeship</td>
<td>3.80</td>
</tr>
<tr>
<td>%Missing</td>
<td>5.70</td>
</tr>
<tr>
<td>Combined Annual Income</td>
<td></td>
</tr>
<tr>
<td>%&lt; $15,000</td>
<td>1.90</td>
</tr>
<tr>
<td>%$15,000 - $34,999</td>
<td>5.70</td>
</tr>
<tr>
<td>%$35,000 - $50,000</td>
<td>3.80</td>
</tr>
<tr>
<td>%&gt; $50,000</td>
<td>77.40</td>
</tr>
<tr>
<td>%Missing</td>
<td>11.30</td>
</tr>
</tbody>
</table>

Note: * denotes that 1 participant did not provide a response for this variable

4.4.2 Fruit Habit Processes Factor Analysis

Prior to examining the measurement models, one-factor congeneric models were conducted. All three of the proposed factors demonstrated adequate-to-good fit indices; patterned response, $\chi^2 (5) = 15.35, p = .009, TLI = .91, CFI = .97, RMSEA = .14 (.06-.22)$, automaticity, $\chi^2 (2) = 1.20, p = .55, TLI = 1.02, CFI = 1.00, RMSEA = .00 (.00-.02)$. 

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74
and negative consequences for non-performance, $\chi^2 (2) = 4.48, p = .11, TLI = .88, CFI = .98, RMSEA = .11 (.00-.25)$.

Once the congeneric models were conducted, two measurement models were examined; (i) a uni-dimensional habit model and (ii) a three-factor higher-order model. The uni-dimensional model demonstrated a poor fit to the data, $\chi^2 (65) = 403.33, p < .001, TLI = .35, CFI = .54$ and RMSEA = .22 (.20-.24). The higher-order model demonstrated a good fit to the data, $\chi^2 (62) = 84.61, p = .030, TLI = .96, CFI = .97, RMSEA = .06 (.02-.09)$, and a superior fit over the uni-dimensional model, $\Delta \chi^2 = 318.72, \Delta df = 3, p < .001$. Additionally, the higher-order factor model demonstrated good fit when predicting fruit consumption (Figure 4.1), $\chi^2 (74) = 107.48, p = .007, TLI = .94, CFI = .96, RMSEA = .07 (.04-.09)$. 
Figure 4.1: The higher-order fruit habit model (Study 3; $N = 106$). Values above single-headed arrows represent standardised factor loadings. All values are significant to $p < .05$. Numbers above the items represent squared multiple correlations. Aut = Automaticity; Neg = Negative consequences for non-performance; and Patt = Patterned Response, Fruit = Reported average fruit consumption (s/d).

4.4.3 Fruit Habit Factors, Current Fruit Consumption and Fruit Stages-of-change

To examine the inter-relationships of the three factors and their relations with fruit consumption, the behavioural items and each factor were summed and correlated with the behavioural self-reports. All factors showed a significant, modest to moderate positive relationship with at least one other factor (Table 4.2). Furthermore, the factors showed significant positive correlations with self-reported fruit consumption.

A MANOVA procedure was used to assess whether scores on the subscales increased throughout a history of fruit and vegetable consumption, as reflected by stage-of-change. Participants who reported being in the pre-contemplation, contemplation and preparation stages-of-change (32.08%) were recoded into a single category while those
in the action and maintenance stages (67.92%) were recoded into a second category.

Findings from this analysis revealed a significant multivariate effect for stage-of-change, $\lambda = .83, F(3, 106) = 6.89, p < .001, \eta_p^2 = .17$, with subsequent examination of univariate results confirming significant stage-related differences on all three subscales [$F(1, 104) = 9.99, p = .002, \eta_p^2 = .09$, for negative consequences for non-performance; $F(1, 104) = 12.20, p = .001, \eta_p^2 = .11$, for automaticity; $F(1, 104) = 8.88, p = .004, \eta_p^2 = .08$, for patterned response]. These differences are presented in Figure 4.2.
Table 4.2: Descriptive statistics for habit factors and correlations with reported fruit consumption (Study 3)

<table>
<thead>
<tr>
<th></th>
<th>M (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tr>
<td>Negative consequences for non-performance (1)</td>
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<td>1</td>
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<tr>
<td>Automaticity (2)</td>
<td>14.67 (5.76)</td>
<td>.39</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>(α = .89)</td>
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<tr>
<td>Patterned response (3)</td>
<td>19.66 (7.87)</td>
<td>.33</td>
<td>.21</td>
<td>1</td>
<td></td>
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<tr>
<td>(α = .91)</td>
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<tr>
<td>Fruit consumption (4)</td>
<td>1.80 (1.26)</td>
<td>.27</td>
<td>.41</td>
<td>.46</td>
<td>1</td>
<td></td>
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<tr>
<td>Self-report Automaticity Index (5)</td>
<td>20.42 (7.06)</td>
<td>.39</td>
<td>.79</td>
<td>.43</td>
<td>.62</td>
<td>1</td>
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<tr>
<td>(α = .94)</td>
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<tr>
<td>Intention (6)</td>
<td>3.97 (1.21)</td>
<td>.39</td>
<td>.51</td>
<td>.45</td>
<td>.71</td>
<td>.71</td>
<td>1</td>
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<td>(α = .94)</td>
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<tr>
<td>Instrumental Attitude (7)</td>
<td>4.71 (.51)</td>
<td>.33</td>
<td>.14</td>
<td>.26</td>
<td>.30</td>
<td>.21</td>
<td>.28</td>
<td>1</td>
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<tr>
<td>Affective Attitude (8)</td>
<td>4.53 (.66)</td>
<td>.34</td>
<td>.41</td>
<td>.32</td>
<td>.57</td>
<td>.58</td>
<td>.60</td>
<td>.50</td>
<td>1</td>
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<td>(α = .78)</td>
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<tr>
<td>Perceived Norms (9)</td>
<td>4.03 (.64)</td>
<td>.29</td>
<td>.33</td>
<td>.08</td>
<td>.20</td>
<td>.30</td>
<td>.29</td>
<td>.15</td>
<td>.26</td>
<td>1</td>
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<tr>
<td>(α = .75)</td>
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<tr>
<td>Perceived Behavioral Control (10)</td>
<td>3.99 (1.23)</td>
<td>.36</td>
<td>.58</td>
<td>.45</td>
<td>.75</td>
<td>.79</td>
<td>.91</td>
<td>.27</td>
<td>.65</td>
<td>.29</td>
<td>1</td>
</tr>
<tr>
<td>(α = .89)</td>
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</tbody>
</table>

Notes: correlation coefficients ≥|.20| are significant at p <.05; correlation coefficients ≥|.26| are significant at p < .01.
4.4.4 Fruit Habit Processes, Self-Report Behavioral Automaticity Index and Theory of Planned Behavior Regression Analyses

To examine whether the habit factors predicted unique variance in fruit consumption beyond that explained by Self-Report Behavioral Automaticity Index (SRBAI), automaticity, patterned response and negative consequences for non-performance processes were regressed onto fruit consumption (step 1) followed by responses on the SRBAI (step 2). When the habit processes and the SRBAI measure were included in the analysis, approximately 44% of the variance in fruit consumption was accounted for (Table 4.3).
To examine whether the habit processes predicted unique variance in fruit consumption beyond that explained by the variables of the TPB, a further hierarchical regression was performed. In the analysis, intention, automaticity, patterned response and negative consequences for non-performance were entered into the first step, followed by instrumental and affective attitudes, perceived norms and perceived behavioral control in the second step. When the sample was examined collectively, approximately 53% of the variance in fruit consumption was accounted for by intention and the habit processes, with intention and patterned response being significant predictors of fruit consumption (Table 4.4). Adding the additional TPB process measures accounted for an extra 7% of the variance in fruit consumption. Furthermore, when these additional processes were added to the regression model, perceived behavioral control was the only process considered to be a significant predictor of fruit consumption.

Table 4.3: Fruit consumption regression analysis. Fruit consumption (DV) with the Self-Report Behavioral Automaticity Index (SRBAI) and habit factors as predictors.

<table>
<thead>
<tr>
<th></th>
<th>Step 1</th>
<th></th>
<th>Step 2</th>
<th></th>
<th>F-change (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>$R^2$</td>
<td>β</td>
<td>$R^2$</td>
<td></td>
</tr>
<tr>
<td>Automaticity</td>
<td>.32**</td>
<td>.31</td>
<td>-.16</td>
<td>.44</td>
<td>$F(1, 101) = 23.15, p &lt; .001$</td>
</tr>
<tr>
<td>Patterned response</td>
<td>.38**</td>
<td></td>
<td>.21*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.01</td>
<td>.002</td>
<td></td>
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<tr>
<td>SRBAI</td>
<td></td>
<td>.65**</td>
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</table>

* indicates p < .05, ** p < .01
**Table 4.4:** Fruit consumption and Theory of Planned Behavior (TPB) regression analysis. Fruit consumption (DV) with TPB and habit factors as predictors.

<table>
<thead>
<tr>
<th>Step 1</th>
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<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intention</strong></td>
<td>.61**</td>
</tr>
<tr>
<td></td>
<td>.11</td>
</tr>
<tr>
<td><strong>Patterned response</strong></td>
<td>.19*</td>
</tr>
<tr>
<td></td>
<td>.14</td>
</tr>
<tr>
<td><strong>Automaticity</strong></td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>-.01</td>
</tr>
<tr>
<td><strong>Negative consequences for non-performance</strong></td>
<td>-.07</td>
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<tr>
<td></td>
<td>-.06</td>
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<tr>
<td><strong>Perceived behavioral control</strong></td>
<td>.53**</td>
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<td></td>
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<tr>
<td><strong>Instrumental attitude</strong></td>
<td>.05</td>
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<tr>
<td><strong>Affective attitude</strong></td>
<td>.12</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Perceived social norms</strong></td>
<td>-.01</td>
</tr>
</tbody>
</table>

* indicates p < .05, ** p< .01

### 4.4.5 Vegetable Habit Processes Factor Analysis

Prior to examining the measurement models, one-factor congeneric models were conducted. The patterned response and automaticity processes demonstrated poor-adequate fit indices: patterned response, $\chi^2 (5) = 28.93, p < .001$, TLI = .69, CFI = .90, RMSEA = .21 (.14-.29), and automaticity, $\chi^2 (2) = 10.79, p = .005$, TLI = .70, CFI = .94, RMSEA = .21 (.10-.33). The negative consequences for non-performance factor demonstrated good fit to the data, $\chi^2 (2) = 2.32, p = .31$, TLI = .99, CFI = 1.00, RMSEA = .04 (.00-.20).

Once the congeneric models were conducted, two measurement models were examined: (i) a uni-dimensional habit model and (ii) a three-factor higher-order model. The uni-dimensional model demonstrated a poor fit to the data, $\chi^2 (65) = 442.07, p < .001$, TLI = .10, CFI = .36, RMSEA = .24 (.22-.26). The higher-order model also demonstrated poor fit to the data, $\chi^2 (62) = 154.29, p < .001$, TLI = .77, CFI = .84, RMSEA = .12 (.10-.14), but provided a superior fit over the uni-dimensional model, $\Delta \chi^2 = 287.78, \Delta df = 3, p < .001$. Additionally, the higher-order model demonstrated a poor fit in predicting vegetable consumption (Figure 4.3), $\chi^2 (74) = 168.21, p < .001$, TLI = .78, CFI = .84, RMSEA = .11 (.09-.13).
4.4.6 Vegetable Habit Factors, Current Vegetable Consumption and Vegetable Stages-of-change

To examine the interrelationships of the three factors and their relations with vegetable consumption, the behavioural items and each factor was summed and correlated with the other factors and the behavioural self-reports. Negative consequences for non-performance and automaticity showed a significant, modest to moderate positive relationship with each other (Table 4.5). Furthermore, these two factors showed significant positive correlations with self-reported general vegetable consumption. The sizes of these correlations ranged from small ($r = .34$) to moderate ($r = .37$). Patterned...
response was unrelated to vegetable consumption and automaticity or negative consequences for non-performance.

A MANOVA procedure was used to assess whether scores on the subscales increased as a result of the individual’s history of vegetable consumption, as reflected by stage-of-change. Participants who reported being in the pre-contemplation, contemplation and preparation stages-of-change (33.01%) were recoded into a single category while those in the action and maintenance stages (66.99%) were recoded into a second category. Findings from this analysis revealed a significant multivariate effect for stage-of-change, $\lambda = .85$, $F(3, 102) = 6.10$, $p = .001$, $\eta^2_p = .152$, with subsequent examination of univariate results (presented in Figure 4.4) confirming significant stage-related differences on two of the three processes [$F(1, 104) = 8.70$, $p = .004$, $\eta^2_p = .08$, for negative consequences for non-performance; $F(1, 104) = 16.02$, $p < .001$, $\eta^2_p = .13$, for automaticity; $F(1, 104) = .013$, $p = .910$, $\eta^2_p < .001$, for patterned response].
### Table 4.5: Descriptive statistics for habit factors and correlations with reported vegetable consumption (Study 3)

|                                      | M (SD)     | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|--------------------------------------|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Negative consequences for non-performance (1) | 15.85 (5.20) | 1   |     |     |     |     |     |     |     |     |     |     |
| Automaticity (2)                     | 15.08 (5.30) | .43 | 1   |     |     |     |     |     |     |     |     |     |
| Patterned response (3)               | 20.41 (6.17) | .15 | .03 | 1   |     |     |     |     |     |     |     |     |
| Vegetable consumption (4)            | 3.43 (1.32)  | .32 | .35 | .02 | 1   |     |     |     |     |     |     |     |
| Self-report Behavioral Automaticity Index (5) | 22.20 (5.77) | .30 | .69 | .30 | .46 | 1   |     |     |     |     |     |     |
| Intention (6)                        | 3.51 (1.32)  | .41 | .48 | -.01| .61 | .44 | 1   |     |     |     |     |     |
| Instrumental Attitude (7)            | 4.74 (.46)   | .28 | .35 | .02 | .25 | .19 | .29 | 1   |     |     |     |     |
| Affective Attitude (8)               | 4.26 (.81)   | .33 | .54 | .04 | .50 | .53 | .57 | .40 | 1   |     |     |     |
| Perceived Social Norms (9)           | 3.78 (.74)   | .34 | .40 | .01 | .41 | .30 | .36 | .30 | .38 | 1   |     |     |
| Perceived Behavioral Control (10)    | 3.52 (1.32)  | .32 | .55 | -.05| .62 | .54 | .86 | .27 | .64 | .35 | 1   |     |

Notes: correlation coefficients ≥|.20| are significant at p < .05; correlation coefficients ≥|.26| are significant at p < .01.
4.4.7 Vegetable Habit Processes, Self-Report Behavioral Automaticity Index and Theory of Planned Behavior Regression Analyses

To examine whether the habit factors predicted unique variance in vegetable consumption beyond that explained by Self-Report Behavioral Automaticity Index, the automaticity, patterned response and negative consequences for non-performance processes were regressed onto vegetable consumption (step 1), followed by responses on the SRBAI measure (step 2). Vegetable consumption was shown to best be accounted for (~27% of the variance) when habitual processes (particularly negative consequences for non-performance) were entered into the regression alongside the SRBAI (Table 4.6).
Chapter Four: Differential Relationships Between Fruit and Vegetable Habits

To examine whether the habit processes predicted unique variance in vegetable consumption beyond that explained by the variables of the TPB a further hierarchical regression was performed. In the analysis, intention, automaticity, patterned response and negative consequences for non-performance were entered into the first step, followed by instrumental and affective attitudes, perceived norms and perceived behavioral control in the second step. When the sample was examined collectively, approximately 38% of the variance in vegetable consumption was accounted for by intention and the habit processes (Table 4.7), with intention being a significant predictor of vegetable consumption. Adding the additional TPB process measures accounted for an extra 8% of the variance in vegetable consumption. In the overall regression model, only perceived behavioral control and social norms were considered to be significant predictors of vegetable consumption.

Table 4.6: Vegetable consumption regression analysis. Vegetable consumption (DV) with the Self-Report Behavioural Automaticity Index (SRBAI) and habit factors as predictors.

<table>
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<tr>
<th></th>
<th>Step 1</th>
<th>Step 2</th>
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<tbody>
<tr>
<td></td>
<td>( \beta )</td>
<td>( R^2 )</td>
</tr>
<tr>
<td>Automaticity</td>
<td>.26*</td>
<td>.16</td>
</tr>
<tr>
<td>Patterned response</td>
<td>-.02</td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.22*</td>
<td></td>
</tr>
<tr>
<td>SRBAI</td>
<td>.49**</td>
<td></td>
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</tbody>
</table>

* indicates \( p < .05 \), ** \( p < .01 \)
Table 4.7: Vegetable consumption and Theory of Planned Behavior (TPB) regression analysis. Vegetable consumption (DV) with TPB and habit factors as predictors.

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<thead>
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<td>$R^2$</td>
<td>$\beta$</td>
<td>$R^2$</td>
<td>($F$)</td>
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<td>Intention</td>
<td>.55**</td>
<td>.38</td>
<td>.19</td>
<td>.46</td>
<td>$F(4, 97) = 3.62$, $p = .009$</td>
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<td>Automaticity</td>
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<td>Negative consequences for</td>
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<td>Perceived social norms</td>
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<td>.19*</td>
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* indicates $p < .05$, ** indicates $p < .01$

4.5 Discussion

The current study aimed to examine: (i) the factor structure of a three-process (patterned response, automaticity and negative consequences for non-performance) habit measure for fruit/vegetable consumption; (ii) the relationships between the three habit processes, fruit/vegetable consumption, automaticity, and variables based on the Theory of Planned Behavior for fruit and vegetables separately; and (iii) the additional variance in fruit consumption and vegetable consumption accounted for by the habit processes beyond that of behavioural automaticity and variables from the Theory of Planned Behavior.

Our findings supported the use of a three-process habit measure (patterned response, automaticity, and negative consequences for non-performance) in examining fruit consumption. Correlational analyses revealed that all three processes were significantly interrelated for fruit habits, and significantly correlated with current fruit consumption. Furthermore, participants who reported a stronger history of fruit consumption reported significantly higher scores on the habit processes than those with a weaker history of consumption. However, our findings did not support the use of a three-process habit measure for examining vegetable consumption. Correlational
analyses revealed that the patterned response process was unrelated to both the automaticity and negative consequences for non-performance processes. Additionally, while the automaticity and negative consequences for non-performance processes were significantly related to current vegetable consumption and increased with a stronger history of consumption, the patterned response process showed no significant relationship with current or previous vegetable consumption.

An inspection of the relationships between the habit processes and the variables from the Theory of Planned Behavior and Self-report Behavioral Automaticity Index provided overall support for the construct validity of the process measures. The automaticity process of the three-factor habit measure was strongly correlated with the Self-Report Behavioral Automaticity Index for both fruit and vegetable behaviours, suggesting that the measure from the three-process framework was capturing the spontaneity and lack of awareness in performing these behaviours (Gardner, Abraham, et al., 2012b; Verplanken & Orbell, 2003). The automaticity process of the three-factor habit measure was also strongly related to the intention to eat, and the perceived behavioural control for eating, both fruit and vegetables. This finding suggests that individuals who consume fruits and vegetables with minimal awareness generally intend to consume fruits and vegetables regularly and feel that doing so is within their volitional control. This is in agreement with previous research which has suggested that as behaviours become habitual, intentions are more likely to be acted upon (Chatzisarantis & Hagger, 2007; Gardner et al., 2011).

The negative consequence for non-performance process for both fruit and vegetable consumption was only weakly-to-moderately correlated with both affective and instrumental attitude. This finding suggests that generally having favourable expectations about the health benefits and liking of fruit and vegetables relates to
negative psychological consequences when consumption does not occur. However, the generally weak correlations between the processes suggests that favourable attitudes alone are not sufficient to account for why interrupting habitual fruit and vegetable consumption would result in these negative psychological states. Additionally, the remaining relationships between the habit process measures, and measures of automaticity and variables from the Theory of Planned Behavior were all weakly to moderately correlated. The lack of strong correlations between the processes and these variables demonstrate that, while related, the habit process measures may be capturing something distinct from the conscious process measures already used in the literature.

Regression analyses revealed that for both fruit and vegetable consumption, the inclusion of habit processes accounted for additional variance in consumption when compared to the SRBAI alone. However, there may be differences in how the habit processes account for the additional variance in fruit and vegetable consumption. The analyses indicated that in predicting fruit consumption, the patterned response process was considered a significant predictor in addition to the SRBAI, whereas for vegetable consumption, the negative consequences for non-performance process was a significant predictor in addition to the SRBAI. This suggests that different underlying processes may drive habitual fruit and vegetable consumption. However, while the habit processes accounted for a significant amount of variance in fruit and vegetable consumption alongside the SRBAI, the processes were no longer considered significant predictors of consumption when additional measures of the TPB were included in the analyses.

Taken together, these findings support the use of a three-process fruit habit measure and support the reliability and validity of the processes in predicting fruit consumption. While the proposed three-process habit measure was not supported for vegetable consumption, the automaticity and negative consequences for non-
performance processes were considered reliable and demonstrated good construct validity. Furthermore, the findings supported the inclusion of additional habit processes such as the patterning of responses and negative consequences for non-performance alongside automaticity when accounting for variance in fruit and vegetable consumption. Similarly, when the three-habit processes were included alongside intention, the patterned response factor was a significant predictor of fruit consumption and the negative consequences for non-performance process significantly predicted vegetable consumption. Incorporating these processes in studies of fruit and vegetable consumption may therefore contribute to explaining the intention-behaviour gap identified in previous research (Chatzisarantis & Hagger, 2007; M. Conner & Armitage, 1998). However, the predictive utility of the habit processes may be limited when additional measures from the Theory of Planned Behavior (e.g. Perceived Behavioral Control) are considered.

4.5.1 Limitations

These findings should be considered alongside some potential limitations. This study utilised a cross-sectional design. It is unclear as to whether increases in the negative consequences for non-performance, automaticity and patterned-response factors led to an increased history of repetition and overall fruit and vegetable consumption or whether the increased consumption and history of repetition led to stronger process responses. Furthermore, it is unclear whether increases in the habit processes drive actual behavioural change. Previous research has demonstrated strong correlations between the TPB variables and fruit and vegetable consumption (Klama, 2013), however, experimental research on whether interventions based on these processes drive behaviour change has been inconsistent (Kellar & Abraham, 2005; Kothe & Mullan, 2014; Kothe et al., 2012). Similarly, while correlations between nutrition behaviours
and habit strength have been moderate to strong (Gardner, 2015b; Gardner et al., 2011), research is still needed to determine if strengthening these processes leads to increases in behaviour.

Additionally, there was a large amount of missing data on the subjective norm variable (~40%). While missing data were handled using regression analysis, which has been shown to be a superior imputation method to mean imputation (Landerman, Land, & Pieper, 1997; Marshall et al., 2010), the relationships between the habit processes and the subjective norm variable may be unreliable. The size of the sample was also relatively small, and this may have influenced the reliability of the factor analyses. Although the fit indices examined were robust to small sample sizes (Hu & Bentler, 1998), future research should examine the factor structure of the habit processes and examine the relationships between the habit processes and the subjective norm variable in order to reaffirm the findings of the present study.

The measures examined in the current study were assessed by self-report. While many of the self-report measures utilized in the study have been previously validated and widely used in the Western Australian population, we do acknowledge that there is some criticism in the use of self-report measures in examining habitual behaviour. We encourage researchers to incorporate objective measures of habit alongside our self-report measure in order to further evaluate the measures’ construct validity.

4.5.2 Conclusion

This study provides psychometric support for a three-process habit measure (automaticity, patterned response and negative consequences for non-performance) for fruit consumption. The findings of this study also provide clues as to the processes that underlie fruit and vegetable habits. Specifically, the patterned response process may help drive habitual behaviour for fruit consumption, while the negative consequences
for non-response process might promote vegetable consumption habits. These findings could have important implications for designing dietary interventions. Together, they suggest that interventions designed to promote fruit consumption should emphasise different behaviour change processes than those designed to promote vegetable consumption. While experimental research is required, targeting processes such as the psychological benefits for consuming vegetables and the patterned/routinized nature in which fruit consumption occurs may allow for fruit and vegetable consumption to become habitual and promote long-term behaviour change.
Chapter Five: Impact of a Habit-based Intervention

5 Study 4: Impact of a Habit-focussed Informational Intervention on Fruit and Vegetable Consumption Among University Students: a Randomized Controlled Trial

This chapter is presented in the format of a journal article manuscript. A version of this chapter has been published (details listed below). Additional analyses have been included (noted as ‘secondary analyses’) in the chapter and have not been published. Minor changes to the published manuscript have been made to accommodate for these additional analyses.

Chapter Five: Impact of a Habit-based Intervention

5.0 Foreword

Studies 1-3 (Chapters Three and Four) examined the factor structure of three habit processes (patterned response, automaticity and negative consequences for non-performance) and their relationships with measures of cognitive predictors (e.g. intention and attitude) and current/past fruit and vegetable consumption. However, there is a need to examine whether the habit processes can be incorporated into interventions designed to change fruit and vegetable consumption behaviours. Furthermore, the small sample size and missing data on the social norms variable in Study 3 (Chapter Four) warrants a re-examination of the factor structure of the three habit processes for fruit and vegetable consumption and their relationships to measures of processes from The Theory of Planned Behavior.

The present chapter aims to extend upon previous habit research in the field by examining the effectiveness of a habit-based informational intervention on changing the fruit and vegetable consumption behaviours of young adults. An additional aim of the chapter is to replicate the findings of Chapter Four by examining the factor-structure of three-process fruit and vegetable habit measures and their relationships with measures of cognitive processes.
5.1 Abstract

The primary purpose of the present study was to assess the effectiveness of a habit-based intervention delivered by e-mail or sms in improving fruit and vegetable consumption among young adults. Additionally, the study aimed to examine the factor structure and predictive validity of three-process habit measures for fruit consumption and vegetable consumption. An eight-week randomized controlled trial compared the effectiveness of three different types of message content and two delivery methods on habit strength and consumption of fruits and in vegetables in 71 undergraduate participants. A significant message content by time interaction indicated that the habit-based intervention improved fruit consumption over the eight-week period. Vegetable consumption significantly increased over the intervention period regardless of message content. Delivery method did not influence these results. Messages based on a habit framework can be utilised to improve fruit consumption in young adults. Furthermore, simply reminding young adults to be conscious of their food choices may be sufficient to improve their overall vegetable consumption. Additionally, the study confirmed a three-process factor structure for fruit consumption and supported the inclusion of a multi-process habit measure for predicting vegetable consumption.
Chapter Five: Impact of a Habit-based Intervention

5.2 Background

Sufficient fruit and vegetable consumption may protect against some cancers, chronic illness and obesity (Gundgaard, Nielsen, Olsen, & Sorensen, 2003; Ledoux, Hingle, & Baranowski, 2011; Riboli & Norat, 2003). To promote fruit and vegetable consumption, The Western Australian Department of Health designed a social marketing campaign, ‘Go for 2 and 5’ (www.gofor2and5.com.au), which launched nationally in 2005 and raised awareness of the need to consume at least two serves of fruit and five serves of vegetables each day (Department of Health and Ageing, 2007; Pollard et al., 2008; Pollard, Miller, et al., 2009). Despite increased awareness, only half of all Australian adults report eating two servings of fruit each day and only 8.2% report eating five servings of vegetables each day (Australian Bureau of Statistics, 2013). Importantly, younger adults 18-34, were identified as the lowest fruit and vegetable consumers.

Young adults tend to be unconcerned about their future health (Betts et al., 1995) and may therefore engage in a variety of high-risk behaviours (Gore et al., 2011). The increased participation in health-adverse behaviours can lead to the development of chronic illness in later life, for which fruit and vegetable consumption is a protective factor. Fruit and vegetable interventions targeting young adults may result in a reduced long-term health burden, as eating patterns developed during early adulthood are often maintained into later life (Dawson, Schneider, Fletcher, & Bryden, 2007; Kreausukon, Gellert, Lippke, & Schwarzer, 2012). At the same time, interventions targeting this group need to consider the life circumstances and time burdens that young adults may face, e.g. socialising, tertiary studies and paid employment (Kreausukon et al., 2012; Rozmus, Evans, Wysochansky, & Mixon, 2005), and deliver information in a timely and accessible manner.
Young adults, particularly university students, are strong users of internet and mobile phone technology (Pew Research Internet Center, 2012; Skierkowski & Wood, 2012). Delivering intervention messages to students via internet-based communication (e.g. e-mail) may be accessible and cost-effective, as computer facilities and e-mail accounts are available on university campuses. However, as students may not check their e-mails as regularly as they do text-messages on their mobile phones (Kennedy, Judd, Churchward, Gray, & Krause, 2008), interventions that deliver information via text-messaging could be especially effective. Previous research has demonstrated that web-based interventions that included additional messages delivered by sms led to large effects on behavior, while web-based interventions that included additional content delivered by e-mail only produced small effects on behaviour (Webb, Joseph, Yardley, & Michie, 2010). A recent review of sms-delivered interventions demonstrated generally positive short-term health outcomes (Fjeldsoe, Marshall, & Miller, 2009). However, many of the studies within the review provided additional material to participants such as e-mails or informational pamphlets. To our knowledge, no studies have examined the effectiveness of informational interventions targeting fruit and vegetable consumption using either e-mail or sms as the exclusive mode of message delivery.

In addition to the issue of delivery method, dietary behaviours are known to be multifaceted and a difficult target for change (Kreausukon et al., 2012; Milligan et al., 1997). Informational interventions in this area should therefore focus on delivering messages based on theoretical principles in order to maximise their potential impact (Baker et al., 2010). Accordingly, prior interventions have focused on changing attitudes, self-efficacy and intentions towards consumption of fruits and vegetables in an effort to influence behaviour (Kellar & Abraham, 2005; Kreausukon et al., 2012;
Richards, Kattelmann, & Ren, 2006). While these interventions have produced modest short-term increases in consumption, it is unclear whether they are capable of producing longer-term behaviour change. Strategies that deliberately emphasise processes associated with the habitual aspects of behaviour may prove useful for promoting longer-term change (Brug et al., 2006; de Bruijn, 2010; de Bruijn et al., 2007; Verplanken & Faes, 1999).

Habitual behaviours are those that are enacted automatically (without intent or awareness) in relation to specific cues (Verplanken & Orbell, 2003). Previous research has demonstrated that when habitual food consumption takes place in a consistent context (e.g. eating popcorn in a theatre of snacking in front of the TV), environmental cues can activate behavior and mechanisms such as hunger and enjoyment of the food become less relevant for its subsequent occurrence (Neal et al., 2011). Furthermore, repeating simple nutrition behaviours, such as eating a piece of fruit with morning tea each day, have been shown to increase the automaticity (spontaneity and lack of conscious awareness) with which the behaviour was later performed (Lally et al., 2010).

Habitual health behaviours may also result in negative psychological consequences (e.g. feelings of guilt or being unhealthy) when they are not performed (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2013). Interventions that seek to strengthen the habitual nature of fruit and vegetable consumption should investigate the effectiveness of messages that encourage the patterning (routinisation) of consumption and emphasise the psychological benefits of their regular consumption.

Habit-based interventions have not been applied towards fruit and vegetable consumption. However, the associated processes provide guidance for message content in these types of interventions. For example, the patterning (routinisation) of fruit and vegetable consumption could be targeted by messages that emphasise consuming the
same types of fruits and vegetables at the same time of day and in the same location each time (Grove et al., 2013). Messages that focus on promoting self-reflection after consuming fruits and vegetables (e.g. feeling healthy after eating fruits and vegetables and thinking about how tasty fruits and vegetables can be) may increase the positive feelings participants experience for their continued consumption (Grove et al., 2013; van't Riet et al., 2011). Furthermore, making fruits and vegetables more visible (e.g. placing a fruit bowl in the centre of the dining table or keeping vegetables on the top shelf of the fridge) may strengthen the contextual cues for which future fruit and vegetable consumption can be triggered (Grove et al., 2013; van't Riet et al., 2011; Verplanken & Wood, 2006).

Additionally, previous research examining the relationships between habit processes and fruit and vegetable consumption (Chapter 4) was limited by a small sample size. Findings from the study indicated that targeting processes such as the patterning of response for fruit consumption and negative consequences for non-performance for vegetable consumption might increase the subsequent consumption of fruits and vegetables. Furthermore, the study found that three habit processes were structurally sound for fruit consumption. However, there is a need to replicate these findings in an independent sample.

The primary objective of the present study was to assess the impact of messages emphasising habit processes and delivered by e-mail or sms on factors associated with fruit and vegetable consumption. Two active control groups were used to determine if the habit-based intervention had a greater impact than generic fruit and vegetable consumption messages already available to Western Australian adults through previous and current public health campaigns: ‘Go for 2 and 5’, and ‘LiveLighter’. More specifically, the habit-based intervention was expected to produce: (a) significant
increases in the strength of processes supporting habitual fruit and vegetable consumption (i.e. patterning of action; automaticity; negative consequences for non-performance); (b) significant increases in the self-reported consumption of fruits and vegetables; and (c) more change in the process and consumption measures than generic fruit and vegetable consumption messages.

The secondary objective of the present study was to replicate the relationships between the habit processes, fruit and vegetable consumption and variables including attitudes and intentions based on the Theory of Planned Behavior identified in previous research (Chapter 4). It was expected that: (a) the three habit processes would be structurally sound for fruit consumption; (b) the three habit processes (automaticity, patterned response and negative consequences for non-performance) processes would account for significant variance in fruit and vegetable consumption; and (c) the habit processes would account for additional variance in consumption compared to intention alone.

5.3 Methods

5.3.1 Participants and Procedure

Undergraduate students enrolled in a first-year Psychology unit at The University of Western Australia participated in the study. Participants were recruited through an electronic bulletin board between August and November 2013. Participants were eligible to participate if they had access to a mobile phone and a student e-mail account. Interested participants accessed a web-link that presented them with an online information sheet and consent form. One-hundred and sixty-five participants provided informed consent and completed the initial online measures. Of these, four were over the age of 34 and were not considered representative of the young adult population of interest. The remaining 161 participants were randomly assigned to one of six
conditions using a random number generator through Research Randomizer (www.randomizer.org).

Participants were randomised into groups that received messages via e-mail or sms and into one of three message content groups. The message content variations consisted of an intervention group that received messages based on habit framework principles (Grove et al., 2013; Grove & Zillich, 2003) and two active control groups; one that received general fruit and vegetable consumption messages and one that received general healthy eating messages. Thus, there were three groups that received content by email [an intervention group (n = 30), active control group 1 (n = 29), and active control group 2 (n = 29)] and three groups that received content via sms [an intervention group (n = 26), active control group 1 (n = 24) and, active control group 2 (n = 23)].

After participants had been randomised into one of these six groups, they were sent 24 informational messages over an eight-week period. During this period, 11 participants were lost to drop-out. Eight weeks later, after participants had received all 24 messages, an invitation to complete follow-up measures was sent to the remaining 150 participants. Approximately half of these participants (n = 72) completed the follow-up measures, with retention rates essentially the same across the six groups (see Figure 5.1).

**Intervention and Control Groups**

The study employed three message content groups, with a habit-based message framework being considered the intervention group and a general fruit and vegetable tips group (control group 1) and general healthy eating tips group (control group 2) as active controls. The intervention group messages aimed to strengthen the automaticity of fruit and vegetable consumption by improving the patterned nature of consumption
and emphasising the psychological benefits of consuming fruits and vegetables.

Messages sent to participants provided strategies that focussed on self-reflection (e.g. “Think about how healthy you feel after you eat vegetables”), stimulus control and environmental re-evaluation (e.g. “Place a piece of fruit somewhere that’s easy to see before you go to sleep. Make it the first thing you see in the morning”) and an emphasis on eating the same types of fruit/vegetables at the same time each day (e.g. “Eat a piece of fruit for morning tea each day”). Half the messages sent to participants emphasised strategies to improve fruit consumption, while the remainder focussed on vegetable consumption (Table 5.1).

The first control group received general fruit and vegetable tips (e.g. “Chop and add vegies to an omelette or savoury pancake”), taken from the ‘healthy eating tips’ section of the ‘Go for 2 and 5’ website (Western Australia Deparment of Health, n.d.). The purpose of the first control group was to determine whether the intervention group messages changed fruit and vegetable consumption to a greater extent than messages already incorporated into public health campaigns. Half the messages sent to participants emphasised strategies to improve fruit consumption, while the remainder focused on vegetable consumption.
Figure 5.1: Consort flowchart with number of participants who completed each condition.
<table>
<thead>
<tr>
<th>Message</th>
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<tbody>
<tr>
<td>1. Eat a piece of fruit for morning tea each day.</td>
</tr>
<tr>
<td>2. Include a salad with your dinner every night.</td>
</tr>
<tr>
<td>3. Eat your two favourite types of fruit each day.</td>
</tr>
<tr>
<td>4. Eat your favourite types of vegetables each day</td>
</tr>
<tr>
<td>5. Eat fruit in the same meals each day.</td>
</tr>
<tr>
<td>6. Eat vegetables in the same meals each day.</td>
</tr>
<tr>
<td>7. The next time you are having deep fried chips with a meal think about choosing a salad instead.</td>
</tr>
<tr>
<td>8. Keep vegetables and salads on the top shelf of your fridge so you can easily see them.</td>
</tr>
<tr>
<td>9. Keep a bowl of fruit in the centre of your dining table so you can easily see how much fruit you are eating.</td>
</tr>
<tr>
<td>10. Keep fruit on hand when you are stressed. A handful of cranberries and cashews can be a good alternative to a chocolate bar.</td>
</tr>
<tr>
<td>11. Keep vegetables on hand when you are stressed. Some roasted vegetables with olive oil can be a good alternative to deep fried chips.</td>
</tr>
<tr>
<td>12. Place a piece of fruit somewhere that’s easy to see before you go to sleep. Make it the first thing you see in the morning.</td>
</tr>
<tr>
<td>13. Wrap some vegetables (such as carrots) and keep them near your phone and wallet overnight. That way you remember to take them with you the next day.</td>
</tr>
<tr>
<td>14. Prepare a shopping list each week in which you include at least two fruits.</td>
</tr>
<tr>
<td>15. Prepare a shopping list each week in which you include at least three vegetables.</td>
</tr>
<tr>
<td>16. Think about how healthy you feel after you eat a piece of fruit.</td>
</tr>
<tr>
<td>17. Think about how healthy you feel after you eat vegetables.</td>
</tr>
<tr>
<td>18. Think about how well you feel after you eat fruit.</td>
</tr>
<tr>
<td>19. Think about how well you feel after you eat vegetables.</td>
</tr>
<tr>
<td>20. Take some time to think about how tasty fruit is while you are eating it.</td>
</tr>
<tr>
<td>21. Take some time to think about how tasty vegetables are while you are eating it.</td>
</tr>
<tr>
<td>22. The next time you are planning to have dessert think about choosing fruit or fruit salad.</td>
</tr>
<tr>
<td>23. Think about how easily you feel full after eating fruit.</td>
</tr>
<tr>
<td>24. Think about how easily you feel full after eating vegetables.</td>
</tr>
</tbody>
</table>
The second control group received general dietary tips for maintaining a healthy weight (e.g. “Try using a smaller plate during main meals”) derived from the ‘top tips to live lighter’ section of the ‘LiveLighter’ website (National Heart Foundation Western Australia, 2013). The purpose of this control group was to determine whether simply priming individuals about fruits and vegetables (i.e. the intervention group and control group 1) was responsible for any increases in consumption.

5.3.2 Measures

Demographics

Information on the age, sex, BMI, availability of fruits/vegetables, primary purchaser and vegetarian/vegan status of the participants was assessed. Participants were asked on a binary ‘yes/no’ scale whether; (i) they had fruits and vegetable regularly available at their residence, (ii) whether they were the primary purchaser of groceries and (iii) whether they were vegetarian/vegan.

Fruit and Vegetable Consumption

For the consumption items, a serving of fruit was defined as, “one medium piece of fruit, two small pieces of fruit, or one cup of diced fruit”, while a serving of vegetables was defined as, “half a cup of cooked vegetables, one small potato or one cup of salad vegies”. Participants were asked, “On average, how many days per week (over the past week) did you eat fruit/vegetables?” with possible responses from none (0) to every day (7). Participants were also asked, “When you ate fruit/vegetables, how many servings a day did you usually eat?” These items were multiplied and then divided by seven to give an average number of fruit/vegetable servings consumed per day over the past week. These definitions of fruit and vegetable servings and measures of consumption have been used in previous studies monitoring the success of the ‘Go for 2 and 5’
campaign in Western Australia (Pollard et al., 2008) and have been validated against a 24-hour food intake measure (Marks et al., 2001).

**Habit Processes**

The habit process items were modelled on those used in examining aerobic exercise behaviours (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2013) and were adapted for fruit and vegetable consumption. Each statement began with, “The following statements describe feelings, attitudes, and behaviours related to eating fruit/vegetables. Please read each statement, and select the number that indicates how much you agree or disagree with it.” Four items examined the automaticity of fruit/vegetable consumption (e.g. “When I eat fruit, I do not consciously remember deciding to do so”). Five items examined the extent to which fruit/vegetable consumption was patterned (e.g. “I eat vegetables in the same meals each day”). The remaining four items examined negative psychological consequences for not consuming fruits/vegetables (e.g. “If I don’t eat vegetables, I feel unhealthy”). All responses were made on a six-point scale (1 = Not true for me, 6 = Very true for me).

**Message Incorporation**

Following the intervention, participants were asked, ‘What percentage of messages did you attempt to put into practice throughout your daily routine?’ Participants responded on a percentage scale that ranged from 0-100%.

**Fruit/Vegetable Theory of Planned Behavior Processes**

For the Theory of Planned Behaviour processes, items were modelled off previous research examining the relationships between the processes and fruit consumption habits (de Bruijn, 2010). The items were identical to those used in Study 3 (Chapter 4) and reflected measures of intention, instrumental/affective attitudes, perceived social norms and perceived behavioral control. All responses were given on five-point scales.
5.3.3 Analyses

Data Screening

Normality and skewness were determined by visual inspection of item histograms and obtaining an absolute value of skewness and kurtosis between -3.3 to 3.3 (Field, 2009). The data were screened for univariate outliers (defined as scores 3.3 standard deviations from the mean) and multivariate outliers (Mahalanobis scores that exceeded the p < .001 critical value) prior to the analyses.

Primary Analyses

Mixed-design ANOVA was conducted for the dependent variables with two levels of time (pre-intervention versus post-intervention), three levels of message content (intervention messages versus control group 1 versus control group 2), and two levels of message delivery (e-mail versus sms). A two-way ANOVA was conducted to determine message content and delivery differences in message incorporation.

Secondary Analyses

Secondary analyses were conducted to replicate the findings of Chapter 4, by examining the factor structure of the multi-process habit measures and the predictive value that these processes add when assessed alongside variables from The Theory of Planned Behavior.

Confirmatory factor analyses were conducted using AMOS 20.0. To assess the uni-dimensionality of each habit process, one-factor congeneric models were conducted for the automaticity, negative consequences for non-performance and patterned response processes. A non-significant chi-square value indicates good model fit. However, as the chi-square value can be influenced by sample size, additional fit indices were used to evaluate the fit of each factor and the overall measurement model. Based on previous recommendations (Hu & Bentler, 1998), we assessed the Tucker-
Lewis Index (TLI), Comparative Fit Index (CFI), Standardised Root Mean Square (SRMR) and Root Mean Square Error of Approximation (RMSEA) as they are robust to smaller sample sizes (N< 250). Values > .95 and >.90 were considered good and acceptable fits respectively for the TLI and CFI indices, while values of < .05 and <.08 were considered good and acceptable fits respectively for the SRMR. Values of <.05 and <.10 were considered good and acceptable fits respectively for the RMSEA indices (Hooper et al., 2008; Hu & Bentler, 1999).

To test the additive effects of the habit processes, hierarchical regression analyses were conducted with baseline fruit/vegetable consumption as the dependent variable and intention and habit processes in step 1, and the remaining cognitive factors in step 2.

5.4 Results

Of the 72 participants who completed the follow-up measures, one completed them outside the allotted time and was removed from subsequent analyses. Prior to the analyses, completers and non-completers were compared on group allocation, demographic information, baseline fruit/vegetable consumption, and baseline habit process scores. No significant differences were found on any of the variables indicating that completers were similar to non-completers (all $F$-values < 3.69, all $p$-values > 0.06).

5.4.1 Participant Demographic and Baseline Measures

The demographic information for the 71 participants who completed the initial and follow-up measures is presented in Table 5.2. Differences in the demographic variables and baseline consumption and habit measures were examined between the six groups. Participants within the six groups were similar in age, BMI, availability of fruits and vegetables in their households, primary purchaser status and gender distribution.
However, there was a marginally significant difference between groups on vegetarian/vegan distribution, $\chi^2 (5) = 10.07, p = .05$.

### 5.4.2 Intervention Impact

**Fruit Consumption and Habit Strength Measures**

A mixed-design ANOVA indicated that the time main effect was not significant for fruit consumption, $F(1, 65) = 1.31, p = .26, \eta^2 = .02$. Similarly, no interaction between time and delivery method was found, $F(1, 65) = .06, p = .81, \eta^2 = .001$, nor was the three-way interaction significant, $F(2, 65) = 1.42, p = .25, \eta^2 = .04$. However, a significant interaction was obtained between time and message content, $F(2, 65) = 5.22, p = .008, \eta^2 = .14$ (Figure 5.2). Follow-up analyses on this interaction revealed that the group receiving habit-based messages increased their fruit consumption over the eight-week intervention period, $t(26) = 3.83, p = .001, d = .42$, but no change in fruit consumption occurred for the groups receiving generic fruit consumption messages, $t(22) = -.44, p = .66$, or general nutrition messages, $t(20) = -.87, p = .40$.

Analysis of the habit processes related to fruit consumption revealed no main effects or interactions for automaticity (all $F$-ratios < 1.33, all $p$-values >.27) or negative consequences for non-performance (all $F$-ratios < 2.11, all $p$-values >.14). However, a significant main effect of time, $F(1, 65) = 5.96, p = .02, \eta^2 = .08$, as well as a
<table>
<thead>
<tr>
<th></th>
<th>E-mail</th>
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<th></th>
<th>SMS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention group (n = 15)</td>
<td>Control group 1 (n = 14)</td>
<td>Control group 2 (n = 11)</td>
<td>Intervention group (n = 12)</td>
<td>Control group 1 (n = 9)</td>
<td>Control group 2 (n = 10)</td>
</tr>
<tr>
<td>Age (M, SD)</td>
<td>20.27 (4.62)</td>
<td>19.86 (3.98)</td>
<td>20.82 (4.85)</td>
<td>19.00 (3.86)</td>
<td>18.56 (1.13)</td>
<td>18.10 (0.99)</td>
</tr>
<tr>
<td>BMI (M, SD)</td>
<td>21.44 (2.16)</td>
<td>19.99 (3.13)</td>
<td>22.08 (2.96)</td>
<td>22.90 (6.18)</td>
<td>20.53 (2.54)</td>
<td>22.64 (4.63)</td>
</tr>
<tr>
<td>Gender</td>
<td>86.70%</td>
<td>85.70%</td>
<td>54.50%</td>
<td>91.70%</td>
<td>66.70%</td>
<td>100%</td>
</tr>
<tr>
<td>% Female</td>
<td>100%</td>
<td>100%</td>
<td>90.90%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Availability</td>
<td>26.70%</td>
<td>28.60%</td>
<td>36.40%</td>
<td>25.00%</td>
<td>11.10%</td>
<td>22.00%</td>
</tr>
<tr>
<td>Primary purchaser</td>
<td>0%</td>
<td>14.30%</td>
<td>27.30%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Vegetarian/vegan</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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</tbody>
</table>
significant time x message content interaction, $F(2, 65) = 6.92, p = .002, \eta_p^2 = .18$, was found for the patterned response measure (Figure 5.3). Follow-up analyses on the interaction indicated that the group receiving habit-based messages became more patterned in their fruit consumption over the eight-week intervention period, $t(26) = 4.32, p = .0002, d = .64$, but no change in patterned response occurred for the groups receiving generic fruit consumption messages, $t(22) = 1.19, p = .25$, or general nutrition messages, $t(20) = -1.22, p = .24$.

**Vegetable Consumption and Habit Strength Measures**

A mixed-design ANOVA revealed a significant main effect of time for vegetable consumption, $F(1, 65) = 7.22, p = .009, \eta_p^2 = .10$, with participants reporting more vegetables consumed post-intervention ($M = 2.66$) than at baseline ($M = 2.32$). The interaction between time and message delivery was not significant, $F(1, 65) = .28, p = .60, \eta_p^2 = .004$. Similarly, no significant interactions were found between time and message content, $F(2, 65) = 2.18, p = .12, \eta_p^2 = .06$, or between time, message delivery and message content, $F(2, 65) = 1.24, p = .30, \eta_p^2 = .04$. No impact of the intervention was observed on any of the habit processes related to vegetable consumption (all $F$-ratios < 2.78, all $p$-values > .07).

**5.4.3 Message Incorporation**

Mode of delivery (sms versus e-mail) did not influence the percentage of dietary strategies that participants reported incorporating into their daily routines, either alone or in combination with message content (all $F$-ratios <1.26, all $p$-values > .27).

However, there was a significant difference in the percentage of strategies participants reported incorporating as a result of message content, $F(2, 65) = 4.54, p = .01$. Post-hoc analyses indicated that habit-based messages ($M = 41\%$) and the messages based on the
‘LiveLighter’ campaign ($M = 43\%$) were incorporated significantly more often than those based on the ‘Go for 2 and 5’ campaign ($M = 24\%$).

**Figure 5.2:** Interaction between time (pre- versus post-intervention) and message content (intervention group using habit-based messages versus control groups based on ‘Go for 2 and 5’ and ‘LiveLighter’ messages) for fruit consumption.
5.4.4 Secondary Analyses

Prior to conducting the secondary analyses, the initial 161 participants (<34 years of age) who provided baseline measures were examined for univariate and multivariate normality. Five participants were identified as univariate outliers and were excluded from subsequent analyses.

**Fruit Habit Processes Structural Fit**

Prior to examining the measurement model, one-factor congeneric models were conducted. The patterned response and automaticity processes demonstrated excellent fit indices: patterned response, $\chi^2 (5) = 6.07, p = .299$, TLI = .99, CFI = 1.00, RMSEA = .04 (.00-.12), SRMR = .03; automaticity, $\chi^2 (2) = 4.99, p = .083$, TLI = .96, CFI = .99,
RMSEA = .098 (.00-.21), SRMR = .03. The negative consequences for non-performance factor demonstrated a poor-adequate fit to the data, $\chi^2 (2) = 14.17, p = .001$, TLI = .81, CFI = .94, RMSEA = .20 (.11-.30), SRMR = .05.

Once the congeneric models were conducted, two measurement models (a uni-dimensional and a three-factor higher-order model) were examined. The uni-dimensional model demonstrated poor fit to the data, $\chi^2 (65) = 417.75, p < .001$, TLI = .38, CFI = .48, RMSEA = .19 (.17-.20), SRMR = .16. However, the proposed three-factor higher-order model demonstrated an adequate-good fit to the data, $\chi^2 (62) = 107.25, p < .001$, TLI = .92, CFI = .93, RMSEA = .07 (.05-.09), SRMR = .07 and a superior fit to the uni-dimensional model, $\Delta \chi^2 = 310.50, \Delta df = 3, p < .001$. Additionally, the three-factor higher-order model demonstrated acceptable fit for most indices when predicting fruit consumption (Figure 5.4), $\chi^2 (74) = 148.05, p < .001$, TLI = .88, CFI = .90, RMSEA = .08 (.06-.10), SRMR = .08.

**Fruit Habit Processes Regression Analyses**

Responses to the three habit processes at baseline were entered into a single step as predictors of baseline fruit consumption. The habit processes accounted for approximately 17% of the variance in fruit consumption with automaticity and patterned response being considered significant predictors (Table 5.3).

In order to examine whether the habit processes predicted variance in fruit consumption in addition to that of the Theory of Planned Behavior processes, a hierarchical regression was conducted in which intention and the habit processes were entered into a single step, followed by the remaining cognitive processes in the second step. The analysis revealed that the habit processes did not significantly account for additional variance beyond that of intention (Table 5.4).
Figure 5.4: The higher-order fruit habit model (Study 4; N = 156). Values above single-headed arrows represent standardised factor loadings. All values are significant to p < .05. Numbers above the items represent squared multiple correlations. Aut = Automaticity; Neg = Negative consequences for non-performance; and Patt = Patterned Response, Fruit = Reported average fruit consumption (s/d).

Table 5.3: Fruit consumption regression analysis. Fruit consumption (DV) with the habit factors as predictors.

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>R²</th>
<th>F-change (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automaticity</td>
<td>.27**</td>
<td>.17</td>
<td>F(3, 152) = 10.56, p &lt; .001</td>
</tr>
<tr>
<td>Patterned response</td>
<td>.22**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ** indicates significant at p < .01
Table 5.4: Fruit consumption and The Theory of Planned Behavior regression analysis. Fruit consumption (DV) with Theory of Planned Behavior processes and habit factors as predictors.

<table>
<thead>
<tr>
<th></th>
<th>Step 1</th>
<th></th>
<th></th>
<th>Step 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>R²</td>
<td>F-change (df)</td>
<td>β</td>
<td>R²</td>
<td>F (4, 147) = 1.27, p = .286</td>
</tr>
<tr>
<td>Intention</td>
<td>.61**</td>
<td>.48</td>
<td>.47**</td>
<td>.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patterned response</td>
<td>.11</td>
<td></td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automaticity</td>
<td>.12</td>
<td></td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>-.05</td>
<td></td>
<td>-.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived behavioral control</td>
<td></td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumental attitude</td>
<td></td>
<td>.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affective attitude</td>
<td></td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived social norms</td>
<td></td>
<td>-.05</td>
<td></td>
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</tr>
</tbody>
</table>

Note: ** indicates significant at p < .01

Vegetable Habit Processes Structural Fit

Prior to examining the measurement model, one-factor congeneric models were conducted. The patterned response process demonstrated poor fit to the data, $\chi^2 (5) = 79.46, p < .001$, TLI = .48, CFI = .74, RMSEA = .31 (.25-.37), SRMR = .11. The negative consequences for non-performance process demonstrated a poor-adequate fit to the data, $\chi^2 (2) = 15.43, p = .001$, TLI = .85, CFI = .95, RMSEA = .21 (.12-.31), SRMR = .05, while the automaticity process demonstrated excellent fit indices, $\chi^2 (2) = 1.37, p = .505$, TLI = 1.01, CFI = 1.00, RMSEA = .00 (.00-.14), SRMR = .01.

Once the congeneric models were conducted, two measurement models (a uni-dimensional and a three-factor higher-order model) were examined. The uni-dimensional model demonstrated a poor fit to the data, $\chi^2 (65) = 596.01, p < .001$, TLI = .30, CFI = .42, RMSEA = .23 (.21-.25). Furthermore, the three-factor higher-order model also demonstrated poor fit to the data, $\chi^2 (62) = 245.09, p < .001$, TLI = .75, CFI = .80, RMSEA = .14 (.12-.16), however, the three-factor higher-order model demonstrated a superior fit to the uni-dimensional model, $\Delta \chi^2 = 350.92, \Delta df = 3, p < .001$. Additionally, the three-factor higher-order model did not demonstrate an
acceptable fit when predicting vegetable consumption (Figure 5.5), $\chi^2 (74) = 264.48, p < .001$, TLI = .75, CFI = .78, RMSEA = .13 (.11-.15), SRMR = .10.

**Vegetable Habit Processes Regression Analyses**

Responses to the three habit processes at baseline were entered into a single step as predictors with baseline vegetable consumption as the dependent variable. The habit processes accounted for approximately 14% of the variance in vegetable consumption, with the negative consequences for non-performance process being considered a significant predictor of vegetable consumption (Table 5.5).

In order to examine whether the habit processes predicted variance in consumption in addition to that of the Theory of Planned Behavior processes, a hierarchical regression was conducted in which the habit processes and intention were entered into a single step, followed by the remaining cognitive predictors in the second step. The analysis revealed that the final regression model accounted for approximately 36% of the variance in vegetable consumption, with the negative consequences for non-performance process being considered a significant predictor of vegetable consumption alongside intention to consume vegetables and instrumental attitudes towards them (Table 5.6).
Figure 5.5: The higher-order vegetable habit model (Study 4; $N = 156$). Values above single-headed arrows represent standardised factor loadings. All values are significant to $p < .05$. Numbers above the items represent squared multiple correlations. Aut = Automaticity; Neg = Negative consequences for non-performance; and Patt = Patterned Response, Veg = Reported average vegetable consumption (s/d).

Table 5.5: Vegetable consumption regression analysis. Vegetable consumption (DV) with the habit factors as predictors.

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>$R^2$</th>
<th>F-change (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automaticity</td>
<td>.06</td>
<td>.14</td>
<td>$F(3, 152) = 8.48$, $p &lt; .001$</td>
</tr>
<tr>
<td>Patterned response</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td>.33**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ** indicates significant at $p < .01$
Table 5.6: Vegetable consumption and The Theory of Planned Behavior regression analysis. Vegetable consumption (DV) with Theory of Planned Behavior processes and habit factors as predictors.

<table>
<thead>
<tr>
<th></th>
<th>Step 1</th>
<th></th>
<th>Step 2</th>
<th></th>
<th>F-change (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>R²</td>
<td>β</td>
<td>R²</td>
<td></td>
</tr>
<tr>
<td>Intention</td>
<td>.44**</td>
<td>.32</td>
<td>.28*</td>
<td>.36</td>
<td>F(4, 147) = 2.55, p = .042</td>
</tr>
<tr>
<td>Patterned response</td>
<td>.04</td>
<td>-.03</td>
<td>.01</td>
<td>-.01</td>
<td></td>
</tr>
<tr>
<td>Automaticity</td>
<td>-.29**</td>
<td>.29**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative consequences for non-performance</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Perceived behavioral control</td>
<td>.15</td>
<td></td>
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<tr>
<td>Instrumental attitude</td>
<td>.21**</td>
<td></td>
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<tr>
<td>Affective attitude</td>
<td>.01</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Perceived social norms</td>
<td>-.10</td>
<td></td>
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</tbody>
</table>

Note: * indicates p < .05, ** p < .01

5.5 Discussion

Habit development is important because intentions to engage in positive health behaviours are more likely to be enacted upon when habit strength is high (Chatzisarantis & Hagger, 2007; Gardner et al., 2011). In this study, we examined whether a habit-based intervention improved the fruit and vegetable consumption of undergraduate university students. The intervention messages were designed to reflect potential strategies suggested in previous research that targeted underlying habit processes, i.e., automaticity, patterning of consumption and negative psychological consequences for non-performance (Grove et al., 2013; Kreausukon et al., 2012; Verplanken & Wood, 2006). Mixed-design analyses revealed significant message content by time interactions for fruit consumption itself as well as the extent to which fruit consumption followed a consistent pattern. Post-hoc analyses revealed that only the group receiving the habit-based messages improved their fruit consumption and the patterned nature by which they consumed fruit over the eight-week period. Additionally, the strength of the habit-based messages in improving fruit consumption (d = .42) is comparable to established intervention strategies (e.g. implementation...
intentions) in improving nutrition behaviours (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011). These findings suggest that the particular strategies used in the habit-based messages were responsible for the improvement in fruit consumption and that a habit-based framework may be a useful approach in targeting nutrition behaviours. Furthermore, a significant main effect of time was found for vegetable consumption suggesting that regardless of the message content, participants increased their overall vegetable consumption post-intervention.

Previous research has demonstrated that performing behaviours in a patterned manner increases the automaticity of subsequent performance (Lally et al., 2010). However, in the present study, responses to fruit automaticity did not significantly increase post-intervention. One explanation for this finding was that the habit intervention used messages that asked participants to be actively mindful of their fruit consumption (e.g. “Think about how healthy you feel after you eat fruit”). As the automaticity measure used in this study was designed to capture the spontaneity and lack of awareness surrounding fruit consumption, measuring it directly post-intervention may not have accurately reflected the extent to which consumption had been habituated. Future research with delayed follow-up assessments is required to determine whether improving the patterned nature of response increases the long-term automaticity of fruit consumption.

Significant increases in vegetable consumption were also observed as a function of delivering dietary messages, but these improvements occurred regardless of the delivery format or message content. In other words, regular reminders to eat in a healthier manner were just as effective in improving this type of consumption as more focused messages specifically targeting fruits, vegetables and habit processes. This finding could reflect a general association between healthy eating and vegetable
consumption within the population. Alternatively, others have noted that longer preparation time tends to be a barrier towards vegetable consumption (Glasson et al., 2011; Pollard, Daly, & Binns, 2009; Pollard, Miller, et al., 2009). Given that the habit-based messages emphasised the consumption of vegetables in the same meals each day, and same times of day, the preparation time for vegetables may have made the messages difficult to implement in a routine manner. Furthermore, no measures that assessed whether participants were responsible for meal preparation were included in this study. If participants were not involved in meal preparation, then they may have had difficulties following-through with some of the habit-oriented vegetable consumption strategies (e.g. “Include a salad with your dinner every night”). Additionally, fruit and vegetable interventions may benefit from the inclusion of alternative strategies, with fruit consumption influenced by perceptions of cost and food preferences, and vegetable consumption influenced by food preferences and a lack of time (Glasson et al., 2011). Future research that investigates additional strategies specific to fruit and vegetable consumption alongside those based on habit-processes is warranted.

Participants who received the ‘LiveLighter’ and habit-based interventions reported incorporating more messages into their daily routine than those receiving the ‘Go for 2 and 5’-based intervention. However, only participants who received the habit intervention reported a subsequent change in fruit consumption. Given that the ‘LiveLighter’ messages did not focus solely on fruit and vegetable consumption, it is not known whether the strategies pursued by these individuals were related to fruit and vegetable consumption per se or were related to other nutritional behaviours targeted by these messages (e.g. reducing salt intake). Additionally, ‘Go for 2 and 5’-based messages have been circulated in Western Australian since 2002 (Pollard et al., 2008). Thus, those messages may have been less noticeable, less salient and therefore less
likely to be enacted by the participants than the more novel strategies emphasised by the ‘LiveLighter’ and habit-based interventions. Unfortunately, participants in this study were not required to identify which specific messages they acted upon during the intervention, so we can only speculate about these mechanisms. Future research evaluating different types of informational interventions would therefore benefit from a more detailed analysis of the impact of specific messages on behaviour.

No significant effects of message delivery format were observed for any of the measures examined in the current study. This is a potentially important finding because it suggests that messages delivered by e-mail or sms can be equally effective as dietary-oriented informational interventions. Indeed, contemporary trends in electronic media development and use have blurred the distinction between these formats, with smartphone technology, enabling the use of mobile phones to receive both sms and email messages. Previous research has demonstrated that university undergraduates are increasingly reliant on mobile phones rather than single-mode devices to access electronic information (Kennedy et al., 2008), and although not specifically assessed, it would be surprising if the participants in this study did not exhibit similar preferences.

Furthermore, the current study replicated the findings of the previous chapter (Study 3) and supported the importance of incorporating multiple habit processes alongside intentions in accounting for health behaviours (Sheeran, 2002). Specifically, the findings suggest that the habit processes may relate differentially to fruit and vegetable consumption behaviours. Similar to the findings of Study 3, automaticity and patterned response processes were significant predictors of fruit consumption. Conversely, for vegetable consumption only the negative consequences for non-performance process significantly predicted consumption behaviour. Additionally, the present findings suggest that incorporating a measure of negative consequences for non-
performance may account for additional variance in vegetable consumption beyond variables of previous cognitive measures (i.e., The Theory of Planned Behavior). However, for fruit consumption, habit processes did not account for additional variance above that of the Theory of Planned Behavior processes. These differential relationships between the habit processes for fruit and vegetable consumption behaviours may provide clues as to what strategies future interventions should emphasize when targeting these behaviours. For example, interventions targeting vegetable consumption may benefit from a focus on promoting the psychological benefits of regularly consuming vegetables.

5.5.1 Limitations

The findings of this study must be considered alongside its potential limitations. Participants were restricted to those who were studying at a Western Australian university and enrolled in a first-year Psychology unit. While Psychology students come from diverse fields of study (e.g., Arts, Science and Commerce), they may not be representative of a broader young adult population. Additionally, the limited number of participants in each of the six groups may have made it difficult to detect three-way interactions between message content (habit versus ‘Go for 2 and 5’ versus ‘LiveLighter’), message delivery (e-mail versus sms) and time (pre-post intervention). However, given that no significant two-way interactions between time and message delivery were detected, it would be unlikely to expect significant three-way interactions. Lastly, participants largely reported having access to fruits and vegetables within their households. It is unclear as to whether the strategies in the current intervention would have been effective for young adults without ready access to fruits and vegetables.
5.5.2 Conclusions

The current study provides support for the use of electronic media as a cost-effective method for delivering diet-focused health messages to young adults as well as the merits of utilizing habit-based informational content within those messages. The current study also identified differences in the relationships between habitual processes and fruit and vegetables consumption. Future interventions should consider these behaviours separately.
6 General Discussion
The present thesis examined the factor structure, predictive validity and applicability of a multi-process habit framework for fruit and vegetable consumption. Studies 1 and 2 (Chapter 3) explored the factor structure of a four-process habit measure (automaticity, patterned response, negative consequences for non-performance and stimulus-response bonds), and the relationships between these processes with current and prior fruit and vegetable consumption. Study 3 (Chapter 4) examined the relationships between three habit processes and measures of automaticity and cognitive processes (derived from the Theory of Planned Behavior) for fruit and vegetable behaviours separately. Finally, Study 4 (Chapter 5) examined the effectiveness of an informational intervention based on a multi-process habit framework. In this final chapter, I summarise the major findings of the thesis and address the theoretical implications. In particular, I discuss what the findings of the four studies can tell us about: (i) the structure and relationships of the habit processes with fruit and vegetable consumption; (ii) the relevance of multiple habit processes within a dual-processing framework; and (iii) the effectiveness of informational interventions based on a multi-process habit framework.

6.1 Structure of Fruit and Vegetable Habits

Previous research within the exercise domain has proposed that four primary processes (automaticity, patterned response, stimulus-response bonds and negative consequences for non-performance) underlie habitual behaviours (Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). An exercise habit measure based on these four processes demonstrated good validity and internal consistency (Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). However, research into fruit and vegetable consumption habits has focused primarily on automaticity (Allom & Mullan, 2012; Brug et al., 2006; de Bruijn, 2010; Gardner,
Abraham, et al., 2012b; Gardner et al., 2011), and the role of additional habit processes (such as the patterning of consumption) has not been examined.

Findings from the present thesis did not provide support for the proposed four-process habit measure of fruit and vegetable consumption. Studies 1 and 2 (Chapter 3) demonstrated that a three-process habit measure (automaticity, patterned response and negative consequences for non-performance) provided a good structural fit in predicting combined fruit and vegetable consumption. Similarly, studies 3 and 4 extended this finding to fruit consumption when it was considered as an individual behaviour (Chapters 4 and 5). However, support was not found for the three-process habit measure in predicting vegetable consumption (Chapters 4 and 5). While the present findings supported previous research which found habit frameworks to predict fruit consumption (de Bruijn, 2010; de Bruijn et al., 2012; Menozzi & Mora, 2012), and combined fruit and vegetable consumption (Allom & Mullan, 2012; Wiedemann et al., 2014), limited research has examined these frameworks in predicting vegetable consumption. Given the misspecification of the proposed habit frameworks throughout this thesis in predicting vegetable consumption, an investigation of how individual habit processes relate to fruit and vegetable behaviours separately may help researchers to develop a more coherent understanding of habit formation and performance.

Results from Chapters 3-5 supported previous research, which found positive relationships between automaticity and fruit and vegetable consumption (Allom & Mullan, 2012; Brug et al., 2006; Gardner, Abraham, et al., 2012b; Gardner et al., 2011). Findings from the thesis indicated that individuals who consumed more fruit and vegetables on average, and had been consuming fruit and vegetables consistently over longer periods of time (Chapters 3 and 4), reported higher scores on measures of automaticity. One implication of this finding is that regularly consuming fruit and
vegetables, over long periods of time, may make their subsequent consumption more efficient and unintentional (Bargh, 1994; Bargh & Chartrand, 1999; de Bruijn, 2010; de Bruijn et al., 2012; Gardner et al., 2011; Verplanken & Orbell, 2003). Given this implication, encouraging the frequent and consistent consumption of fruit and vegetables may enable their long-term adoption and maintenance. However, further research examining the construct validity of the automaticity scale used in the multi-process framework is warranted. While the automaticity process was strongly correlated with a validated automaticity subscale, the Self-report Behavioral Automaticity Index (Gardner, Abraham, et al., 2012b), researchers have argued that self-report measures might not be adequate to examine behaviours performed outside conscious awareness (Gardner & Tang, 2014; Sniehotta & Presseau, 2012). Future research should examine objective measures of automaticity (e.g. implicit associations) alongside the multi-process habit measures to strengthen their validity.

Previous research into the multi-process habit framework for aerobic exercise demonstrated that the inclusion of items purported to assess stimulus-response bonds produced a structurally sound measure of exercise habits, and was positively correlated with exercise intensity, frequency and duration (Grove & Zillich, 2003; Grove et al., 2014; Hashim et al., 2011; Hashim et al., 2013). However, findings in Chapter 3 led us to suggest that the role of stimulus-response bonds may not extend towards assessing fruit and vegetable consumption. Specifically, we found that including stimulus-response items produced a poor factor structure when compared to a model that only assessed the automaticity, negative consequences for non-performance and patterned response processes. Additionally, participants who had reported eating fruits and vegetables regularly did not report stronger stimulus-response bonds than those who did not regularly consume fruits and vegetables. While this finding was inconsistent with
previous research into the aerobic exercise domain, contextual cues might influence fruit and vegetable consumption in a different manner. Alternatively, external stimuli that are associated with habitual behaviours may be a necessary pre-condition to habit formation but not be a part of the habit construct itself (Sniehotta & Presseau, 2012). Furthermore, the specific environmental cues that trigger healthy eating behaviours may be unique and varied amongst individuals (Tappe & Glanz, 2013). If this is the case, then including items that assess set categories of environmental triggers may be too broad to detect on an individual level. Future research may benefit from employing experimental designs that manipulate the presence of critical cues (e.g., fruit bowls in the centre of dining room tables) tailored for individuals. This will allow researchers to determine if specific environmental cues influence the formation and execution of automatic fruit and vegetable consumption.

A consequence of non-adherence to habitual behaviours may be an increase in negative psychological consequences. For example, within the exercise literature regular exercisers report feelings of guilt, anxiety and irritability if their physical activity is restricted (Acevedo, Dzewaltowski, Gill, & Noble, 1992; Blumenthal, O'Toole, & Chang, 1984; Robbins & Joseph, 1985; Szabo, 1995). Fruit and vegetable consumption has been demonstrated to be positively associated with affective attitudes, mental health and intrinsic motivation, and negatively related with measures of stress (Kiviniemi & Duangdao, 2009; Roohafza et al., 2007; Sarlio-Lähteenkorva, Lahelma, & Roos, 2004; Sjoberg et al., 2004; Trudeau et al., 1998; Unusan, 2006; Van Duyn et al., 2001). However, the extent to which failing to eat fruits and vegetables results in negative psychological consequences has not been previously examined. Responses to the negative consequences for non-performance process were consistently higher amongst individuals who reported a stronger history of fruit and vegetable consumption.
Chapter Six: General Discussion

(Chapters 3 and 4). Positive correlations were also found between the negative consequences process and measures of current fruit and vegetable consumption (Chapters 3-5). Taken together, these findings support the idea that the negative consequences for non-performance process extends beyond aerobic exercise and may be utilised in assessing fruit and vegetable consumption habits. Additionally, Chapters 4 and 5 demonstrated that the process might have differential impacts on fruit and vegetable consumption. When incorporated alongside automaticity, negative consequences for non-performance was considered a significant predictor of vegetable, but not fruit consumption. Future research into vegetable habits may benefit from emphasising the positive benefits of consuming vegetables and encouraging individuals to reflect positively on their behaviour upon consuming vegetables.

Habitual behaviours tend to be patterned in their performance. That is, they are performed in the same way, at the same times of day and in the same locations each time (Anderson, 1982; Chen & Chaiken, 1999; Grove et al., 2013; Grove & Zillich, 2003; Grove et al., 2014; Ronis et al., 1989). Previous research into nutritional behaviours, such as eating popcorn in a movie theatre (Neal et al., 2011), has demonstrated that disrupting regular patterns of behaviour (e.g., eating using a non-dominant hand) can bring them into conscious awareness. It therefore would appear that the efficiency and unconscious execution of particular behaviours are related to their patterned nature. The present thesis provides mixed findings as to the contribution of patterned response to fruit and vegetable consumption habits. Chapter 3 demonstrated that when fruit and vegetable consumption was examined as a single behaviour, a stronger history of, and greater levels of current consumption, were related to more frequent reports of patterned eating. These findings were also demonstrated for fruit consumption when examined individually (Chapters 4 and 5). Furthermore, when
incorporated as an additional process to automaticity, patterned response was considered a significant predictor of fruit consumption. However, patterned response was not considered a significant predictor of vegetable consumption (Chapters 4 and 5). Similarly, there were no significant differences on the responses to the patterned response process as a result of a strong history of vegetable consumption (Chapter 4). It therefore seems that encouraging the patterned nature of fruit consumption may be useful in establishing regular consumption and habitual behaviour. However, emphasising strategies that influence the patterned nature of vegetable consumption may not lead to long-term habituation. It may be that, there are additional barriers (e.g. preparation time) that makes the consumption of vegetables difficult to be carried out in a patterned manner. Research that compares the patterned consumption process between primary food preparers and non-preparers may give clues as to whether the patterned process is unrelated to vegetable consumption and habits or whether barriers such as preparation affects this relationship.

These findings provide two key advancements in our knowledge of fruit and vegetable habits. Firstly, a multi-process habit model can be extended towards fruit and combined fruit and vegetable consumption behaviours. Previous habit measures have been limited by their inclusion of measures of past behaviour and processes that may not be necessary features of habitual behaviour, such as self-identity (Gardner, de Bruijn, et al., 2012; Sniehotta & Presseau, 2012). The present thesis offers a 10-item fruit and vegetable habit measure and a 13-item fruit habit measure that have been demonstrated to be reliable, structurally sound and have adequate construct validity. Secondly, these measures overcome some of the limitations of previous measures in the field in that they do not contain items of past-behavioural frequency and examine the relationships of the constructs individually with subsequent behavioural performance.
Chapter Six: General Discussion

6.2 Relationships Between Habitual and Volitional Processes

The utilisation of dual-processing frameworks has been proposed in the investigation of energy balance related behaviours (Kremers et al., 2006). Previous research into the volitional components of behaviour (e.g. attitudes, intentions, and perceived norms) have consistently accounted for variance in health-related behaviours, including fruit and vegetable consumption (Allom & Mullan, 2012; M. Conner et al., 2002; Guillaumie et al., 2010; Kothe et al., 2012; Menozzi & Mora, 2012; Sjoberg et al., 2004). However, these cognitive processes do not always translate into subsequent behaviour.

Researchers have identified an intention-behaviour gap, which cognitive processes cannot account for (Sniehotta, Scholz, & Schwarzer, 2005; Webb & Sheeran, 2006). Previous researchers have recommended examining the unconscious, automatic processes identified in the dual-processing model to account for this gap (Brug et al., 2006; Chatzisarantis & Hagger, 2007; Grove & Zillich, 2003; Grove et al., 2014; Ronis et al., 1989; Rothman et al., 2009; Verplanken & Orbell, 2003).

Research has suggested that incorporating measures of past behavioural performance, self-reported habit, and self-reported automaticity can predict the performance of health behaviours beyond that of intention alone (Gardner, Abraham, et al., 2012b; Gardner et al., 2011). The present thesis provides support for previous research in this regard. Findings in Chapter 4 demonstrated that the patterned response process and intention were considered significant predictors of fruit consumption, with the regression model accounting for approximately 53% of the variance in consumption. Similarly, in Chapter 5 the negative consequences for non-performance process and intention were significant predictors of vegetable consumption, with the regression model accounting for approximately 32% of the variance in consumption. These findings suggest that habitual processes such as the patterning of consumption and the
negative psychological consequences for non-consumption should be considered alongside intentions when predicting fruit and vegetable consumption behaviours.

The findings of the present thesis also extend our knowledge of the specific manner in which habitual processes work alongside volitional processes. Previous research into dual-processing approaches towards fruit and vegetable consumption have been limited in three key ways: (i) confounding multiple habit processes using a single outcome measure; (ii) examining only the automaticity component of habitual behaviours and; (iii) not applying habitual constructs towards fruit and vegetable consumption as separate behaviours. By investigating multiple habit processes as distinct constructs, this thesis furthers our understanding about how each process contributes to fruit and vegetable consumption separately. For example, the negative consequences for non-performance process was a significant predictor of vegetable consumption alongside instrumental attitude and intention (Chapter 5). This would suggest that considering the consumption of vegetables to be healthy and good, intending to consume vegetables regularly and considering that not eating vegetables may result in negative psychological consequences may be relevant ways to assess the likelihood that an individual will consume vegetables. However, the habit processes were not shown to be significant predictors of fruit consumption when additional cognitive measures (e.g. perceived behavioral control) were considered (Chapters 4 and 5).

These findings provide two key developments in the study of habitual behaviours. First, that habit measures of health behaviours may benefit from the inclusion of additional processes than simply past behavioural frequency or automaticity. While automaticity is a key component of habitual behaviour, the present findings demonstrate that the inclusion of additional processes, such as patterned
response and negative psychological consequences for non-performance can account for a larger percentage of variance in fruit and vegetable consumption. Second, that a dual-processing approach to fruit and vegetable consumption as individual behaviours can identify differential volitional and habitual processes associated with each. By applying a dual-processing approach to fruit and vegetable consumption, future researchers may be aware of the specific processes to drive health campaigns and interventions.

6.3 The Application of Habit-based Models in Guiding Behavioural Interventions

Experimental research into habitual behaviour has demonstrated that associated external cues within the environment can trigger nutrition behaviours with minimal cognitive awareness (Wansink, 1994, 2004). Furthermore, the scripted or patterned nature in which behaviours are performed has been demonstrated to be important in establishing and maintaining nutritional habits. For example, eating with a non-dominant hand can bring popcorn consumption back into conscious awareness (Neal et al., 2011). Lastly, research has demonstrated that behaviours performed in regular locations and at the same times of day generally allow individuals to focus on unrelated tasks, requiring less control and conscious awareness in performing the behaviour (Neal et al., 2006; Quinn, Pascoe, Wood, & Neal, 2010; Wood et al., 2002). While these experiments have provided insight into the processes that drive habits, they have not been translated into behavioural interventions for promoting positive health behaviours.

Current public health campaigns (such as LiveLighter or Go for 2&5) employ the use of informational interventions to engage with a large audience in an accessible and cost-effective manner. They have been effective in changing knowledge and attitudes towards healthy eating within the Australian population, however, as the campaigns focused on targeting volitional processes, it is unclear as to whether these changes persist/will persist at the cessation of the campaigns. Addressing processes that
underlie habitual behaviours may help in establishing and maintaining long-term
behavioural change. A previous informational intervention that incorporated habit
strategies into a weight loss intervention demonstrated significantly more weight loss in
the intervention groups at 8-weeks post intervention than the control group (Lally et al.,
2008). However, the informational leaflet included additional strategies that were non
habit-based, making it difficult to distinguish if the effects of the intervention relied on
changes in habitual processes. Furthermore, the intervention included a variety of
strategies that targeted multiple health behaviours (exercise, snacking etc.) which made
it difficult to distinguish if the effects of the intervention were a result of a particular
behaviour or multiple behaviour changes.

Study 4 (Chapter 5) examined the effectiveness of a habit-based informational
intervention on fruit and vegetable consumption and compared it to the effectiveness of
messages based on previous (‘Go for 2 and 5’) and current (LiveLighter) public health
campaigns. The findings of this experiment demonstrated that a habit focused
informational intervention improved fruit consumption after 8-weeks. Furthermore, the
change in responses to patterned response process for fruit consumption indicated that
perhaps the driving force of this change was the focus of incorporating fruit into the
same meals and locations each day. However, for vegetable consumption, while there
was an overall increase in the consumption of vegetables post intervention, this could
not be attributed to the content of the particular messages.

These findings demonstrated that informational interventions based on habit-
focused frameworks may be useful in changing fruit consumption behaviours. However,
different strategies might be warranted for targeting vegetable consumption behaviours.
Previous researchers have suggested that informational campaigns designed to target
fruit and vegetable consumption should instead tailor specific messages and focused
segments for fruit and vegetable consumption (Wansink & Lee, 2004). Findings from the present thesis support this suggestion and the use of different strategies for fruit and vegetable consumption is encouraged. Specifically, given the findings presented throughout the thesis, we suggest that including messages to individuals that include habitual, and in particular the patterned response processes, should be used to promote fruit consumption. While findings from the intervention were not clear as to the processes that drive vegetable consumption, Chapters 4 and 5 provide clues into the use of negative consequences for non-performance in changing vegetable consumption behaviours.

Additionally, interventions that target fruit and vegetable consumption behaviours based using a dual-processing framework may be more effective in driving behaviour change. Findings from Chapters 4 and 5 indicated that both fruit and vegetable consumption can be best accounted for by incorporating habit processes alongside constructs from the Theory of Planned Behavior. The significant predictors of fruit (patterned response and intention) and vegetable (negative consequences for non-performance, intention and instrumental attitude) consumption may provide clues as to the specific processes that should be targeted. While previous research has produced mixed findings on the effectiveness of fruit and vegetable interventions based on the Theory of Planned Behavior (Kellar & Abraham, 2005; Kothe & Mullan, 2014; Kothe et al., 2012), no research to our knowledge has examined the effectiveness of a dual-processing based informational intervention. Given the findings throughout Chapters 4 and 5, there may be a benefit to examining dual-processing informational interventions for fruit and vegetable consumption behaviours separately.

6.4 Summary
Understanding the processes that underlie habitual behaviours can help guide the construction of theoretically sound measures and behavioural interventions. The present thesis has provided insight into the relationships between three habit processes (automaticity, patterned response and negative consequences for non-performance) and fruit and vegetable consumption. Habit measures that examine combined fruit and vegetable consumption behaviour or fruit consumption as an individual behaviour can benefit from the incorporation of items that assess the patterned nature of consumption and negative psychological consequences for not consuming fruit. Furthermore, strategies based on the habit processes can be successfully incorporated into informational interventions to drive fruit and vegetable consumption. Given, that different processes may be driving fruit and vegetable consumption, interventions that target these behaviours individually may be more effective than those that target them simultaneously (Wansink & Lee, 2004).
7 References


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