Exploring Habit Theory in Sugary Drink Consumption

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Abstract

Introduction

Sugary drink consumption is associated with a range of negative health outcomes. In an effort to reduce population-level consumption a greater understanding of the psychological drivers of this behaviour is warranted. One psychological driver may be habit. Habits are automatic cognitions, that when activated upon exposure to an associated context or goal, have the capacity to drive behaviour directly. In this thesis, I explore the role of habit in sugary drink consumption to better inform public health interventions targeting this behaviour and to contribute to habit theory more broadly.

Aims

There are four aims of this thesis, corresponding to chapters 2 through 5. In chapter 2, we seek to identify whether habit theory provides a useful theoretical framework for guiding the selection and implementation of public health interventions targeting sugary drink consumption. In chapter 3, we assess whether habit reduces an individual's control over their drink behaviour. In chapter 4, we assess whether habit reduces an individual's responsiveness to educational interventions targeting this behaviour. In chapter 5, we assess whether the two most common methods of measuring habit (i.e., experienced automaticity measures and behaviour frequency × context stability measures) capture the same construct.

Methods

In chapter 2, we conducted a narrative review of the literature, by drawing on studies exploring the influence of habit on behaviour and the mechanisms by which we can intervene or avoid this influence. In chapter 3, we draw on local data from a small cross-sectional survey of adults (N = 72) and assess whether habit moderates the relationship between intentions to avoid drinking sugary drink and consumption. In chapter 4, we draw on data from a discrete choice experiment conducted in Australia (N = 1,659) and survey responses collected as part of the DOIT (i.e., Dutch Obesity Intervention in Teenagers) evaluation (N = 851). In both studies we test whether habit moderates the effect of the intervention. In chapter 5, we draw on data from a survey of adolescents from a Dutch secondary school (N = 260), and the baseline measure of DOIT (N = 910) and survey responses collected in the follow-up measure in the control condition of the Australian Capital Territory It's Your Move project (N = 116). Across all three studies we assess whether experienced automaticity measures share a positive association with behaviour frequency × context stability measures. Moreover, to provide a

stringent assessment of this relationship, we compared the strength of this association against the strength of the relationship experienced automaticity measures share with 1) behaviour frequency measures, 2) context stability measures, and 3) behaviour frequency × context variability measures.

Results

Findings from chapter 2 suggest that habit theory may offer a useful theoretical framework to guide the selection and implementation of public health interventions targeting sugary drink consumption. It appears that intention-based interventions (i.e., those based on the assumption that we can influence behaviour by targeting expectancy/reason based cognitions) are likely to face a number of barriers associated with habit, although these approaches may help reduce the incidence of strong habits and may be effective with strategic implementation. Structural interventions appear to be the most effective for targeting habitual consumption, although these approaches are confined to limited contexts. In chapter 3, we found that the intention-behaviour gap is greater among individuals with a stronger habit, in other words, habit does seem to reduce an individual's control over their drink behaviour. In chapter 4, however, we did not find any evidence that individuals with a stronger habit are less responsive to educational interventions, in other words, habit does not appear to be a barrier to the success of these approaches (as was proposed in chapters 2 and 3). In chapter 5 we found that experienced automaticity measures shared a stronger association with behaviour frequency × context variability measures (than with behaviour frequency × context stability measures), in other words, individuals who experience greater automaticity tend to report performing the behaviour across a greater variety of situations (as opposed to fewer different situations as is commonly proposed in the habit literature). In addition to these findings, it was also evident that across each of the topics covered in my thesis (i.e., chapters 2 – 5) all of them had a limited body of evidence to draw upon. For example, although numerous scholars had claimed that habits render educational/informational interventions ineffective, there were no studies that had actually tested this for any behaviour.

Discussion

Habit theory offers an additional theoretical framework to inform sugary drink policy. The findings in my thesis, however, suggest that a number of important research questions still need further examination before we can appreciate the extent to which habit theory can be used to inform policy. For example, due to a lack of empirical investigation (and because of methodological limitations in my research) we are not yet in a position to assert that habit reduces an individual's control over their unwanted behaviour or that habit constrains responsiveness to intervention. Until these questions are resolved, the utility of habit theory for informing policy will be limited. There is also a need to

improve, or better understand, the measures we use to capture habit strength. Our research shows, quite convincingly, that the measures used by habit theorists are capturing different constructs, at least within the realm of sugary drink consumption. Given the importance of measurement, further research in this area will be integral to developing habit theory and bringing habit theory into practice.

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Student signature:

Date: 1/5/2018

List of abbreviations and acronyms

- BF Behaviour frequency
- BFCS Behaviour frequency × Context stability
- CS Context stability
- SRBAI Self Report Behavioural Automaticity Index
- SRHI Self Report Habit Index

Chapter 1 – Introduction

Any sequence of mental action which has been frequently repeated tends to perpetuate itself; so that we find ourselves automatically prompted to think, feel or do what we have before been accustomed to think, feel or do, under like circumstances, without any consciously formed purpose, or anticipation of results.

- William James, 1890

1. Introduction

1.1. Defining habit

In this thesis I view habits from a psychological perspective, although within this view the definition of habit is not universal. As outlined by Gardner (2014), habit has been defined as a type of behaviour that has become automatic (e.g., Nilsen et al., 2012), as a tendency to perform a behaviour (e.g., Quellette & Wood, 1998) and as a type of automaticity (i.e., automatic cognitions) (e.g., Wood & Neal, 2009). A further point of difference within the literature is whether or not habits are goal dependent. Some scholars argue that habits are directly cued by environmental stimuli that have come to be associated with the behaviour (e.g., the sound of the school lunch bell triggers the activity of going to the canteen to get a hot dog and fruit juice) (e.g., Neal et al., 2012) while others argue "habits are represented as associations between goals [e.g., 'going to the university'] and behavioural responses [e.g., 'taking the bike'] . . ." (Aarts & Dijksterhuis, 2000, pp. 76). This latter perspective is sometimes discussed within the view that habits are a type of script or schemata, where habit "represents knowledge of behaviour sequences that are appropriate or expectable in certain situations, and can be triggered without first processing all aspects of the situation" (Friedrichsmeier, Matthies, & Klockner, 2013). A final point of difference is the extent to which habit necessitates the behavioural response. As Gardner outlines, some definitions imply the behaviour is inevitable (e.g., "a rigid contextual cueing of behaviour" – Wood & Neal, 2009, pp.580) while other definitions recognise the potential for individuals to intervene and prevent the initiation of the behaviour (e.g., "a process by which a stimulus automatically generates an impulse towards action" – Gardner, 2014, pp. 280).

1.2. Different paradigms

In addition to the variability in the way psychology defines habit, the phenomenon has also been explored through different paradigms. Some scholars take a neurobiological perspective using neuroimaging techniques to reveal the brain structures and neural pathways by which habit influences behaviour (e.g., Yin & Knowlton, 2006). Others develop computational models to study the influence of habit via computer simulation (Wood & Runger, 2016), while others study animal (e.g. rats and pigeons) behaviour to explore habit development (i.e., reinforcement learning) and its behavioural outcomes (i.e., insensitivity to rewards) assuming that the learnings carry across mammalian species (e.g., Dickinson, 1985). Other scholars take a cognitive psychological perspective and conduct labbased experiments with humans where they create habits (via altering participants' level of practice in a computer task) and measure decisions (e.g., choice options) and behaviour (e.g., response time

latencies) in order to test habit theory with the assumption that practice is equivalent (or similar) to the slowly developed habits occurring in everyday life (e.g., Danner & de Vries, 2007). However, perhaps the most common approach involves the social psychological perspective, where researchers administer self-report surveys, and participants reflect on their lived experiences as they complete measures intended to capture habit strength (Gardner, 2014)¹.

1.3. History of habit

It follows from the above discussion that the definition of habit and the paradigms in which it is explored within psychology are diverse. This diversity is not surprising given the long history of habit research. Early accounts of habit in psychology date back well over a century to the polymath, William James², who dedicated an entire chapter to the concept in his seminal work The Principles of Psychology (James, 1890). As can be seen in the epigraph to my introduction, James recognised the automatization of cognitions and behaviour resulting from practice and the distinction from more conscious drivers of behaviour. However, as the field of psychology moved away from investigating internal processes, and towards the behaviourist perspective (i.e., 1910-1950), habit became a key focus of reinforcement-base models (e.g., classical conditioning and operant conditioning) that treated habits as observable events (Hull, 1943; Skinner, 1938). This perspective of habit, though, was outside the focus of information-processing accounts of behaviour, and so habit was largely put aside as the field of psychology entered the cognitive revolution (i.e., 1950 onwards) (Miller, Galanter, & Pribram, 1960). Nevertheless, from the late 1970s, as psychology evolved to embrace dualinformation-processing perspectives (i.e., behaviour is the product of both automatic and controlled cognitive processes) habit was again seen as a legitimate area of research (e.g., Triandis, 1977). This momentum has increased in recent years, with a growing number of publications focusing on, or including, the concept of habit (e.g., Gardner, 2014).

1.4. Scope of habit theory

In order to narrow down the scope of my thesis, I have taken a particular perspective of habit. In this thesis I follow the perspective of Gardner (2014) that habit should not be defined as a behaviour, or

¹ This overview of research paradigms is overly simplistic. For example, cognitive and social psychologists tend to view habits in a similar way, and draw on similar methods to explore habit and may better be described as taking a social-cognitive perspective. Moreover, researchers often draw from different paradigms to explore habit (e.g., a social psychologist can draw on neuroscience, animal learning literature and computational models to further support their own research – see for example Wood & Runger, 2016).

² James is often credited as being the founder of habit theory in psychology, however, it is important to note that his work was heavily influenced by earlier scholars who also wrote of habit (Blanko, 2014).

as a tendency to perform a behaviour, as both of these lack explanatory value (i.e., "habit cannot be both the behaviour and the cause of the behaviour" – Maddux, 1997, pp. 336). Instead I view habit as a type of automatic cognition that is activated upon exposure to an associated context or goal. I have not taken an either/or stance on the role of goals, as it is possible some habits could be activated by associated environmental stimuli while others are activated by associated goals. Although I recognise that the automatic cognitions are activated upon exposure to an associated context or goal, I also recognise the potential for individuals to 'step-in' and prevent the initiation (and completion) of a behaviour. This way, habits do not necessitate the behavioural response, but instead, promote the behaviour as the default course of action. The view that habit is a script or schemata, is also not entirely dismissed, although my reservation is that these concepts are unique in their own right, and so researchers should distinguish them as such. In further narrowing down the scope of my thesis, I draw from the social psychological literature to explore the concept of habit. This is not based on a proposed hierarchy of evidence, as all paradigms have their strengths and limitations, but instead aligns to my professional expertise and a personal preference for this paradigm over others. As a consequence, however, relevant learnings from other paradigms are not considered, and so the body of evidence supporting this thesis is inevitably incomplete.

A wide range of behaviours have been explored from the perspective adopted in the current thesis. For example, a review by Gardner (2014) identified 136 empirical studies on health related habits alone. These included investigations into text messaging while driving, wearing protective equipment when using a motorcycle, smoking, alcohol consumption, vaccination, sun protection, condom use, flossing, breast self-examination, medication adherence, antibiotic prescription, hand hygiene, sedentary screen behaviours, active travel, physical activity, unhealthy snacking, fruit and vegetable consumption, seafood consumption, salt and saturated fat consumption, binge eating, food preparation, water consumption, and sugary drink consumption. The majority of these were behaviour prediction studies where habit strength was typically shown to correlate positively with behaviour frequency, such that the stronger the habit the more frequently the individual performed the behaviour. Gardner (2014) also identified that scholars have also commonly tested the validity of the self-report measures used within the social psychological literature; included habit in intervention research (although usually only as a covariate accounted for in the analysis); and explored predictors of habit strength, among other less common pursuits of enquiry.

1.5. Sugary drink consumption

Although the concept of habit has been considered across a great variety of health related behaviours, in this thesis, I apply learnings from the literature to one behaviour, namely, sugary drink consumption.

Sugary drinks (also known as sugar-sweetened-beverages) are drinks comprising added sugar, and include: regular soft-drink, energy drink, sports drink, flavoured waters, flavoured milk, some fruitjuices, and sweetened tea/coffee. Consumption of these drinks has shown to be a considerable public health risk, with over consumption linked to overweight and obesity (Trumbo & Rivers, 2014), type 2 diabetes mellitus (Malik et al., 2010a), cardiovascular disease (Malik et al. 2010b) and tooth decay (Tahmassebi et al., 2006). Indeed, for every additional daily serving of sugary drink consumed, we gain an additional 0.22kg in adiposity (Malik et al., 2013) and increase our risk of diabetes by 20% (Imamura et al., 2015) while providing little or no nutritional benefit (Trubo & Rivers). Unfortunately, in light of these consequences, 2010 global estimates indicate that adults consume, on average, 132 ml per day (Singh et al., 2015) and although we have generally seen a decrease in recent years across high-income countries, there has been an increase in consumption in low- and middle-income countries (Popkin & Hawkes, 2015).

A range of public health intervention strategies have been proposed to tackle sugary drink consumption, including mass media campaigns (Chaloupka, Powell, & Chriqui, 2011; Farley et al., 2017), fiscal policy (Backholer, Blake, & Vandevijvere, 2016; New Zealand Beverage Guidance Panel, 2014; Pomeranz, 2012), school-based educational strategies (Levy, Friend, & Wang, 2011; New Zealand Beverage Guidance Panel, 2014), nutrition labelling (Chaloupka et al., 2011; Levy, Friend, & Wang, 2011), provision of clean potable drinking water in schools (Chaloupka et al., 2011; New Zealand Beverage Guidance Panel, 2014; Patel et al., 2011), marketing restrictions (Chaloupka et al., 2011; New Zealand Beverage Guidance Panel, 2014; Patel et al., 2011), marketing restrictions (Chaloupka et al., 2011; New Zealand Beverage Guidance Panel, 2014), restricting access in selected settings (Capacci, Mazzocchi, & Shankar, 2018; Chaloupka et al., 2011; Hsiao & Wang, 2013; Levy et al., 2011), and portion control (Hsiao & Wang, 2013; Levy et al., 2011). These approaches are intended to tackle different drivers and barriers of sugary drink consumption (e.g., mass media seeks to change attitudes while removing sugary drinks from supermarket check-outs seeks to reduce access to sugary drinks). Together, these approaches may explain why sugary drink consumption has decreased in recent years within developed countries, although further evaluation in this area is required.

1.6. Gaps for exploration and aims of thesis

Confined within the social psychological paradigm, there has been relatively little exploration of the role of habit in sugary drink consumption. Instead, when exploring the psychology underpinning sugary drink consumption, most investigations utilise social-cognitive models to understand the psychological drivers of this behaviour (e.g., Penaranda, Modave, & Diaz, 2014; Rosas et al., 2017; Zoellner et al., 2012). Nevertheless, those that have investigated habit, suggest that habit is a strong contributor to sugary drink consumption (e.g., de Bruijn et al., 2009; Tak et al., 2011; van der Horst et

al., 2007) and so habit appears to be an important psychological construct worthy of further investigation. With this in mind, the overall aim of this thesis is to explore habit theory in sugary drink consumption in order to advance habit theory research in this area and to better inform public health intervention targeting sugary drink consumption.

Our exploration begins with a narrative review of the literature examining the potential utility of habit theory for informing the development and selection of public health interventions targeting this behaviour (Chapter 2). Our intention is to uncover the features of habit that may influence responsiveness to intervention and to identify public health interventions that may overcome any negative influence of habit. Similar reviews have already been conducted, although none of these focused on sugary drink consumption, but instead focused on eating behaviour (i.e., van't Riet et al., 2011) or behaviour change more broadly (e.g., Verplanken & Wood, 2006; Wood & Neal, 2016).

One of the key features of habit highlighted and discussed within earlier reviews, is the limited control individuals have over their habitual behaviour. Research supporting this comes from behaviour prediction studies showing that the predictive strength of intentions on behaviour is weaker among individuals with a stronger habit. However, recent investigations suggest that this moderating effect of habit occurs when researchers measure intentions to perform the behaviour (i.e., strong habits derail weak intentions to perform the behaviour) but does not occur when researchers measure intentions to avoid the behaviour (i.e., strong habits do not derail strong intentions to avoid the behaviour (i.e., strong habits do not derail strong intentions better represent settings in which habit and intentions would be expected to prompt opposing behavioural patterns" (Gardner, et al., 2015, Discussion, para. 2) we measured intentions to avoid the behaviour and examined whether sugary drink habits reduce an individual's control over how much sugary drink they consume (Chapter 4).

If individuals with a strong habit of drinking sugary drink have reduced control over their drink behaviour, then this is likely to have important implications for many public health interventions targeting sugary drink consumption. Interventions that rely on the individual to take control and limit their consumption (e.g., educational campaigns) may have limited impact among individuals with a strong habit. From a public health perspective this poses a particular challenge given that individuals with a stronger habit tend to consume more sugary drink than other individuals, and so are arguably more in need of intervention. To date, research has found support for the idea that individuals with a strong habit are less responsive to intervention (e.g., Orbell & Verplanken, 2010, study 2) but the evidence is mixed (e.g., Matthies, Klöckner, & Preibner, 2006) and none of these investigations examined educational interventions or were in the domain of sugary drink consumption. Therefore, a

further aim of this thesis is to test whether habit limits responsiveness to educational interventions targeting sugary drink consumption (Chapter 4).

A final area of exploration in this thesis pertains to the measurement of habit. Scholars usually capture habit via self-report measures, with the two most utilised measures being experienced automaticity measures (e.g., Verplanken & Orbell, 2003) and behaviour frequency × context stability measures (e.g., Ouellette & Wood, 1998). Both of these approaches are grounded in the same definition of habit (i.e., automatic cognitions activated upon exposure to an associated context) and both have demonstrated construct validity across a range of different health related behaviours (e.g., Danner, Aarts, & de Vries, 2007; Gardner, de Bruijn, & Lally, 2011). However, in recent years there has been a growing debate around the strengths and limitations of these approaches (Haggar, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Labrecque & Wood, 2015; Orbell & Verplanken, 2015). Given the importance of measurement to developing and testing theory, I aim to test the relationship between these measures in the domain of sugary drink consumption (Chapter 5).

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Chapter 2 – A narrative review of the literature

From a habit perspective, behavior change interventions are likely to fail unless they account for the ways in which people form healthy habits and break unhealthy ones. Although the research literature on behavior change offers sophisticated understanding of many intervention features (for example, offering appropriate incentives, tailoring messages to specific subsets of the target audience, tracking nonintrusive outcomes such as credit card charges), little attention has been paid to the importance of habits in maintaining lifestyle choices.

- Wood & Neal, 2016

2. Exploring the utility of Habit theory for informing the selection and implementation of public health initiatives targeting sugary drink consumption

2.1. Summary

Sugary drink consumption is associated with overweight and obesity and has been shown to have a habitual component. A range of public health interventions have been suggested for addressing this behaviour. To assess the potential utility of habit theory for informing and guiding the selection and implementation of proposed initiatives, a narrative and critical review of the habit literature was conducted. The review identified a number of features of habit which represent potential barriers for interventions that are dependent on self-regulation (e.g., school-based education, information campaigns, fiscal policy, nutrition labelling etc.). However, these intervention approaches may play a role in reducing the incidence of strong habits. In addition, there do appear to be opportunities to avoid the habit related barriers with strategic implementation. Interventions that are less dependent on an individual's intentions (e.g., removing sugary drinks from schools and supermarket check-outs, and sugary drink portion control) are likely to avoid the influence of habit and provide an effective means to reduce habitual sugary drink consumption, however, these approaches are confined to limited contexts. There is limited empirical research to support these findings, but they do suggest that habit theory may be a useful theoretical framework for informing the implementation of public health interventions targeting sugary drink consumption.

2.2. Introduction

Obesity has expansive financial and health consequences and as a result there has been an increased recognition of the importance of prevention (van Koperen et al., 2013). A range of health related behaviours have been shown to lead to overweight and obesity, with the consumption of sugary drink likely to be a strong contributor (Hu, 2013), especially among younger population groups such as adolescents (Harrington, 2008). With this in mind, a number of public health interventions have been proposed in order to reduce sugary drink consumption. Unfortunately, due to their nature, the effectiveness of such interventions is often difficult to assess prior to their implementation. A useful means of informing and predicting the likely effectiveness of these interventions is to utilise behaviour theory (Cerin, Barnett, & Baranowski, 2009). Through developing an understanding of how the behaviour occurs and the factors that maintain and prevent the behaviour, we can identify key leverage points to inform and critique proposed interventions (Cerin et al., 2009).

There are a broad range of behaviour theories which may inform our understanding of sugary drink consumption. Most of these are social-cognition theories (e.g., theory of planned behaviour, social cognitive theory, health belief model), which argue that behaviour is mostly the result of an individual's intentions (Kremers, 2010). These intentions are developed through the consideration of personally meaningful attitudes (e.g., "I like soft-drink'), beliefs (e.g., "I'll have more energy during sport if I drink sports-drink"), and their interaction with the environment (e.g., "it's convenient...I can pretty much get it anywhere"). However, despite the success of social-cognition theories there remains scope for improvement when explaining everyday health behaviour (Jeffery, 2004; Sniehotta, Presseau, & Araújo-Soares, 2014). One reason for this is due to the potential lack of decision making involved in performing a given behaviour ("I don't really think about it, it's just something I do" or "I intended to stop, but in the moment I forget") (Kremers, 2010; Neal, Wood, & Quinn, 2006; Sniehotta et al., 2014).

Habit theory is one behavioural theory that pertains to everyday behaviours, which are performed without deliberation and often under limited control, and provides an additional theoretical framework to understand many health related behaviours (de Bruijn, & va den Putte, 2009). This review aims to examine habit theory in relation to sugary drink consumption in order to: 1) assess the utility of habit theory for predicting the likely effectiveness of proposed interventions at reducing sugary drink consumption and 2) provide an initial guide to intervention selection and modification based on habit theory. With this in mind, we first outline a range of proposed interventions that target sugary drink consumption. We then introduce habit theory and explore a number of characteristics of habit that may explain how habit may influence responsiveness to the proposed initiatives, and where

possible, suggest ways that may reduce this influence. Following this, we outline what habit theorists have already explored in the domain of sugary drink consumption and highlight areas requiring further research.

2.3. Proposed interventions to reduce sugary drink intake

Within the U.S. 50% of adults and 61% of children consume sugary drink on any given day (Bleich, Vercammen, Koma & Li, 2018), with roughly 16% of adolescents consuming more than 500 kilocalories per day from sugary drinks (Han & Powell, 2013). High levels of consumption have also been observed elsewhere such as in Australia (Jensen et al., 2012) and Europe (Duffey et al., 2012). In an effort to reduce sugary drink consumption, a range of public health interventions have been proposed. In this section we outline these approaches under two broad categories, intention-based interventions and structural interventions.

2.3.1. Intention-based interventions

Grounded in social-cognitive models of behaviour, intention-based interventions are based on the assumption that we can influence behaviour by targeting expectancy/reason based cognitions (Bandura, 2004). Some are intended to change intentions: mass media campaigns (Chaloupka, Powell, & Chriqui, 2011; Farley et al., 2017), school-based educational strategies (Levy, Friend, & Wang, 2011; New Zealand Beverage Guidance Panel, 2014) and fiscal policies (Backholer, Blake, & Vandevijvere, 2016; Chriqui, Khan, Wada, & Chaloupka, 2013; New Zealand Beverage Guidance Panel, 2014; Pomeranz, 2012). These approaches recognise that many individuals consume sugary drinks because the perceived benefits outweigh the perceived costs. In response, these interventions try to shift this balance by decreasing the appeal of sugary drinks and/or increasing the appeal of healthier alternatives³. Other approaches aim to enable intentions: nutrition labelling (Chaloupka, Powell, & Chriqui, 2011; Levy, Friend, & Wang, 2011) and the provision of clean potable drinking water (Chaloupka et al., 2011; New Zealand Beverage Guidance Panel, 2014; Patel et al., 2011). These approaches understand that individuals may already have 'good' intentions and that providing information or increasing access may help them follow-through with these good intentions and avoid consuming sugary drinks. Other approaches try to protect intentions: strategies that restrict the promotion of sugary drinks (Chaloupka et al., 2011; New Zealand Beverage Guidance Panel, 2014).

³ Although for some individuals increasing the cost of a sugary drink may prevent them from being able to purchase the drink (i.e., not having the money required to make a purchase), it is likely that for most individuals the increased price takes effect by decreasing the appeal of the product (i.e., that's no longer a 'reasonable' purchase so I won't buy it).

These approaches acknowledge that individuals may be persuaded by sugary drink marketing strategies and so intervening (via marketing restrictions) should reduce this effect.

2.3.2. Structural interventions

Structural interventions, on the other hand, directly restrict or reduce access to sugary drinks and are based on the assumption that consumption will decrease irrespective of an individual's intentions. Approaches under this category include prohibiting the selling of sugary drinks in school canteens/school vending machines (or any setting where children/adolescents are the main population group) (Capacci, Mazzocchi, & Shankar, 2018; Chaloupka et al., 2011; Hsiao & Wang, 2013; Levy et al., 2011), removing sugary drink from supermarket check-outs (Pomeranz, 2012) and capping portion size of these beverages (Hsiao & Wang, 2013; Levy et al., 2011). The former approaches remove the choice option, and so individuals cannot purchase sugary drinks even if they intend to, while the latter approach reduces the quantity of sugary drink from a single purchase, and is based on research showing that individuals consume less when offered smaller portion sizes, regardless of motivational factors (Wansink & Cheney, 2005). In this way, compared to intention-based interventions, structural interventions are less dependent on the self-regulatory capacity of the individual.

2.4. Habit theory

Habits are conceptualised as 'a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations' (Gardner, 2015). Over time, as an individual performs behaviour (e.g., purchasing soft-drink) in a recurring context (e.g., the school canteen) the context and behaviour become associated in memory (i.e., a mental context-behaviour association is established). As a consequence, subsequent exposure to the context automatically prepares the individual to enact the behavioural response (e.g., entering the school canteen produces the impulse to purchase a soft-drink) (Neal, Wood, Wu W, & Kurlander, 2011; Wood & Neal, 2007). At this point, the behaviour has acquired features of behavioural automaticity, in that it can be initiated and performed without conscious intent (e.g., the individual does not need to 'think about' the behaviour in order to initiate it or to guide its performance) the behaviour may be performed in parallel with other complex activities (e.g., the individual can select soft-drink while in conversation with peers) and the behaviour can be difficult to control (e.g., it takes effort to prevent the behaviour from initiating) (Lally & Gardner, 2013; Verplanken, 2006). As a consequence, habits become the default option and are believed to drive much of our everyday behaviour.

It is important to recognise that in order to establish the habit the individual performed the behaviour to satisfy some goal (e.g., have a palatable drink with lunch, or, 'fit in' with the social expectation of peers) however over time as the mental context-behaviour association strengthens, the need for intentions reduces and the role of automaticity increases (Wood & Neal, 2007). It follows that if intentions remain stable the developed habit and intentions will be congruent (e.g., 'desired habit'). In these instances habits serve a functional purpose in that they allow individuals to achieve their valued outcomes with minimal cognitive effort (Neal et al., 2013). However, as intentions change (e.g., if the individual forms the intention to quit drinking soft-drink) the engrained automatic response becomes counter-intentional (e.g., 'undesired habit'). In these instances the habit becomes dysfunctional, in that the individual needs to override the habit impulse if they are to avoid carrying out the undesired behavioural response (Neal et al., 2007).

In the next section we explore how habits may influence the responsiveness to interventions. Specifically, we outline a number of important features of habit that represent potential barriers to intervention strategies and discuss ways to overcome these barriers. It is important to note that much of this discussion is based on limited research findings and from other behavioural domains.

2.5. Implications for intention-based interventions

Intention-based interventions are founded upon the assumption that sugary drink purchasing and consumption behaviours are volitional (Verplanken & Wood, 2006; Wood & Neal, 2009). However, research across a range of dietary behaviours has found intention to be a good predictor of behaviour among individuals with a weaker habit, but a poor predictor of behaviour among individuals with a stronger habit (Gardner, 2015). If this effect occurs for sugary drink consumption, there is perhaps little benefit in targeting expectancy/reason based cognitions when the goal is to decrease sugary drink consumption across the entire population (Verplanken & Wood, 2006). Support for this comes from a meta-analysis of intervention studies that found that even when interventions were successful at changing intentions, these new intentions were unlikely to translate into improved behaviour for those behaviours likely to be habitual (i.e., behaviours that are performed regularly and in stable contexts) (Webb & Sheeran, 2006). Given this backdrop, it would seem that the effectiveness of the proposed intention-based interventions may be largely dependent on their capacity to empower intentions (i.e., strengthen the intention-behaviour relationship).

2.5.1. Habits proceed outside awareness

Disconnect between intention and behaviour may occur because individuals are often unaware that they are performing the habitual response. Diary studies have shown that when individuals perform habitual behaviours they tend to think about other issues, but when they are performing non-habitual behaviours their thoughts tend to correspond to their current actions (Wood, Quinn, & Kashy, 2002). It seems reasonable to assume that this lack of awareness of current action may clear the way for habit to initiate and guide unwanted behaviour. Indirect support for this comes from two studies which found vigilant monitoring (e.g., frequently reminding yourself "don't do it") was an effective self-directed method for controlling strong habits (Quinn, Pascoe, Wood, & Neal, 2010). Presumably this was because the individual was being attentive to their current actions and therefore less likely to miss opportunities to intervene and prevent the undesired behaviour from occurring.

From this it appears that one possible way to empower intentions is to increase individual's awareness of their current actions. In order to achieve this, health authorities may select intention-based interventions that are salient and administered at the point of habitual action (e.g., large posters in school canteens outlining the exercise required to burn off the energy consumed from drinking sugary drinks). If effective at capturing individual's attention, this type of intervention may increase behavioural awareness at the critical moment of habitual action (see Table 1 below). To date, only a few intervention studies have investigated whether increasing behavioural awareness reduces the control habit has over behaviour (Eriksson, Garvill, & Nordlund, 2008; Garvill, Marell, & Nordlund, 2003; Verplanken, Aarts, van Knippenberg, & Moonen, 1998). These studies were in the transport domain and found mixed results, therefore further research is needed to determine the likely effectiveness of this type of intervention approach for reducing sugary drink consumption.

2.5.2. Habits are context dependent

The intention-behaviour discordance may also be dependent on the stability of the performance context. Support for this comes from observational studies across a range of behaviours (e.g., using public transport, reading the newspaper, doing exercise), finding that when participants changed residence their habitual behaviour came under intentional control (Thomas, Poortinga, & Sautkina, 2016; Verplanken, Walker, Davis, & Jurasek, 2008; Wood, Tam, & Witt, 2005). In other words, it took a change in context to enable participants to overcome their habit and behave in line with their intentions. Presumably this effect occurred because the cues that activated the habit were no longer present. If this holds for sugary drink consumption then an additional approach to empower intentions may be to target individuals during natural life transitions which inherently destabilise the performance context.

Such an opportunity may arise within the first month of starting a new job or school. For these individuals sugary drink purchase and consumption is unlikely to be habitual (within the work or school environment) because old stimuli are not present and new stimulus-response associations have not

developed. From the initiatives proposed, information approaches can be targeted at new employees/students and therefore if effective at changing intentions, these new intentions should translate into improved behaviour and provide protection from developing habits in this setting. To date, only two studies have assessed whether context destabilisation disrupts habit and increases responsiveness to intervention (Bamberg, Rolle, & Weber, 2003; Thøgersen, 2009). These studies were in the realm of transport use and found mixed results and so again further research is needed to determine whether this type of intervention approach is likely to be effective for reducing sugary drink consumption.

In the above discussion we highlighted two approaches (i.e., increasing awareness of current behaviour and utilising periods of context destabilisation) that have the potential to strengthen the intention-behaviour relationship which may increase individuals responsiveness to relevant intention-based interventions. However there is an additional factor, consideration bias, which should also be taken into account.

2.5.3. Habits lead to consideration bias

Individuals with a stronger habit tend not to consider alternative behavioural options. For example, two studies in the transport domain have shown that when individuals deliberate on a mode of transport, those with a stronger habit (e.g., a strong habit of using a bicycle) were much less likely to actively consider the pros and cons of alternative transport options (e.g., how quick the journey would take by bus) (Aarts, Verplanken, & van Knippenberg, 1997; Verplanken, Aarts, & van Knippenberg, 1997). This research may have implications for those intention-based interventions we identified as being potential candidates for empowering intentions. Consider for example, a school-based information initiative promoting water consumption among first year students. If adolescents with a stronger sugary drink habit exhibit consideration bias then the content of this message may be given less attention than a comparable initiative discouraging sugary drink consumption. Again, further research is needed to assess whether this holds.

2.5.4. Beyond vulnerability

The above discussion highlighted how habits may influence individuals responsiveness to the proposed intention-based interventions and how we may be able to increase their effect. Essentially, the proposed initiatives were evaluated against their expected vulnerability to strong habits. This may be a valid criterion for determining the effect of the intervention among individuals with an established habit but the overall effect of the intervention was not considered. For example, what about individuals who consume sugary drinks as part of a reasoned process? According to habit theory these individuals should benefit from intention-based interventions and so these initiatives may still

provide an opportunity to reduce the 'reasoned' portion of overall sugary drink consumption and an opportunity to reduce the incidence of strong sugary drink habits (i.e., encouraging individuals to maintain low levels of consumption thereby preventing habit development). If this holds, then there may be a significant lag between intervention implementation and reduction in sugary drink consumption at the population level.

2.6. Implications for structural interventions

As we have outlined, intention-based interventions take effect via intentions. In order for these approaches to be successful individuals need to exert control over their behaviour and, when attempting to change or enable intentions, the individual also needs to be attentive to the intervention. In many situations these approaches may be less effective among individuals with an established sugary drink habit because intentional control and attention processes may be restricted among these individuals, as we have described. Structural interventions, on the other hand, do not require the individual to exert control over their behaviour, or pay attention to the intervention in order for these approaches to take effect. For this reason structural interventions are likely to be effective interventions at avoiding the various influences of habit (see Table 1 below).

Consider the approach of removing sugary drinks from school canteens/vending machines or the approach of removing sugary drinks from supermarket check-outs. In each of these cases the habitual response is irrelevant because the option is no longer available (i.e., the individual cannot follow through with their habit of selecting sugary drink in this situation). Consequently, these approaches are free to act on all individuals irrespective of habit strength. In the case of capping sugary drink portion size the beverage is still available (and so the individual may follow-through with the habit) but the total amount habitually consumed is restricted. Therefore it would appear that this approach is also free to act on all individuals irrespective of habit strength. To our knowledge, however, research has not examined these predictions in any behavioural domain.

From the above discussion, it seems that interventions with a greater structural component may take effect among individuals who consume sugary drink as part of a reasoned process (as outlined at the beginning of this review) and among individuals who consume sugary drink as part of a habitual process. With this in mind, structural interventions may offer an effective means of tackling not only habitual sugary drink consumption but consumption in general. Despite this potential advantage, however, it is important to keep in mind that these approaches act only within a limited number of contexts and so their overall effect on total consumption may be limited.

Table 1. Interpretation of the likely effect of specific sugary drink reduction interventions among habitual consumers, based on the behavioural features associated with strong habits

Intervention	Likely effect of inter	f intervention*		
Intention-based interventions				
Changing intentions				
Mass media	Ineffective	Persuasive message likely to be forgotten during habitual performance.		
School-based education	Possibly effective	Salient information delivered at point of habitual purchase or to first year students may prevent habitual performance. Effect is more likely to occur when presenting information pertaining to sugary drinks.		
Fiscal policy	Ineffective ⁺	Price change is likely to be overlooked during habitual performance.		
Enabling intentions				
Nutrition labelling	Ineffective/ possibly effective	Enabling information is likely to be overlooked during habitual performance (unless it is salient at the point of purchase e.g., large posters).		
Increased accessibility to water	Ineffective	Provision of water may be overlooked during habitual performance and/or simply not considered by individuals with a stronger habit.		
Protecting intentions				
Sugary drink promotion control	Ineffective	May be little benefit in protecting intentions (if intentions are not guiding behaviour anyway).		
Structural interventions				
Removing sugary drink from cashier	Effective	Approach is free to act irrespective of habit strength.		
Removing sugary drink from schools	Effective	Approach is free to act irrespective of habit strength.		
Capping portion size of sugary drinks	Effective	Approach is free to act irrespective of habit strength.		

*Responses based on the assumption that intentions have little influence over habitual behaviour (unless individual is aware of their current behaviour and/or during periods of contextdestabilisation) and that information pertaining to alternative behavioural options may not receive the necessary consideration required for behaviour change.

⁺ However, this approach is likely to be effective in those instances where the price increase prevents accessibility to the drink product.

2.7. Habit theory and sugary drink consumption

In the few studies that have explored habit theory in relation to sugary drink consumption, all have focused on adolescent populations (see Table 2 below)⁴. In this group, it appears that habit does play a role in this behaviour. Across each study, individuals with a stronger habit consumed greater amounts of sugary drink than individuals with a weaker habit (de Bruijn & van den Putte, 2009; Kremers, van der Horst, & Brug, 2007; Paw, Sing, Brug, & van Mechelen, 2008; Tak, Te Velde, & Oenema, 2011). Importantly, one study found that this relationship was not mediated by expectancy/reason based cognitions (de Bruijn & van den Putte, 2009). In other words, in this population group, habit appeared to drive behaviour directly.

Only one study utilised habit theory within an intervention study design (Paw et al., 2008). In this study it was shown that the effect of the intervention on reducing sugary drink consumption was only partially mediated by habit strength and attitude, suggesting that the intervention influenced behaviour primarily via non-cognitive pathways. This intervention utilised a range of intention-based approaches and so it is difficult to explain why the measured expectancy/reasoned based cognitions were not stronger mediators of the intervention effect. However, it is not surprising that habit was not a strong mediator as the intervention would need to modify the slowly developed mental context-behaviour association underpinning habitual behaviour (Lally, Van Jaarsveld, Potts, & Wardle, 2010).

⁴ A recent study using an adult sample has been published (see McKee et al., 2019). This study used an extended theory of planned behaviour (incorporating habit theory) to predict what mothers feed their pre-schoolers. The habit measure, however, was not specifically focused on sugary drink (i.e., habit of 'ensuring that my child eats healthily') and neither was the outcome variable (i.e., 'unhealthy snacking and drinking').

Study & Design	Relevant research question	Sample	Habit measure	Outcome variable	Findings
de Bruijn <i>et al.</i> (2009). Cross- sectional, self-report.	Do TPB* variables (intention, attitude, subjective norm, perceived behavioural control) mediate the relationship between Habit and sugary drink consumption?	312 adolescents <i>M</i> years =14.6 Male = 34.7%	SRHI**	Sugar-sweetened soft drinks. Consumption in millilitres per day.	TPB variables did not mediate the relationship between habit and sugary drink consumption.
van der Horst et al. (2007). Cross- sectional, self-report.	Do habit and behaviour- specific cognitions (attitude, subjective norm, social modelling, social pressure, self- efficacy) mediate the relationship between home environmental variables (parental rules and accessibility) and sugary drink consumption?	383 adolescents <i>M</i> years = 13.5 Males = 44.9%	SRHI	Carbonated drinks, other non-carbonated sugar-sweetened drinks (water- based beverages that contain sugar) and sport drinks. Consumption in millilitres per day.	Habit was the strongest mediator explaining 44% of the relationship between the predictors and outcome (followed by attitude 22.7%, modelling from parents 17.6% and self-efficacy 9.9%).
Tak et al. (2011). Cross- sectional, self-report.	Do habit and TPB variables (intention, attitude, perceived behavioural control, subjective norm) mediate the relationship between home environmental variables (availability, accessibility, bought when asked, parental modelling, and parental rules) and sugary drink consumption?	1361 adolescents <i>M</i> years = 14.1 Male = 54.0%.	SRHI	Carbonated drinks, other non-carbonated sugar-sweetened drinks (water- based beverages that contain sugar) and sport drinks. Consumption in millilitres per day.	Habit was the strongest mediator explaining between 39.4-62.6% of the association between the predictors and outcome (followed by intentions 18.1- 36.6%)
Paw et al. (2008). Cluster randomised controlled trial, self- report.	Do habit and TPB variables (attitude, subjective norm and perceived behavioural control) mediate the relationship between a school based obesity prevention program and sugary drink consumption?	854 adolescents <i>M</i> years = 12.7 Male = 49.0%	SRHI	Soft drinks and fruit juices. Consumption in millilitres per day.	The intervention was effective at reducing sugary drink consumption by 303.5 ml/day in boys and 222.3 ml/day in girls. None of the TPB variables or habit mediated the intervention effect in girls while attitude (4.5%) and habit (3.8%) were small partial mediators in boys.

Table 1 Studies using habit theory to explore sugary drink consumption

*Theory of Planned Behaviour; **Self-Report Habit Index

2.8. Future directions

It is clear from this review that further research is required to: 1) investigate habit theory for sugary drink consumption across age groups (not just adolescents), 2) better understand the role that habit may play in influencing individual's responsiveness to sugary drink interventions. Indeed, the link between the mechanisms of influence (e.g., reduced behavioural awareness, context dependency, consideration bias) and responsiveness to intervention is based on limited, and sometimes tenuous research that has been conducted in other behavioural domains (e.g., transportation). It follows that these remain important areas of enquiry when considering how habit may influence responsiveness to interventions targeting sugary drink consumption. However, before investigating these mechanisms, there are other areas that should be investigated. Specifically, research should first investigate whether individuals with a stronger sugary drink habit do in fact have less control over their drink behaviour compared to individuals without a strong habit. If we find that individuals with a stronger habit remain in control over their behaviour then intention-based interventions should be free to act irrespective of habit strength. Nevertheless, even if habit does restrict control over behaviour a more direct examination of the influence of habit on responsiveness to intention-based interventions is warranted. Research should seek to assess whether habit strength moderates the intervention effect, that is, is the effect restricted to individuals with a weak/no sugary drink habit? Answers to these questions will further help determine how useful habit theory will be for informing the development and selection of public health interventions targeting sugary drink consumption.

2.9. Limitations

One limitation of this review is the simplistic framework used to categories proposed public health interventions. Certainly, each of the interventions act via a number of pathways and not exclusively through the framework we have provided. Nevertheless, the broader distinction between motivational and structural interventions is well accepted and provides a suitable framework for exploring the differential impact habit may have on these interventions. Also, the scope of research drawn upon was restricted to one paradigm of habit. Some scholars have taken a broader view of habit exploring diverse fields such as animal learning studies and neuroscience (Wood, & Rünger, 2016). It follows that by considering only the social/health psychological paradigm of habit we have potentially missed valuable insight from other fields of research.

2.10. Conclusion

Sugary drink consumption contributes to overweight/obesity and a range of preventative strategies have been proposed to curb this effect. The responsiveness to these approaches may depend on how habitual the behaviour is and how the intervention is expected to decrease sugary drink consumption. Interventions that try to change intentions (e.g., mass media campaigns, fiscal policy, health education), enable intentions (e.g., nutrition labelling, increasing accessibility to water) or protect intentions (e.g., sugary drink promotion control) are less likely to lead to behaviour change among individuals with stronger sugary drink habits. However, there does appear to be opportunity for some of these approaches to take effect among these individuals provided they are delivered strategically. Intention-based interventions may also be a suitable means of reducing consumption among individuals with weaker/no sugary drink habit. Initiatives that are less dependent on individual's intentions (e.g., removing sugary drink from schools and other points of purchase, capping sugary drink portion size) are likely to act irrespective of an individual's habit strength (or intentions). For this reason these more structural-based approaches appear to be promising candidates for reducing sugary drink consumption within specific contexts. Much of this discussion, however, is based on limited research and so continued investigation is required to more fully appreciate the role of habit theory. In summary, this narrative review with critical analysis suggests that a range of interventions is likely to be required if we are to effectively tackle sugary drink consumption and that habit theory may provide a useful additional theoretical framework to guide decision making.
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Chapter 3 – Habit drives behaviour

Habits keep us doing what we have always done, despite our best intentions to act otherwise

- Neal, Wood, & Quinn, 2006

3. Intentions to avoid drinking sugary drink: Does habit matter?

3.1. Summary

Sugary drink consumption is associated with a range of negative health outcomes. In order to better inform intervention a greater understanding of the barriers to behaviour change is warranted. One potential barrier is habit. Habits are a mental construct characterised by shallow cognitive processing forged through repeated behavioural action. Once established habit becomes the default and may drive behaviour without drawing upon explicit intentions. However, scholars have recently questioned habits dominance over intentions on the grounds that two studies revealed that intentions to avoid behaviour were predictive of behaviour irrespective of habit strength. This study seeks to test for a moderation effect of habit in the domain of sugary drink consumption. A cross-sectional investigation whereby 72 adults (M = 23.37 years, SD = 3.75; female = 66.7%) completed a survey containing validated measures of habit, intention and consumption. Data were analysed using hierarchical multiple regression. In addition to independent effects of habit and intention, a moderation effect of habit on the intention-behaviour relationship emerged such that avoidant intentions were a weaker predictor of behaviour among individuals with a stronger habit. In support of habit theory, individuals with a stronger sugary drink habit showed reduced control over limiting their consumption relative to individuals with a weaker/no habit. These findings suggest that habit is a barrier to behaviour change and that interventions that are dependent on self-regulatory capacity may be less effective among individuals with a sugary drink habit.

3.2. Introduction

Consumption of sugary drink is associated with a range of negative health outcomes (Han & Powell, 2013; Hu, 2013). In an effort to improve consumption patterns, health authorities may implement initiatives that encourage individuals to make 'better' choices (e.g., mass media, fiscal policy, education, nutrition labelling) (Levy, Friend, & Wang, 2011; New Zealand Beverage Guidance Panel, 2014). These initiatives are based on the premise that consumption is purposeful and that changing individuals' intentions (e.g., "I am now going to avoid drinking sugary drinks") should lead to improvements in behaviour (e.g., reduced consumption of these drinks) (Bandura, 2004). However, a number of studies have shown that this assumption may not hold when behaviour has become habitual, and as a result, intention-based interventions may be ineffective among those with a stronger habit (de Bruijn, Kremers, De Vet, De Nooijer, Van Mechelen, & Brug, 2007; Neal, Wood, Wu, & Kurlander, 2011; Webb & Sheeran, 2006; Webb, Sheeran, & Luszczynska, 2009).

Habits can be distinguished from intentional courses of action (Gardner, 2015). Over time, as an individual repeatedly performs behaviour the need for deliberative reasoning decreases and the capacity for automatic cognitive processes to guide behaviour increases (e.g., an individual at the start of the football season needs to make an 'active choice' to drink a sports drink at the weekend game, however by the end of the season this behaviour comes to mind automatically). It follows that for the most part, habits are functional in that they allow us to achieve our valued outcomes with minimal cognitive effort. However, if goals change (e.g., the individual is persuaded by a public health message and subsequently forms the intention to switch to water) intentions diverge from habits and habit forms a barrier to behaviour change (e.g., during the game the individual forgets their new intention and continues the default behaviour) (Verplanken & Wood, 2006).

3.2.1. Habit strength as a moderator

A number of studies have explored the influence habit has over intentions in the realm of unhealthy dietary behaviour. Across these studies intentions to consume the product was a weaker predictor of behaviour among individuals with a stronger habit (Danner, Aarts, & de Vries, 2008; Ji & Wood, 2007). These findings suggest that having a strong habit of consuming unhealthy dietary products may ensure continued consumption even when an individual's motivation to consume the product wanes. However, the purpose of intervention is often more about motivating individuals to purposively limit their consumption as opposed to simply weakening their intention to consume the product (Gardner, 2015). Interestingly, in the two studies that have captured the strength of the participant's intentions to avoid the product, habit strength did not moderate the intention-behaviour relationship (Gardner,

Abraham, Lally, & de Bruijn, 2012; Gardner, Corbridge, & McGowan, 2015). That is to say, individuals with a strong habit of consuming unhealthy products had the same capacity to limit their consumption as individuals without a strong habit.

3.2.2. Aim and hypothesis

This lack of moderation effect has led some authors to question the proposal that individuals with a stronger habit have reduced control over their behaviour and therefore reduced likelihood of responding to motivational interventions (Gardner et al., 2015). With this in mind, we aimed to examine whether habit moderates the intention-behaviour relationship, in the domain of sugary drink consumption, when using conflicting intentions (i.e., strength of intention to avoid the habitual behaviour). If individuals with a stronger sugary drink habit have reduced control over this behaviour, as proposed by habit theory, then we would expect their intentions to avoid the behaviour to be less predictive of behaviour relative to individuals with a weaker/no habit. However, if habit does not moderate the intention-behaviour relationship then this would suggest that intentions to avoid the behaviou the behaviour are free to influence behaviour for both habitual and non-habitual consumers.

3.3. Methods

3.3.1. Ethics

Ethical approval for the study was granted by the Deakin University Human Ethics Advisory Group (HEAG-H 110_2014) and the Monash University Human Ethics Committee (CF15/3377 – 2015001439).

3.3.2. Sample

Advertisement was placed on health-related discussion boards, forums and social media pages and flyers were distributed at Deakin University. Of the 73 participants that responded and took part in the study, 72 participants (female = 66.7%, *M* age = 23.37, SD years = 3.75) provided complete data and were utilised in the current study.

3.3.3. Measures

3.3.3.1. Sugary drink consumption

In order to capture sugary drink consumption, participants were asked to estimate how often they consumed regular soft-drink/flavoured water, fruit juice/fruit drink, cordial, and flavoured milk over the last month, with response options from 'never, or less than once per month' to '6+ times per day'. Responses were then converted to frequency per month and combined to capture total sugary drink consumption.

3.3.3.2. Intention

Intention was measured using 3-items (Cronbach's α = .89) 'I plan/intend/want to avoid sugarsweetened beverages every day', with response options 1 (strongly disagree) to 7 (strongly agree). Higher scores on the intention measure were therefore indicative of a stronger intention to avoid sugary drinks.

3.3.3.3. Habit strength

Habit strength was captured using the Self-Report Behavioural Automaticity Index (Gardner et al., 2012). This 4-item (Cronbach's α = .95) measure captures experienced automaticity (e.g., Drinking sugar-sweetened beverages is something I do automatically/without having to consciously remember/do without thinking/start doing before I realise I'm doing it) with response options from 1 (strongly disagree) to 7 (strongly agree). Higher scores on this measure represent a stronger habit of drinking sugary drinks.

3.3.4. Statistical analysis

Statistical analyses were conducted in SPSS 22 (IBM Corp, 2013). Two high scoring outliers on sugary drink consumption were identified and replaced with one unit higher than the next highest value. Sugary drink consumption was positively skewed and corrected using a square root transformation. In order to examine whether habit moderates the intention-behaviour relationship, a hierarchical multiple regression was conducted. Sugary drink consumption was regressed onto age and gender (step 1), followed by intention and habit (step 2), and the intention × habit interaction term (step 3). In line with Aiken et al. (Aiken & West, 1991), intention and habit were mean centred prior to constructing the interaction term to avoid potential issues with multi-collinearity.

3.4. Results

3.4.1. Descriptive statistics

As shown in Table 1, sugary drink consumption was lower among individuals who held a stronger intention to avoid sugary drinks, and higher among individuals with a stronger sugary drink habit. Individuals with a stronger intention to avoid sugary drinks were also less likely to have a stronger habit. Gender was positively associated with intention suggesting that females held stronger intentions to avoid sugary drinks than males.

	Mean (SD)	1	2	3	4	5
1. SSB consumption	11.04 (12.09)	_				
2. Intention	5.61 (1.39)	421**	_			
3. Habit	2.49 (1.78)	.404**	395**	_		
4. Age	23.37 (3.75)	104	.072	.080	_	
5. Female	66.7%	174	.257*	.007	.947	_

Table 1. Means (Standard Deviations) and correlations between study variables and demographics

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

To further describe the sample, we then dichotomised the intention measure such that individuals who scored above the centre on this measure were deemed to 'hold an intention to avoid sugary drinks every day' while individuals who scored at or below the centre were deemed to not hold an intention to avoid sugary drinks. Likewise we dichotomised the habit measure such that individuals who scored above the centre of this measure were deemed to 'have a habit of drinking sugary drinks' while individuals who scored at or below the centre were deemed not to have a habit of drinking sugary drinks⁵. As shown in Table 2, the most common profile comprised individuals who 'did not have a habit of drinking sugary drinks and who intended to avoid these beverages' (67% of sample), followed by individuals with a counter-intentional habit (17% of sample).

Table 2. Distribution of	⁻ participants	according to	intention	and habit
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		Intention to avoid sugary drink every day		
		No/Neutral	Yes	
Sugary drink Habit	No/Neutral	8	48	
	Yes	4	12	

3.4.2. Main analysis

The main analysis used continues intention and habit strength measures. As shown in Table 3 below, age and gender were independent of sugary drink consumption. At step 2, intention and habit explained an additional 22.4% of the variance in sugary drink consumption with both being significant

⁵ As there is no established cut-off point to distinguish habitual behaviour from intentional behaviour, the midscale seems to be the most appropriate point.

predictors. Importantly, the interaction term was also significant and accounted for an additional 5.2% of variance in behaviour.

Step	Predictor	в	R ²	F	p
1			.041	1.484	.234
	Age	105			.375
	Gender	174			.143
2			.224	10.240	.000
	Age	111			.299
	Gender	109			.320
	Intention	262			.032
	Habit	.310			.009
3			.052	4.999	.029
	Age	149			.158
	Gender	077			.476
	Intention	248			.037
	Habit	.393			.001
	Intention × habit	.248			.029

Table 3. Regression model predicting sugary drink consumption

To further explore this interaction we graphed the intention-behaviour relationship at two levels of habit strength. Figure 1 below demonstrates that individuals without a habit of drinking sugary drinks (i.e., participants that scored at or below the midscale on the habit measure) had more control over their behaviour than individuals with a habit of drinking sugary drinks (i.e., participants that scored at scored at or below the midscale on the habit measure) had more control over their behaviour than individuals with a habit of drinking sugary drinks (i.e., participants that scored above the midscale of the habit measure).



Figure 1. Intention-behaviour relationship at two levels of habit strength

3.5. Discussion

The present study aimed to test whether habit moderates the intention-behaviour relationship in the domain of sugary drink consumption. Prior research has found this moderating effect in other dietary domains, but these effects were confined to studies which measured congruent intentions (Allom & Mullan, 2012; Danner et al., 2008; de Bruijn, 2010; de Bruijn et al., 2007; Ji & Wood, 2007; Kothe, Sainsbury, Smith, & Mullan, 2015) with the two studies that measured conflicting intentions finding no effect (Gardner et al., 2012; Gardner et al., 2015). Given that "conflicting intentions better represent settings in which habit and intentions would be expected to prompt opposing behavioural patterns" (Gardner et al., 2015) we measured conflicting intentions. In contrast to previous research using this approach, habit was found to moderate the intention-behaviour relationship and so it appears that individuals with a stronger habit of drinking sugary drinks have reduced control over limiting this behaviour relative to other individuals.

3.5.1. Implications

The distinction between congruent intentions and conflicting intentions has important implications. The body of research which has measured congruent intention suggests that habitual behaviour is likely to continue even when motivation to perform the behaviour wanes. This may be useful for informing interventions targeting healthy products (e.g., developing fruit consumption habits for sustained behaviour change) but it has less value for interventions targeting unhealthy products such as sugary drinks (as was discussed in the introduction). By capturing conflicting intentions we have shown that habitual sugary drink consumption is likely to continue even when motivation to avoid these products increases. If these findings hold, it suggest that intention-based interventions (e.g., mass media, taxation, education, nutrition labelling etc.) may have limited effect among individuals with a stronger sugary drink habit as these interventions require the individual to take control over their behaviour to limit their consumption.

3.5.2. In the context of previous research

It is important to keep in mind, however, that the current findings are not supported by previous studies that also measured conflicting intentions (Gardner, 2015; Gardner et al., 2015). Gardner et al., (2015) has proposed that their non-significant findings, in the domain of unhealthy snacking, may have arisen because most participants in their sample did not appear to hold directly opposed habits and intentions. It is difficult to compare our sample to those of Gardner and colleagues. On the one hand, the negative relationship between intentions and habit was stronger in our sample suggesting that we had even fewer participants that held opposed intentions and habits. However, on the other hand, among those who appeared to have a habit of drinking sugary drinks, most of them intended to avoid these products and so it is possible that our sample had greater capacity to reveal habit's influence over intentions. It is also possible that the moderation effect is behaviour specific, that is, habit may play a more powerful role in sugary drink consumption than unhealthy snack consumption. However, as Gardner (2015a) has pointed out, mixed findings within this literature (i.e., when congruent intentions were measured) have been obtained for a given behaviour, and so differences in behaviour may not explain the difference in findings between our study and those of Gardner and colleagues.

3.5.3. Limitations

Before drawing strong implications from this research, there are a number of limitations of the current study that should be acknowledged. First, it was not a representative sample (i.e., the sample size was extremely small and comprised a relatively well educated group of participants) and so caution should be used when generalising results. The small sample size is of particular concern as small sample sizes are susceptible to unreliable results. Second, the cross-sectional study design prohibits causal inferences. Previous research tends to use prospective study designs and so our findings are arguably less reliable than those of earlier studies. Third, the measures where self-report and are thus susceptible to response biases. This could be especially problematic for capturing habit strength as capacity for reporting automatic cognitive process may be limited (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015, but see Orbell & Verplanken, 2015) although this is a limitation that holds across the literature. Fourth, the habit and intention measures did not specify types of sugary drinks. It is

possible that participant's view of what constitutes a sugary drink is different to what we measured as an outcome variable, and as a consequence, the predictors and the outcome may have pertained to different behaviours. Fifth, our outcome measure captured frequency of consumption as opposed to quantity of consumption. As there is considerable variation between beverages (e.g., 200ml can vs. 600ml bottle) it is possible that results could differ if quantity of consumption was used as the outcome variable. Nevertheless, given that the intention measure pertained to 'avoiding' sugary drink, frequency of consumption can still represents how much the individual deviated from this target. Given these limitations it would seem that more rigorously conducted studies are needed to confirm our findings.

3.5.4. Conclusion

The current study found habit to moderate the intention-behaviour relationship, such that intentions to avoid drinking sugary drinks were a weaker predictor of behaviour among individuals with a stronger sugary drink habit. These findings suggest that sugary drink habits can undermine good intentions to avoid the product and are the first to show that health related habits can do more than simply undermine weak congruent intentions. These findings shed light on habits role as a potential barrier to intervention and suggest that structural interventions, instead of intention-based interventions, may be a more effective approach for reducing consumption among habitual sugary drink consumers.

3.6. References

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Chapter 4 – Responsiveness to intervention

Habits perpetuate prior behaviors and limit the effectiveness of downstream interventions. Consumers with habits have strong expectations for the environment and action alternatives that shield behavior from change through new information. Even when consumers become convinced of the advisability of habit change, they are likely to continue to perform a behavior that is automatically cued by stable features of the environment.

- Verplanken & Wood, 2006

4. Educational interventions targeting sugary drink consumption: Does habit matter?

4.1. Summary

Educational interventions targeting sugary drink consumption are dependent on the individual having control over their behaviour. However, sugary drink consumption is often performed habitually. Across two studies we test the hypothesis that habit moderates the intervention effect, such that individuals with a stronger habit of drinking sugary drink will benefit less from an educational intervention than individuals with a weaker/no habit. Study 1 comprised an on-line experiment of an educational poster (N = 1,659; M age = 45.63, SD age = 16.75, Male = 48.0%) conducted in Australia. Study 2 comprised a field trial of a school-based obesity prevention program (N = 851; M age = 12.52, SD age = 0.49; Male = 48.9%) conducted in the Netherlands. In both studies, regression analysis revealed a main effect of habit and study condition but no interaction between these variables. Findings suggest that habit strength of sugary drink consumption does not influence responsiveness to educational interventions targeting this behaviour. Concerns about the negative influence of habit may be overstated.

4.2. Introduction

Sugary drink consumption is linked to tooth decay and metabolic risk factors including overweight and obesity (Malik et al., 2010a; Malik et al. 2010b; Tahmassebi et al., 2006; Trumbo & Rivers, 2014). In an effort to limit consumption health authorities have a range of intervention strategies at their disposal, one of which includes education. Over recent years a number of education-based approaches have been trialled including mass media campaigns (e.g., Farley et al., 2017; Schwartz et al., 2017) school-based education programs (e.g., Vézina-Im et al., 2017) and point-of-purchase labelling (e.g., Block, Chandra, McManus, & Willett, 2010). These approaches seek to inform and/or persuade individuals to make "better" choices, and in many cases are found to be at least somewhat effective at reducing sugary drink consumption (e.g., Vargas-Garcia et al., 2017). However, education approaches in general have been criticised for having short-lived benefits and/or benefits that are restricted to infrequent consumers (e.g., Wood & Neal, 2016). Assuming this this holds for sugary drink consumption, a greater understanding of the factors that affect responsiveness to educational interventions targeting sugary drink consumption is warranted.

One psychological factor that may be important is habit. Forged in memory through frequent and regular action, habits are automatic cognitive processes that are thought to initiate and guide much of our everyday behaviour (Gardner, 2014). When behaviour is habitual, individuals no longer need to think about the behaviour in order to initiate or guide its performance (Lally & Gardner, 2013; Verplanken, 2006). This efficiency enables fulfilment of everyday needs (e.g., preparing breakfast for the family) while attending to more interesting/complex activities (e.g., organising who will do the afterschool pickup). Although essential to productive functioning, this efficiency also becomes a barrier if the individual decides to avoid the behaviour. As our attention is focused elsewhere, habitual behaviour occurs "under the radar" and so we can monitor our behaviour to ensure we do not initiate a habitual response (Quinn, Pascoe, Wood, & Neal, 2010) or avoid situations where habits are being activated (although this is perhaps unreasonable for everyday habits like drink consumption). Of course, this takes considerable effort, and so we often fail to break our bad habits.

With this backdrop, scholars emphasise the relevance of habit for educational interventions, arguing that even if these approaches are effective at educating/persuading individuals, they may have limited impact on habitual behaviour (Cohen & Farley, 2008; de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; Gardner, 2014; Verplanken & Wood, 2006; Wood & Neal, 2016). Consider Figure 1 below. As the educational intervention improves our intentions, these new intentions drive behaviour only if the behaviour is not habitual. When behaviour is habitual, we continue to perform the unwanted behaviour.

Figure 1. Theoretical representation of how educational interventions influence consumption of sugary drink, and how habit influences responsiveness to intervention



However, this remains theoretical as researchers have not yet assessed whether habit constrains responsiveness to educational interventions. There are a handful of studies that suggest habit forms a barrier to other interventions which aim to reduce a negative habitual behaviour. In these studies, individuals with a stronger habit (compared to individuals with a weaker/no habit) were more likely to make action-slips (i.e., lighting, or nearly lighting a cigarette) after the introduction of a national smoking ban in pubs (Orbell & Verplanken, 2010, study 2); to consume large quantities of popcorn at the cinema, even if the popcorn was stale (Neal, Wood, Wu, & Kurlander, 2011); and to continue driving, instead of switching to public transport, during an 8-day freeway closure (Fujii, Garling, & Kitamura, 2001). However, not all studies demonstrated this effect. Matthies, Klöckner and Preibner (2006) found individuals with a stronger habit of driving to work to be just as likely to utilise a 1-month free public transport ticket as were individuals with a weaker/no habit of driving to work⁶.

Scholars have also tested the mechanisms by which habit is proposed to constrain responsiveness to educational interventions. The most notable is whether intentions are weaker predictors of behaviour when habit is stronger (see Figure 1 above). In line with this, a meta-analysis revealed that when

⁶ Additional studies have been conducted where the researchers discussed the impact of habit on responsiveness to intervention. However, this research exclusively focused on specialised intervention strategies that are expected to overcome the influence of habit (e.g., Adriaanse et al., 2010; Garvill, Marell, & Nordlund, 2003; Labrecque et al., 2016; Tam, Bagozzi, & Spanjol, 2010; Walker, Thomas, & Verplanken, 2015), or on the effects that desirable habits have on responsiveness to motivational interventions seeking to increase the behaviour (Waterlander, de Boer, Schuit, Seidell, & Steenhuis, 2013; Waterlander, Steenhuis, de Boer, Schuit, & Seidell, 2012), or did not assess whether habit moderated the intervention effect (Bamberg, 2006; Bamberg, Rolle, & Weber, 2003; Fujii & Kitamura, 2003; Schulz et al., 2013; Verplanken & Roy, 2016) and therefore do not provide suitable insight for informing the current discussion.

interventions were successful at changing intentions, these new intentions were less likely to guide behaviour for those behaviours more likely to be habitual (Webb & Sheeran, 2006). However, it is worth noting that this research compared behaviours (e.g., seatbelt use vs. course enrolment) which although may differ on habit strength may also differ on other important factors. More recent studies investigating individual differences in habit strength failed to find a moderating effect of habit on the intention-behaviour relationship (see Gardner, Abraham, Lally, & de Bruijn, 2012; Gardner, Corbridge, & McGowan, 2015) and so from these studies it seems that the ability to control an unwanted behaviour may not depend on whether the individual performs the behaviour habitually⁷.

It follows from the above discussion that claims espousing the importance of habit for educational interventions may be overstated, and so more direct research is needed to confirm the proposal that habit limits responsiveness to educational interventions targeting sugary drink consumption. To this end, we draw on data from two studies that trialled effective educational interventions targeting this behaviour. Study 1 comprised an on-line experiment conducted in Australia during 2015, where participants in the intervention condition were exposed to an educational poster, and behaviour was captured via a discrete choice experiment paradigm (see Blake, Lancsar, Peeters, & Backholer, 2018). Study 2 comprised a field trial conducted in the Netherlands during 2008, where participants in the intervention were exposed to a school-based obesity prevention program (see Paw et al., 2008). Drawing on these studies, we test the hypothesis that habit strength will moderate the intervention effect, such that individuals with a stronger habit of drinking sugary beverages will benefit less from a nutrition educational intervention compared to individuals with a weaker/no habit.

4.3. Methods

4.3.1. Study 1

Data for study 1 came from an online survey conducted in 2016 by Blake et al., (2018) using an external panel provider. Participants (N = 2,021) were randomly assigned to either the intervention condition or control condition. Those in the intervention condition were exposed to a nutrition education poster (<u>http://www.rethinksugarydrink.org.au/downloads/aboriginal-rethink-poster.pdf</u>) that formed part of a broader print and television campaign that ran in Australia from 2014-2016. All participants then took part in a discrete choice experiment where participants were presented with 20 choice scenarios

⁷ A large number of additional studies have also examined the moderating effect of habit on the intentionbehaviour relationship. However, this research assessed strength of intention to perform the behaviour, and so the implications (i.e., whether habitual behaviour continues despite waning motivations to perform the behaviour) are not necessarily relevant to the current research (e.g., whether habitual behaviour continues despite strong motivations to avoid the behaviour).

within a hypothetical convenience store setting. For each scenario participants selected 1 of 8 options (see Figure 2 below). The order of the options was held constant, while the price and beverage size randomly varied across scenarios and between participants. Sugary drink consumption was inferred by the proportion of scenarios the participant chose a sugary drink (i.e., either regular soft-drink, flavoured milk, juice, or energy drink). All participants then completed the 4-item (Cronbach's $\alpha = 0.81$) Self-Report Behavioural Automaticity Index (Gardner et al., 2012) a validated measure of habit strength whereby higher scores indicate a stronger habit. In conducting this research, it is also important to exclude participants who do not drink sugary drink (as they are not a population of interest) and so participants were asked to report how often they consumed sugary drink over the past month, with non-consumers excluded. Ethics for this trial was granted by the Monash University Human Research Ethics Committee CF15/4153 – 2015001760.

	Energy drink	Plain low- fat milk	Flavoured milk	Bottled water	Soft-drink (regular)	Soft-drink (diet)	Fruit juice	No beverage
Price	\$5.90	\$3.90	\$3.50	\$1.00	\$3.50	\$5.50	\$2.00	N/A
Volume	460ml	330ml	330ml	200ml	330ml	600ml	200ml	N/A
Which would you choose?								

Figure 2. Example scenario presented to participants

4.3.2. Study 2

Data for study 2 came from the Dutch Obesity Intervention in Teenagers (DOiT) study (for detailed description of the intervention and methods see Janssen et al., 2012, and Singh et al., 2006). In short, DOiT was an eight month school-based obesity prevention program running from 2003-2004 consisting of an educational component (i.e., 11 structured lessons in biology and physical activity) and environmental component (e.g., limiting access to vending machines). The focus of the intervention was on improving students' knowledge and critical thinking of energy-balance related behaviours, including sugary drink consumption, to enable students to make more informed choices. Although DOiT included non-educational components (e.g., limiting access to vending machines) the intervention was predominantly education-based and deemed suitable for our purposes.

Participants (N = 851) comprised first year students across 18 prevocational secondary schools (10 intervention schools and 8 control schools) that completed baseline and follow-up self-report surveys during class. Sugary drink consumption was measured by asking participants how many days per week

they consumed soft-drink and fruit-juice, and on these days, how many serves they usually consumed. These two estimates where then multiplied and their product divided by seven to provide a measure of sugary drink consumption per day (ml/day). Habit strength of soft-drink consumption was captured at baseline using a reduced version (3-items, Cronbach's $\alpha = 0.81$) of the Self-Report Habit Index (SRHI) (Verplanken & Orbell, 2003). This measure captures experienced automaticity (i.e., Drinking soft-drink is something I do automatically) and experienced repetition (e.g., ...is something I do often, ...is something that 'fits' me) with higher scores indicating a stronger habit of consuming soft-drink⁸. Ethics approval for this trial was granted by the Medical Ethical Committee of the VU University Medical Centre and the Monash University Human Research Ethics Committee (CF15/1019 – 201500476).

4.3.3. Statistical analyses

Statistical analyses were conducted in SPSS version 24 (study 1) and STATA version 12 (study 2). In order to assess whether individuals with a stronger habit were less responsive to the intervention, in Study 1 we conducted a hierarchical multiple regression analysis with the proportion of trials the individual selected a sugary drink regressed onto age and gender (step 1) study condition and habit strength (step 2) and the study condition × habit strength interaction term (step 3). In Study 2 we used Generalised Estimating Equations to account for the clustering of students within schools. Absolute change in soft-drink consumption from baseline to follow-up⁹ was regressed onto age, gender, study condition, habit strength, and the study condition × habit strength interaction term. Across both studies, study condition and habit strength were mean centred prior to constructing the interaction terms to avoid potential issues with multicollinearity (Aiken, West, & Reno, 1991).

4.4. Results

4.4.1. Study 1

After excluding non-consumers of sugary drink (N = 362) the final sample comprised 1,659 adults (age M = 45.63 years, SD = 16.75 years, male = 48.0%). As shown in Table 1, participants scored around the midscale of the habit measure and selected a sugary drink on less than half of the trials.

⁸ Some scholars measure habit strength by multiplying behaviour frequency with context stability (i.e., BFCS measures). To ensure findings of this study apply to research using either measure, we also conducted analysis using a BFCS measure. Results were similar for both measures, and so for ease of interpretation we present findings for one habit measure only.

⁹ It could be argued that individuals with a stronger habit are more likely to have greater absolute reductions in consumption simply because these individuals have more room for improvement (i.e., due to greater levels of consumption at baseline). To account for this, we also examined relative change in sugary-drink consumption. Results were similar and so for ease of interpretation we present findings using absolute change.

	Intervention (N = 823)		Control (N = 836)		
	Habit	Sugary-drink %	Habit	Sugary-drink %	
Min	1	0	1	0	
Max	5	100	5	100	
M (SD)	2.53 (1.03)	40.72 (29.89)	2.64 (1.02)	45.74 (29.44)	

Table 1. Descriptive statistics of study variables by condition

Sugary drink % = proportion of trials participant selected sugary drink

M = Mean, SD = Standard Deviation

As shown in Table 2 below, the proportion of trials the individual selected sugary drink shared a weak negative relationship with exposure to the intervention, age, and gender and a week positive relationship with habit strength. Habit strength shared a weak negative relationship with study condition, age and gender.

	Sugary-drink %	Intervention	Habit	Age	Gender
Sugary-drink %	-				
Intervention	08**	-			
Habit	.24**	05*	-		
Age	06*	.04	10**	-	
Gender	10**	.02	12**	02	-

Table 2. Bivariate correlations among study variables and demographics

Sugary drink % = proportion of trials participant selected sugary drink; *p<.05, **p<.01

As demonstrated in Table 3 below, there was a main effect of study condition with participants in the intervention condition selecting a sugary drink in fewer trials than did participants in the control condition. There was also a main effect of habit strength, with a stronger habit associated with a greater likelihood of selecting a sugary drink. However, there was no interaction between study condition and habit strength, suggesting individuals with a stronger habit were just as likely to benefit from the intervention as were individuals with a weaker/no habit.

Step	Predictor	в	R ²	F	р
1			.014	11.495	.000
	Age	060			.014
	Gender	102			.000
2			.053	47.171	.000
	Age	035			.146
	Gender	073			.002
	Study condition	070			.003
	Habit	.219			.000
3			.000	0.558	.455
	Age	034			.156
	Gender	073			.002
	Study condition	070			.003
	Habit	.220			.000
	Study condition × habit	.018			.455

Table 3. Predictors of sugary drink %

Sugary drink % = proportion of trials the participants selected sugary drink

4.4.2. Study 2

After excluding participants with missing data (N = 194), non-consumers of sugary drink at baseline (N = 36) and outliers on sugary drink consumption (i.e., z-score > 3.3) at either wave (N = 27) the final sample comprised 851 students (age M = 12.52 years, SD = 0.49 years, male = 48.9%). As shown in Table 1, participants in the intervention and control conditions consumed almost one litre of sugary drink per day, prior to the commencement of the intervention, and scored around the midscale on the habit measure. At follow-up, consumption was less, such that individuals in the intervention condition consumed approximately half-a-litre per day while individuals in the control condition consumed approximately three-quarters of a litre per day.

	Intervention (N = 494)			Control (N = 357)			
	Habit	Sugary-drink ¹	Sugary-drink ²	Habit	Sugary-drink ¹	Sugary-drink ²	
Min	1	29	0	1	29	0	
Max	5	3886	3266	5	3687	3157	
M (SD)	3.08 (0.91)	861 (667)	498 (559)	3.21 (0.92)	950 (698)	778 (693)	

Table 1. Descriptive statistics of study variables by condition and wave

¹Baseline (ml/day); ²Follow-up (ml/day); M = Mean, SD = Standard Deviation

As shown in Table 2, sugary-drink consumption at baseline shared a weak positive relationship with sugary-drink consumption at follow-up. Habit strength shared a moderate positive relationship with sugary-drink consumption at baseline and a weak positive relationship with consumption at follow-up. Females were found to consume less sugary-drink at baseline than males and the intervention group tended to be younger than the control group.

	Sugary drink ¹	Sugary drink ²	Intervention	Habit	Age	Gender
Sugary drink ¹	_					
Sugary drink ²	.30**	-				
Intervention	06	27**	-			
Habit	.40**	.26**	07	-		
Age	.05	01	08*	.06	-	
Gender	07*	04	.05	02	13**	_

Table 2. Bivariate correlations among study variables and demographics

¹Baseline consumption; ²Follow-up consumption; *p<.05, **p<.01

As shown in Table 3, study condition was a significant predictor, such that individuals in the intervention group decreased their sugary drink consumption to a greater extent than individuals in the control condition (corroborating findings by Paw et al., 2008). Habit strength was also a significant predictor, as individuals with a stronger habit decreased their consumption of sugary drink to a *greater* extent than individuals with a weaker habit. Moreover, the study condition × habit strength interaction term was not a significant predictor of change in sugary-drink consumption revealing that

the effect of the intervention was not dependent on the strength of the individual's habit of drinking soft-drink.

Predictor	Coef.	Conf. Int. (95%)	z	р
Age	-58.96	-153.88 45.96	-1.10	.271
Gender	-53.66	-156.86 49.54	-1.02	.308
Study condition	-179.63	-289.96 -69.30	-3.19	.001
Habit strength	-76.19	-132.17 -20.20	-2.67	.008
Study condition × Habit strength	-23.12	-136.22 89.97	-0.40	.689

Table 3. Predictors of absolute change in sugary-drink consumption (ml/day)

4.5. Discussion

Educational interventions have been somewhat effective at reducing sugary drink consumption (Vargas-Garcia et al., 2017). However, education approaches in general have been criticised for having short-lived benefits and/or benefits that are restricted to infrequent consumers (e.g., Wood & Neal, 2016). Given that sugary drink consumption has a habitual component (de Bruijn & van den Putte, 2009; Kremers, van der Horst, & Brug, 2007; Paw, Sing, Brug, & van Mechelen, 2008; Tak, Te Velde, & Oenema, 2011) the aim of the current research was to assess whether habit constrains responsiveness to these interventions. Specifically, we assessed the hypothesis that individuals with a stronger habit of drinking sugary drinks would benefit less from an educational intervention compared to individuals with a weaker/no habit. Using an educational poster (study 1) and school-based obesity prevention program (study 2) intervention effects across both studies were found to be independent of habit strength, and so habit does not appear to constrain responsiveness to educational interventions targeting sugary drink consumption. These findings suggest that concerns about the influence of habit over individual's responsiveness to educational interventions may be overstated, at least within the realm of sugary drink consumption.

4.5.1. In the context of previous research

To the best of our knowledge, this is the first research conducted to assess whether habit reduces responsiveness to educational interventions targeting sugary drink consumption. Previous research in other areas has generally found support for the proposal that habit limits responsiveness to intervention. However, there are important differences between our research and those of others.

Orbell and Verplanken (2010) assessed frequency of action-slips (e.g., lighting-up a cigarette) not the frequency of the behaviour (i.e., number of cigarettes smoked). Action-slips may be important from a theoretical perspective (i.e., action-slips reflect the 'mindlessness' involved in habitual action) but they do not necessarily translate to frequency of the behaviour, as efforts to avoid acting out the behaviour still have opportunity to intervene and stop the behaviour from occurring. Neal et al. (2011) assessed the impact of habit on a single experience (i.e., amount of stale popcorn consumed in one sitting) which may not carry forward to future events (e.g., do they continue consuming stale popcorn on subsequent visits to the cinema) as was investigated in our research. And, Fujii et al. (2001) found habitual drivers were also more likely to overestimate travel times for public transport, and so this belief, as opposed to habit, may explain why they were less likely to switch to public transport during the freeway closure.

Another factor that differs between previous and current research involves the types of behaviours examined. It may be that sugary drink consumption is less habitual than popcorn consumption etc. making sugary drink consumption less vulnerable to the influence of habit. Nevertheless, given that sugary drink consumption still has a habitual component, habit should still influence responsiveness to intervention for this behaviour. We are also unaware of any features of sugary drink consumption that would uniquely enable interventions to take control over habit. With this in mind, it is unlikely that the moderating effect of habit on responsiveness to intervention is behaviour specific, although more research is needed to qualify this statement.

Another factor that differs between previous and current research involves the types of interventions employed. If educational interventions are more effective at overcoming or avoiding the influence of habit, then this could explain why our research failed to find a moderating effect of habit. Although, it is difficult to see how educational interventions would be more effective at tackling habitual behaviour, compared to interventions or events that are restrictive of the target behaviour (i.e., banning cigarette smoking in pubs/closure of a freeway) or interventions that directly reduce the rewarding properties of the behaviour (i.e., serving stale popcorn). According to habit theory, interventions that are more reliant on the individual controlling their behaviour, should be more vulnerable to the influence of habit. Given that educational interventions place the ownership of behaviour change onto the individual, it is perhaps *more* likely that educational interventions would be more susceptible to the influence of habit than were those interventions or events trialled in previous research. Further research will also need to be conducted to determine whether this speculation holds. It could be argued that the criteria used in the current research (whether habit moderates the intervention effect) is not a fair assessment of the influence of habit as it assumes that habitual and non-habitual consumers have the same level of motivation to change their behaviour. If individuals with a stronger habit are more likely to find the intervention more persuasive, then all else being equal, we would expect these individuals to benefit *more* from the intervention (and so if they do not benefit more from the intervention – as was the case in our research – then this provides evidence that habit was restricting behaviour change). To account for this, future research could employ more sophisticated research designs that capture differences in motivational variables (e.g., attitudes towards the intervention) and examine results after accounting for any potential differences.

4.5.2. Unexpected findings

There were also a number of unexpected findings in the current research. The habitual consumers in study 2 showed *greater* reductions (absolute and relative reductions) in sugary drink consumption over the 8-month study period compared to individuals with a weaker/no habit. This occurred in both the control and intervention group and suggests that there were broader factors outside the intervention pressuring individuals to reduce their consumption, and more importantly, that habit was not a barrier to these broader influences. This further supports our conclusion that habit does not constrain responsiveness to intervention targeting sugary drink consumption. Another unexpected finding was in study 1, where individuals in the intervention condition reported a stronger habit compared to individuals in the control condition. Given that this study employed random allocation of participants – which was intended to ensure both study conditions were equivalent to each other on measured and unmeasured factors – it would seem that some aspect of the participant experience in the intervention condition encouraged them to report a stronger habit (e.g., the messaging may have prompted them to identify themselves as habitual consumers, and then using this belief scored themselves higher on the habit measure). Further research is needed to test this assumption.

4.5.3. Strengths and limitations

There were a number of strengths and limitations to the current research that should be considered. In terms of strengths, the two studies employed different methodologies (i.e., on-line experiment vs. field trial) implemented different interventions (i.e., nutrition education poster vs. school-based obesity prevention program) targeted different population groups (i.e., adults vs. adolescents) and were conducted in different countries (i.e., Australia vs. Netherlands) and yet they produced similar results, suggesting a robustness of the research findings. In terms of limitations, study 1 was conducted using a hypothetical scenario in a convenience store setting, which may differ from actual sugary drink behaviour and drink behaviour in other settings. It could also be argued that the discrete choice experiment paradigm reduced the influence of habit (given that individuals may pay more attention to their behaviour in this set-up). However, research using similar methods have revealed that individuals with a stronger habit still pay less attention to alternative behavioural options (see Aarts, Verplanken, & van Knippenberg, 1997; Verplanken, Aarts, & van Knippenberg, 1997) and so habit should have the capacity to influence responsiveness to intervention using this method.

In study 2, consumption in the school environment may not have been influenced by habit as students had recently changed schools (i.e., habit discontinuity hypothesis) (Wood, Tam, & Witt, 2005) and because of the structural changes in this setting (i.e., changes in the school cafeteria). Nevertheless, given that most consumption occurs in the home (Bere, Sørli Glomnes, te Velde, & Klepp, 2008) the impact on total consumption (which is what we measured) should be minimal. Also, two activities implemented during the classroom lessons are known to overcome the influence of habit (i.e., implementation intentions and behaviour diary) however when completing these activities students were free to focus on any health behaviour of their choice (e.g., physical activity, unhealthy snacking, water consumption etc.) and so unless most students focused on sugary drink consumption, these intervention components should have minimal impact on the result. A further limitation of study 2 was that the habit strength measure only pertained to soft-drink consumption and so habit targeted only a portion of the outcome variable which focused on soft-drink and fruit-juice consumption. Nevertheless, given that our measure was predictive of current and future sugary drink consumption, it would appear to have been acceptable. This was further qualified when the results were replicated using an alternative measure of habit strength (i.e., behaviour frequency × context stability measure) (Wood, Tam, & Witt, 2005) which pertained to both soft-drink and fruit-juice consumption. Finally, all measures were self-report and therefore susceptible to response biases.

4.5.4. Conclusion

Across two studies we found that individuals with a stronger habit of consuming sugary drink have the same level of responsiveness to educational interventions targeting this behaviour, as do individuals with a weaker/no habit of consuming sugary drinks. In other words, habit did not appear to diminish the effectiveness of these approaches. However, our findings do sit within a broader literature, which for the most part, do suggest that habit forms a barrier to behaviour change, although, there were a number of methodological factors in both the current and earlier research which make it difficult to draw strong conclusions. We encourage further research in this area, using more rigorous approaches, as it has direct implications for theory and practice across a wide range of health related behaviours, not just sugary drink consumption.

4.6. References

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Chapter 5 – Measuring habit strength

In 1993 Eagly and Chaiken wrote "(...) the role of habit per se remains indeterminate (...) because of the difficulty of designing adequate measures of habit" (p.181). Since the introduction of the Self-Report Habit Index, the subsequent development of other habit measures by others, as well as theorising about the measurement of habit, we are now in a much better place than we were two decades ago, and, hopefully, in a good position to further pursue and extend habit research and theory.

- Orbell & Verplanken, 2015

5. Exploring the association between Behaviour Frequency Context Stability measures and Experienced Automaticity measures in sugary drink consumption

5.1. Summary

Within the habit theory paradigm, habits are seen to be an automatic response to an associated context. Researchers capture habit strength by focusing on the conditions conducive to habit (i.e., behaviour frequency × context stability measures) or on the automaticity that guides the response (i.e., experienced automaticity measures). Both of these measurement approaches are grounded in habit theory and both continue to progress our understanding of the habit concept. Nevertheless, researchers have not examined the relationship between these measures. In response, we draw upon three cross-sectional data sources to systematically test the assumed relationship within the domain of soft-drink consumption. In contrast to the current habit theory paradigm, all three studies failed to show a meaningful relationship between behaviour frequency × context stability measures and experienced automaticity measures. These findings bring into question either habit measurement and/or habit theory within the current domain, with further research needed to explore the reason for this lack of a meaningful relationship.

5.2. Introduction

Sugary drink consumption contributes to a range of negative health outcomes (Loh et al., 2016). For some individuals this behaviour may occur intentionally, while for others it may be a force of habit. Habitual behaviour is performed without conscious intent (i.e., the individual does not need to make a purposive decision in order to initiate the behaviour) without awareness (i.e., the individual may only become aware of performing the behaviour after it has already commenced) and under limited control (i.e., the individual has difficulty preventing the behaviour from initiating) (Lally & Gardner, 2013; Verplanken, 2006). According to habit theory, this automaticity is the product of stimulus-behaviour associations forged in memory as an individual repeatedly performs a behaviour (e.g., daily soft-drink consumption) in the presence of a specific stimulus (e.g., eating dinner at home) (Gardner 2014; Neal, Wood, & Drolet, 2013). For this reason, habits have been defined as "a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations" (Gardner, 2014, pg. 4).

5.2.1. Measuring habit strength

For more than a century scholars used behaviour frequency (i.e., how often a person performs the behaviour) as a measure of habit strength (Triandis, 1977). This measure considers the repetitive nature of habit, and for behaviour recurring in the same situation (e.g., brushing your teeth) is still seen as a valid measure of the stimulus-behaviour association underpinning habit strength (Wood, Tam, & Wit, 2005). However, for behaviour occurring across situations (e.g., sugary drink consumption) it is recommended that the variability of the performance context also be considered. Hence, Ouellette and Wood (1998) developed the context stability measure (i.e., the degree the behaviour is performed in the same situation as opposed to performing the behaviour across different situations) and multiplied scores on this measure with scores on the behaviour frequency measure, to create the Behaviour Frequency × Context Stability (BFCS) measure. This way, individuals who perform the behaviour more frequently, and within the same situation each time, receive the highest habit score, as these individuals are seen to have the greatest potential to develop learned stimulus-behaviour associations (see Figure 1 below).
		Context Stability measure					
		Variable (across more situations)	Stable (across fewer situations)				
Behaviour Frequency measure	Infrequent (less often)	Lowest potential of developing a stimulus-behaviour association, resulting in lowest automaticity (weakest habit)	Moderate potential of developing a stimulus-behaviour association, resulting in moderate automaticity (moderate habit)				
	Frequent (more often)	Moderate potential of developing a stimulus-behaviour association, resulting in moderate automaticity (moderate habit)	Greatest potential of developing a stimulus-behaviour association, resulting in greatest automaticity (strongest habit)				

Figure 1. Representation of the learned stimulus-behaviour association captured via BFCS measures

The BFCS measures capture the conditions conducive to fostering a strong habit, however, when measuring habit strength most health researchers target the automaticity that guides the habitual response (Gardner, 2014). The most popular of these approaches are experienced automaticity measures, whereby participants estimate the degree their behaviour exhibits features of automaticity (e.g., Behaviour X is something I do automatically... I do without thinking...I start doing before I realise I'm doing it...) whereby greater experienced automaticity is indicative of a stronger habit (Verplanken & Orbell, 2003). These measures can be targeted at a specific context (e.g., Behaviour X in situation Y is something...), however, in most studies participants are free to reflect on behaviour more broadly without specification of the contexts in which the behaviour occurs (Gardner, 2014).

A growing number of studies support the validity of BFCS measures and experienced automaticity measures across a variety of behaviours. For example, in accordance with habit theory, individuals scoring higher on these measures tend to show faster processing of habit related information (Neal et al., 2012; Orbell & Verplanken, 2010), have less control over the habitual behaviour (Danner, Aarts, & de Vries, 2008; Gardner, et al., 2012), and gain control over the behaviour during periods of context destabilisation, when habit is expected to be vulnerable to motivational forces (Verplanken & Roy, 2016; Wood, Tam, & Witt, 2005). Some scholars, however, still hold reservations towards their validity. Critics argue that an individual who performs the behaviour frequently and across a variety of situations would have a stronger habit than an individual who performs the behaviour infrequently and in limited situations, and yet the BFCS measure assumes similar habit strength for these individuals (Orbell & Verplanken, 2015). Others have questioned the validity of experienced automaticity measures arguing that individuals do not have the capacity to accurately reflect on the

consciousness of automatized behaviour (Haggar et al., 2015). Such concerns highlight a continued uncertainty among some scholars regarding how best to measure habit strength and call for additional testing of habit measures.

5.2.2. Association between measures

One approach of testing the validity of measures is to examine their relationship with each other. If both measures capture the same construct (i.e., habit strength) then individuals who score higher on one measure should also score higher on the other measure, that is, they should share a positive relationship. A large body of research shows that behaviour frequency measures are positively associated with experienced automaticity measures (see review by Gardner, de Bruijn, & Lally, 2011). This aligns with habit theory as individuals who perform the behaviour more frequently should perform the behaviour with greater automaticity. Although, for behaviours that have the potential to occur across situations we would not expect the relationship between behaviour frequency measures and experienced automaticity measures to be especially strong, as behaviour frequency measures, unlike BFCS measures, do not take into account the variability of the performance context. Support for this comes from a meta-analysis of dietary and physical activity behaviour which found a moderate-strong relationship between behaviour frequency measures and experienced automaticity measures (Gardner, de Bruijn, & Lally, 2011), in other words there was room for improvement.

According to habit theory we may also expect measures of context stability alone to share a positive relationship with measures of experienced automaticity, as the theory descried above suggested that individuals who perform the behaviour in fewer situations have greater potential of developing learned stimulus-behaviour associations. Again, we would not expect the relationship to be strong as context stability measures, unlike BFCS measures, do not take into account the frequency of the behaviour. Research to date reveals mixed results. Some studies find a positive association between context stability measures and experienced automaticity measures (Norman & Cooper, 2011; Pimm et al., 2015; Tappe, Tarves, Oltarzewski, & Frum, 2013) others do not find an association (Grove, Zillich, & Medic, 2014; Naab & Schnauber, 2016) and at least one study found a negative association between these measures (Tappe & Glanz, 2013). Together, these studies show that the relationship between context stability measures and experienced automaticity measures is complex, and suggests that context stability measures may be necessary for measuring habit strength only to the degree that behaviour frequency measures are taken into account.

The BFCS measures account for both the frequency of the behaviour and the stability of the performance context, and therefore BFCS measures should reveal the strongest association with experienced automaticity measures. There does not appear to be support for this. Research has found

a positive relationship between BFCS measures and experienced automaticity measures in the domain of adult physical activity (Tappe et al., 2013) and self-breast examination (Norman & Cooper, 2011). However, despite this relationship, close inspection of these studies suggests experienced automaticity measures shared a stronger relationship with behaviour frequency measures alone and with context stability measures alone, than with BFCS measures. In other words, the measure that should best capture the learned stimulus-behaviour association (i.e., BFCS measures) appeared to share the weakest relationship with experienced automaticity measures. Together, these findings suggest that BFCS measures and experienced automaticity measures capture different constructs, however, this research did not explicitly compare these relationships, nor have researchers more broadly discussed these relationships.

5.2.3. Aim & hypotheses

The aim of this paper is to explicitly test the relationship between these measures across three studies focusing on sugary drink consumption. In doing this, we compare behaviour frequency measures, context stability measures, and BFCS measures on the strength of their relationship with experienced automaticity measures (see Table 1 below). Taking this further, we also combine behaviour frequency measures with measures of context variability (i.e., the reverse of context stability - the degree the behaviour is performed across different situations as opposed to fewer situations) to create a behaviour frequency context variability (BFCV) measure. Individuals who perform the behaviour across different situations will tend to score higher on this measure and so BFCV measures should be especially poor at capturing the learned stimulus-behaviour association (see Table 1 below). In line with habit theory, we hypothesise that the strongest association with experienced automaticity measures will be with the BFCS measure and the weakest association will be with BFCV measures, with the behaviour frequency measures and context stability measures falling somewhere in between.

Table 1. Hypothesised relationship between measures

Measures	Relative strength of relationship	Explanation according to habit theory
BFCS & Experienced automaticity	Strongest	Both behaviour frequency and context stability are required to accurately capture the strength of learned stimulus-behaviour associations. The BFCS measure accounts for both of these factors and so it should have the strongest relationship with experienced automaticity measures.
Behaviour Frequency & Experienced automaticity	Neither strongest nor weakest	Both behaviour frequency and context stability are required to accurately capture the strength of learned stimulus-behaviour associations. The behaviour frequency measures only account for one of these and so it will have a weaker relationship (compared to the BFCS measures) with experienced automaticity measures.
Context stability & Experienced automaticity	Neither strongest nor weakest	Both behaviour frequency and context stability are required to accurately capture the strength of learned stimulus-behaviour associations. The context stability measures only account for one of these and so it will have a weaker relationship (compared to the BFCS measures) with experienced automaticity measures.
BFCV & Experienced automaticity	Weakest	The BFCS measure improves upon the behaviour frequency measure because it also takes into account the stability of the performance context. It follows that if we were to reverse code the context stability measure, turning it into a context variability measure, then this would decrease (instead of increase) the accuracy of the behaviour frequency measure.

BFCS – Behaviour Frequency × Context stability; BFCV – Behaviour Frequency × Context Variability

5.3. Methods

5.3.1. Participants

Data for study one came from a 2008 cross-sectional survey of students from a Dutch secondary school (see de Bruijn & van den Putte, 2009). After excluding participants with missing data (N = 26) and/or non-consumers of soft-drink (N = 26) the final sample comprised 260 adolescents. Data for study two came from the baseline measure of the Dutch Obesity Intervention in Teenagers study (Singh et al., 2006/2009). This study took place across 2003-2004 in 18 pre-vocational secondary schools across the Netherlands. After excluding participants with missing data (N = 78) and/or non-consumers of soft-drink (N = 120) the final sample comprised 910 adolescents. Data for study three came from additional survey items included in the follow-up measure (2014) in the control condition (i.e., three schools) of the Australian Capital Territory It's Your Move project (see Malakellis et al., 2017). Parental education was relatively high in this study suggesting an economically advantaged sample. After excluding

participants with missing data (N = 7) and/or non-consumers of soft-drink (N = 33) the final sample comprised 116 adolescents.

5.3.2. Ethics

Study one was approved by the Ethics Committee (AIEC) of the University of Amsterdam (2014-CW-24), study two by the Medical Ethical Committee of the VU University Medical Center, and study three by the Deakin University Human Ethics Committee (2012-015). Ethical approval for the use of secondary data was further provided by the Monash University Human Research Ethics Committee (CF15/1019 – 201500476).

5.3.3. Measures

5.3.3.1. Experienced Automaticity

In studies one and two experienced automaticity was captured with shortened versions of the Self-Report Habit Index (Verplanken & Orbell, 2003). This 12-item measure consists of 9-items capturing experienced automaticity (e.g., Drinking soft-drink is something I do automatically) and 3-items capturing experienced repetition (e.g., Drinking soft-drink is something I do frequently). For the purpose of the current research only items capturing experienced automaticity were utilised, resulting in 9-items (Cronbach's α = .93) in study one and 1-item in study two (the survey in study two only comprised 3-items of the Self-Report Habit Index and only one of these pertained to experienced automaticity). Response options ranged from 1 (strongly disagree) through 5 (strongly agree) with higher scores signifying a stronger habit. In study three, experienced automaticity was captured using the Self-Report Behavioural Automaticity Index, a 4-item measure (Cronbach's α = .86) derived from automaticity focused items from the Self-Report Habit Index (see Gardner et al., 2012) with response options 1 (strongly disagree) through 5 (strongly agree) with higher scores signifying a stronger habit.

5.3.3.2. Behaviour Frequency

In studies one and two behaviour frequency was measured by asking participants how many days per week they typically consumed soft-drink¹⁰, and on these days, how many serves they usually consumed. These two estimates where then multiplied to provide a measure of weekly soft-drink consumption (i.e., serves per week). In study 3, behaviour frequency was captured by asking participants to estimate how many serves of soft-drink they usually consumed per week. In all studies, information about standard serving sizes was provided.

¹⁰ In study 2, behaviour frequency comprised soft-drink consumption and fruit juice consumption combined.

5.3.3.3. Context stability

In studies one and two, context stability was measured by asking participants to select, from a range of everyday situations, which situations they would usually consume soft-drink. Study one provided nine situations (i.e., at breakfast; when I'm at school; in the afternoon, after school; in the evening, during dinner; in the evening after dinner; when I'm watching TV; when I'm playing sports, or after; on the weekend; when I'm with friends) while study two provided three additional situations (i.e., at lunch; in the afternoon, at school; at parties or birthdays). Both studies also gave participants space to write one additional situation (i.e., Other: . . .). In both studies, the number of selected situations served as a measure of context stability whereby fewer situations selected marked a more stable context (i.e., scores higher on this measure) and more situations selected marked a more variable context (i.e., scores lower on this measure).

Study three used a more standard approach to measuring context stability. Based on Ji and Wood (2007) five separate context stability measures were obtained from five items each capturing a different context dimension: "I drink soft-drink... in the same location (i.e., location stability) ... at the same time of day (i.e., time stability) ... while doing the same activity (i.e., activity stability) ... around the same people (i.e., people stability) ... when in the same mood (i.e., mood stability)". Each statement was followed by response options 1 (rarely) through 5 (always) with higher scores signifying a more stable context.

5.3.3.4. Behaviour Frequency Context Stability

In all three studies the BFCS measure was created by multiplying the participants' score on the behaviour frequency measure with their score on the context stability measure (see Adriaanse et al., 2011; Ji & Wood, 2007). This resulted in one BFCS measure in studies one and two, and five BFCS measures for study three (i.e., one for each measured context dimension).

5.3.3.5. Behaviour Frequency Context Variability

In all three studies the BFCV measure was created by reverse coding scores on the context stability measure (i.e., turning it into a context variability measure) prior to the multiplication process. The product was a continuous measure whereby individuals who perform the behaviour frequently and in a more variable context receive higher scores while individuals who perform the behaviour infrequently and in a more stable context receive lower scores. Again, this resulted in one BFCV measure in studies one and two, and five BFCV measures in study three.

5.3.4. Analysis

Analyses were conducted using Stata version 12.0 (StataCorp, 2015). For each study we conducted four multiple regression analyses. For each analysis we regressed experienced automaticity onto the BFCS measure (or the behaviour frequency measure, or the context stability measure or the BFCV measure) while controlling for age and gender and accounting for potential clustering at the school level (via the cluster command in Stata). Although for each study it would have been optimal to include all four measures (i.e., BFCS, behaviour frequency, context stability, BFCV) in the one model, this was not possible due to issues with multicollinearity (data not shown). In all three studies the BFCS measure, the behaviour frequency measure and the BFCV measure were all strongly positively skewed and corrected via logarithmic transformations (except for study two where the behaviour frequency measure was moderately positively skewed and so normalised via a square root transformation¹¹). Study three captured five context dimensions. Of these dimensions only the location context dimension was predictive of experienced automaticity and so only findings for this context dimension are presented (see Wood, Tam, & Witt, 2005)¹².

5.4. Results

5.4.1. Descriptive statistics

Sample characteristics and descriptive statistics for each study are presented in Tables 1, 2 and 3 below. Participants in study one were mostly female with an average age of 13.80 years. In studies two and three the gender distribution was fairly even and participants' average age was 12.63 years and 15.03 years respectively. Across all three studies participants tended to score around the midscale of the experienced automaticity measures and the context stability measures. Sugary drink consumption was relatively high in studies one and two with participants consuming on average two and three drinks per day respectively. Participants in study three consumed considerably less sugary drinks with an average of two drinks per week.

¹¹ Study 2 may have experienced less skew in the behaviour frequency variable (relative to studies 1 and 3) because in this study the behaviour frequency measure captured soft-drink consumption but also fruit juice consumption, which may have a more normal distribution in the population.

¹²Although we only present the findings of the location context dimension, we did conduct all of the analyses when using these other context dimensions. Results for these context dimensions were the same as the results for the location context dimension and so we provide the results for the location context dimension only.

Variable	M (SD)	EA	BFCS	CS	BF	BFCV	Age	Male
EA	2.86 (0.93)	-						
BFCS	70†	.419***	_					
CS	6.08 (1.96)	397***	229***	_				
BF	14†	.500***	.926***	564***	_			
BFCV	42†	.517***	.770***	791***	.939***	-		
Age	13.80 (1.39)	.050	.050	.027	.037	.014	-	
Male	33.50%	043	094	011	093	045	096	-

 Table 1. Means (Standard Deviations) and bivariate correlations of study variables and sample characteristics from Study 1

EA = Experienced automaticity; BFCS = Behaviour frequency context stability; CS = Context stability; BF = Behaviour frequency; BFCV = Behaviour frequency context variability; \dagger value represents the median of pre-transformed variable; ***p<.001

Table 2. Means (Standard Deviations) and bivariate correlations of study variables and samplecharacteristics from Study 2

Variable	M (SD)	EA	BFCS	CS	BF	BFCV	Age	Male
EA	3.18 (1.12)	_						
BFCS	152†	.261***	-					
CS	7.64 (2.54)	289***	.096**	-				
BF	23†	.349***	.843***	341***	-			
BFCV	108†	.389***	.588***	739***	.829***	-		
Age	12.63(0.48)	076*	043	.014	065	031	-	
Male	50.66%	004	055	016	062	018	.134***	-

EA = Experienced automaticity; BFCS = Behaviour frequency context stability; CS = Context stability; BF = Behaviour frequency; BFCV = Behaviour frequency context variability; †value represents the median of pre-transformed variable; *p<.05; **p<.01; ***p<.001

Variable	M (SD)	EA	BFCS	CS	BF	BFCV	Age	Male
EA	2.62 (0.99)	-						
BFCS	4†	.07	_					
CS	2.93 (1.21)	186*	.615***	-				
BF	2†	.183*	.887***	.197*	-			
BFCV	5†	.280**	.555***	312**	.862***	_		
Age	15.03(0.60)	146	.126	.276**	013	150	_	
Male	47.4%	.115	.145	.083	.121	.093	055	_

 Table 3. Means (Standard Deviations) and bivariate correlations of study variables and sample characteristics from Study 3

EA = Experienced automaticity; BFCS = Behaviour frequency context stability (location); CS = Context stability (location); BF = Behaviour frequency; BFCV = Behaviour frequency context variability (location); $^+$ value represents the median of pre-transformed variable; $^*p<.05$; $^*p<.01$; $^{***}p<.001$

5.4.2. Association with Experienced Automaticity

Findings from the multiple regression analyses are presented in Table 4. When controlling for age and gender and accounting for potential clustering at the school level, all three studies found the BFCV measure and the behaviour frequency measure shared a significant positive relationship with experienced automaticity while the context stability measure shared a significant *negative* relationship with experienced automaticity. The BFCS measure, however, was associated with experienced automaticity in studies one and two, but not in study three. Within each study, comparison of the standardised coefficients suggested that the strongest predictor of experienced automaticity was the BFCV measure, followed by the behaviour frequency measure, the context stability measure and then the BFCS measure. The only exception to this was in study 1 where experienced automaticity appeared to have a stronger relationship with the BFCS measure than with the context stability measure.

Study	Predictor	в	Conf. Interv	al (95%)	t	р
1	BFCS	.417	0.28	0.49	7.32	.000
	CS	399	-0.48	-0.27	-6.97	.000
	BF	.499	0.37	0.56	9.19	.000
	BFCV	.516	0.38	0.58	9.65	.000
2	BFCS	.290	0.21	0.37	7.72	.000
	CS	322	-0.43	-0.22	-6.44	.000
	BF	.388	0.29	0.49	8.41	.000
	BFCV	.433	0.34	0.53	9.65	.000
3	BFCS	.074	-0.07	0.22	2.16	.164
	CS	169	-0.30	-0.04	-5.45	.032
	BF	.213	0.06	0.37	5.97	.027
	BFCV	.254	0.07	0.44	6.00	.027

 Table 4. Multiple regression analyses predicting experienced automaticity

BFCS = Behaviour frequency context stability; CS = Context stability; BF = Behaviour frequency; BFCV = Behaviour frequency context variability; Note: each analysis controlled for age and gender and studies 2 and 3 accounted for potential clustering at the school level.

5.5. Discussion

Behaviour Frequency × Context Stability (BFCS) measures and experienced automaticity measures are the most commonly used measures of habit strength within the health literature. When utilising these measures scholars describe habits as learned stimulus-behaviour associations forged in memory through frequent action in stable contexts. Given that either measure is used to capture this construct, we would expect a positive relationship between these measures. The aim of the current research was to test for this relationship in the domain of sugary drink consumption. In order to provide a stringent assessment, we compared the strength of this relationship against the strength of the relationship experienced automaticity measures have with 1) behaviour frequency measures, 2) context stability measures, and 3) behaviour frequency × context variability (BFCV) measures. According to habit theory, none of these should reveal a stronger relationship because 1) behaviour frequency measures do not take into account the stability of the context, 2) context stability measures do not take into account the frequency of the behaviour, 3) BFCV measures assume greater habit strength when behaviour occurs across different situations. As such, we hypothesised that experienced automaticity measures would share the strongest association with the BFCS measures and the weakest association with the BFCV measures. However, across three studies the reverse pattern was found. Moreover, context stability measures shared a negative relationship with experienced automaticity measures, with soft-drink consumption reported across a greater range of situations being linked to higher levels of experienced automaticity. Moreover, the overall strength of the relationship between BFCS measures and experienced automaticity measures was weak across studies. Together, these findings suggest that BFCS measures and experienced automaticity measures capture different constructs within the realm of sugary drink consumption.

5.5.1. Potential explanations

5.5.1.1. Sugary drink consumption

There are a number of potential explanations for these findings. One explanation is that sugary drink consumption is not habitual. If this holds, then a comparison between measures may lead to spurious results. Previous research, however, shows theory congruent effects in that attitudes, beliefs and intentions to consume soft-drink do not mediate the relationship between soft-drink habit strength and consumption (de Bruijn & van den Putte, 2009). In other words, habit was shown to drive this behaviour directly, independent of controlled reasoning processes. It also seems unlikely that this behaviour is less habitual than other similar behaviours (e.g., unhealthy snacking) that have shown to have a habitual component in adolescent samples (De Vet et al., 2015).

Our findings are unique in that we found a consistent negative relationship between context stability measures and experienced automaticity measures. Research in other behavioural domains has not found this consistent relationship. Physical activity studies, for example, have found a positive relationship (Pimm et al., 2015; Tappe et al., 2013), no relationship (Grove, Zillich, & Medic, 2014) and a negative relationship (Tappe & Glanz, 2013) between these measures. Whether the difference between our findings and those of others is a result of the behaviour investigated, and not some other factor, remains unknown. Nevertheless, the broader findings of the current research do not seem to be unique to sugary drink consumption. As discussed in the introduction, experienced automaticity measures shared a weaker relationship with BFCS measures (than compared to behaviour frequency measures alone or context stability measures alone) in the domains of self-breast examination (Norman & Cooper, 2011) and adult physical activity (Tappe et al., 2013). Apart from the fact that these behaviours are also health related, we see no meaningful connection to the behaviour of sugary

drink consumption. Therefore, although our interest lies in examining the measurement of habit for sugary drink consumption, the high-level findings of the current research may apply to health behaviour more broadly.

5.5.1.2. BFCS measures

Another explanation is that compared to the other measures (i.e., behaviour frequency measures, context stability measures, or BFCV measures) the BFCS measures were a poorer measure of the strength of learned stimulus-behaviour associations. This, however, seems difficult to justify as the factors determining the strength of learned stimulus-behaviour associations (i.e., the frequency in which a stimulus and behaviour occur together) is surely better captured by the combination of behaviour frequency measures and context stability measures than captured by either of these measures alone (see Figure 1 above). Moreover, it is especially difficult to see how using context variability measures would more accurately capture the frequency in which a stimulus and behaviour occur together.

Perhaps one explanation is that BFCS measures focus too much on the conditions conducive to habit development, which may not necessarily reflect the behaviour patterns of habitual performers. If this argument holds, then our findings could simply arise from habitual performers having changed the pattern of their behaviour in recent times. Consider for example, an individual with a strong habit (forged by regular consumption of soft-drink in the same situation) who now decides to also consume sugary drink in other situations. Their score on the context stability measure is lowered by their consumption across these situations, and yet, for the consumption that occurs in the associated context the behaviour is still a force of habit. Of course, the counter argument to this is that their overall frequency of consumption also increased, which helped maintain their score on the BFCS measure, and so the impact is minimal. Nevertheless, research has yet to assess the impact that changing behaviour patterns has on the validity of BFCS measures, and so we cannot rule out this potential explanation.

Critics have also questioned the ability of context stability measures to accurately capture the habit stimulus. This criticism has been levelled on three fronts: 1) participants may not be aware of the true stimulus activating their habitual behaviour, and as a consequence, may incorrectly report on their exposure to the stimulus, 2) the stimulus is only one feature within any given situation, and as a consequence, the stimulus may occur across different situations, 3) researcher generated situations (or context dimensions) can miss the idiosyncratic habit stimuli, and as a consequence, the stimulus may not be captured within the measure. Together, these have the potential to invalidate context stability measures, and may help explain why previous research has not found a consistent positive

relationship between context stability measures and experienced automaticity measures. However, they do not necessarily explain the consistent negative relationship observed in our research. In order to explain our findings, there would need to be systematic error, not just random error.

One cause of systematic deviation could arise from confounding. It could be argued that if context stability was negatively associated with behaviour frequency (i.e., individuals who performed the behaviour in more situations also tended to perform the behaviour more frequently) the observed negative association between context stability measures and experienced automaticity measures was confounded by behaviour frequency. That is, participants who performed the behaviour in a variable context obtained higher automaticity scores by virtue of their tendency to perform the behaviour more frequently. To account for this, we examined the relationship between the context stability measures and experienced automaticity measures that behaviour frequency did not confound our findings.

5.5.1.3. Experienced automaticity measures

Another potential explanation for our findings is that the experienced automaticity measures poorly capture the strength of stimulus-behaviour associations. Some scholars have raised concerns about the capacity for individuals to accurately reflect on automatized behaviour, arguing that we inherently lack insight into the processes involved in this behaviour (Haggar et al., 2015). It is entirely possible that participants struggle to estimate the automaticity involved in their behaviour, although again, in order to explain our findings, their responses would need to have systematic error (i.e., participants who consume sugary drink across more situations would need to estimate higher levels of automaticity). One pathway to this may involve participants drawing on pre-conceived ideas of what automatized behaviour looks like, and comparing against these ideas, making their judgement (e.g., "I choose soft-drink in most situations, therefore I must do it automatically"). However, research examining participant's interpretation of experienced automaticity items suggests that, on the whole, they do interpret the items appropriately (Gardner & Tang, 2013) although this research was conducted with adult populations, which may not be reflective of the adolescent populations used in the current research. More research is needed to determine whether this explains our results.

A further proposal is that experienced automaticity measures capture a form of automaticity not derived from stimulus-behaviour associations. Some theorists propose the existence of generalised habits that guide behaviour across situations (Danner, Aarts, & de Vries, 2007; Naab & Schnauber 2016; Verplanken, Aarts, Knippenberg, & Knippenberg, 1994). These habits are seen as an efficient decision process, where the usual response option comes to mind faster and easier than alternative options,

and with less need for consideration of contextual information. Under this framework, we would expect experienced automaticity measures to share a stronger relationship with BFCV measures, as individuals with a stronger habit consume sugary drink across a variety of situations, while individuals with a weaker/no habit act in response to situational factors that made soft-drink more appealing than usual (e.g., on special occasions). If this proposal holds, then our findings are more a product of experienced automaticity measures and BFCS measures capturing different types of habit, as opposed to one or both of these measures being invalid.

5.5.2. Implications

The findings of the current research show that scholars should not assume that BFCS measures and experienced automaticity measures capture learned stimulus-behaviour associations. Given that BFCS measures and experienced automaticity measures failed to show a strong relationship, it would seem that more work needs to be done to improve at least one of these measures. Unfortunately, the current research does not shed light into which measure needs improvement, but it does at least highlight the issue and provides impetus for further research and discussion in the area. On the other hand, it is also possible that our findings simply highlight incorrect use of experienced automaticity measures for capturing the automaticity arising from learned stimulus-behaviour associations, they appear more suited for targeting generalised habits, that is, habits that occur across situations.

5.5.3. Strengths and limitations

There are a number of strengths and limitations with the current research. One strength was the consistency of the findings, especially given the variation in measurement. For example, context stability was captured via the "number of different situations the participant consumes soft-drink", or, the "degree the context is never or always the same across each performance" and yet the role of context was the same across studies. Also, our findings were observed across countries (i.e., Netherlands and Australia) suggesting a robustness across cultures. However, perhaps the greatest strength was the deconstruction and reconfiguration of the BFCS measure to create four measures that incrementally diverge from the habit framework. In this way, we were able to provide a stringent test of the relationship between BFCS measures and experienced automaticity measures.

As for limitations, the experienced automaticity measure utilised in study two consisted of a single item and therefore may not be a reliable measure of experienced automaticity. Furthermore, behaviour frequency in study two comprised soft-drink and fruit juice consumption while the context and habit measures captured soft-drink consumption only. Nevertheless, given that findings were consistent to those in studies one and three, both of these limitations seem to have had little impact on the overall results. Finally, another limitation was the failure to assess whether the difference in strength of association between each measure was statistically significant (this was due to multicollinearity that arose when all four measures were included in the model). Nevertheless, the consistent pattern of results suggests a true difference between measures. Moreover, we were able to conduct analyses with the BFCS measure and the BFCV measure in the same model. In support of our conclusion, across all three studies only scores on the BFCV measure remained significantly associated with scores on the experienced automaticity measure. Finally, all three studies utilised adolescent (i.e., student) samples and so without further testing we do not know whether these findings also hold among adult populations.

5.5.4. Conclusion

This research explored the relationship between BFCS measures and experienced automaticity measures in the domain of sugary drink consumption. Underpinned by habit theory these approaches should converge, with greater behaviour frequency in a more stable context leading to higher scores on experienced automaticity measures. However, we did not find support for this. Scores on experienced automaticity measures were better explained by behaviour frequency measures, context stability measures and best explained when behaviour frequency measures were combined with a measure of context variability. Together, this research reveals low convergence between BFCS measures and experienced automaticity measures, and when using the latter warns against defining habits in terms of context stability, at least when exploring sugary drink consumption.

5.6. References

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Chapter 6 – Discussion

It is important to consider the role(s) that habit may play in the broad behavioural categories of interest to health psychologists, such as dietary consumption, physical activity, or drinking alcohol. Further work is required to document more convincingly the relevance of habit to health behaviour.

- Benjamin Gardner, 2014

6. Discussion

For over a century habits have captured our imagination. The idea that human behaviour can be initiated and guided without purposeful intent is both wondrous and confronting. Our lived experience persuades us to believe that every day we consciously navigate our way through a series of tasks and responsibilities. The concept of habit, however, involves a recognition that sometimes we are not at the steering wheel, but instead, can be a mere passenger in our own life. In the vast majority of situations, this delegation from intentional control to habitual control is beneficial. Indeed, "There is no more miserable human being than one in whom nothing is habitual but indecision, and for whom ... [every act] . . . are subjects of express volitional deliberation" (James, 1980, Chapter IV, para. 41). However, when habits are driving unhealthy behaviour, like sugary drink consumption, their cumulative effect can have a profound negative impact on population health. In this thesis, I explore this darker side of habit, with an interest in further developing habit theory and better informing population-level efforts to curb sugary drink consumption.

6.1. Learnings from chapters 2 – 4

There were a number of key findings generated from this thesis. Beginning with a narrative review of the literature (Chapter 2), we revealed a range of features of habit that may influence individuals' responsiveness to intervention, and we discriminated public health interventions that are likely to reduce habitual consumption, from public health interventions that are unlikely to reduce habitual consumption. The most important feature of habit was that habitual behaviour is not necessarily under the control of the individual (Danner, Aarts, & de Vries, 2008; Ji & Wood, 2007). If this holds, then interventions that take effect via changing people's intentions (e.g., mass media campaigns, school-based education strategies, fiscal policy), or via enabling individuals intentions (e.g., nutrition labelling) or via protecting their intentions (i.e., marketing restrictions) may have limited impact on the behaviour of individuals with a strong habit, given that their intentions have little influence over their behaviour (e.g., Webb & Sheeran, 2006).

However, we also identified strategies that can help increase the effect of some of these initiatives. Research shows that the intention-behaviour discordance may, to some extent, be due to individuals not paying attention to their current behaviour (i.e., when attention is focused elsewhere, habit is free to guide behaviour without interruption) (Wood, Quinn, & Kashy, 2002). One strategy to avoid the influence of habit maybe to grab people's attention at the point of habitual action (e.g., salient signage on drink fridge). This way, the customer is made aware of their behaviour, and can intervene. The intention-behaviour discordance may also be reduced in new and unfamiliar settings. In familiar settings, features of the environment that have come to be associated with the behaviour, activate the habit, and when left unchecked, guide behaviour directly. According to the habit discontinuity hypothesis, new and unfamiliar settings are not associated with the behaviour, and so habit is not activated - and therefore does not influence behaviour - in these situations (Verplanken, Walker, Davis, & Jurasek, 2008; Wood, Tam, & Witt, 2005). It follows that some public health interventions could be implemented during periods of context destabilisation (e.g., when employees or students are starting a new job/school or when people move house) in order to increase their effect on habitual behaviour in the new settings.

Another finding from the review was that habits lead to what we term consideration bias. Research shows that when making decisions, individuals with a stronger habit give greater consideration to habit related information, relative to information pertaining to alternative courses of action (Aarts, Verplanken, & van Knippenberg, 1997; Verplanken, Aarts, & van Knippenberg, 1997). If this holds for sugary drink choices, this bias potentially reduces the influence of interventions promoting consumption of healthier alternatives (e.g., water campaigns) as the message is not given the attention required to influence drink choices. Instead, interventions discouraging consumption of sugary drinks may be given greater consideration, and therefore greater likelihood of success. Of course, this also depends on whether the individual has control over their behaviour, and so this feature of habit should be considered alongside those approaches outlined above intended to reduce the intention-behaviour discordance.

Another finding of the review was that structural interventions may be best placed to reduce habitual consumption of sugary drink. Structural interventions may take effect irrespective of an individual's intentions, and include restricting access to sugary drinks (i.e., prohibiting the selling of sugary drinks in schools and removing sugary drinks from supermarket checkouts) and capping portion sizes of sugary drinks. The former approach removes the choice option, and so individuals cannot purchase sugary drink even if they intend to, while the latter approach reduces the quantity of sugary drink consumed from a single purchase. Together, these approaches may avoid the influence of habit because they do not require the individual to take control of their behaviour (e.g., Wansink & Cheney, 2005), and so may offer the best option to reduce habitual consumption in certain, albeit limited, contexts.

An additional finding from the review was that intention-based approaches, even if constrained by the influence of habit, should not be overlooked. These approaches are appropriate for individuals without a strong habit, and so may be important for reducing consumption for a proportion of the population. These approaches may also be well suited for preventing a strong sugary drink habit from

developing. In other words, even if intention-based approaches are less effective among habitual consumers, there remains an important role to play for these intervention strategies.

Finally, one of the most important learnings for me as a result of conducting the review was learning that there were only a small number of empirical studies to draw upon. Only a handful of studies had explored the impact of increasing awareness of behaviour, or of context destabilisation, or of consideration bias. Moreover, there was no empirical investigations into the influence of habit on any of the public health interventions outlined in the review. As a consequence, much of the discussion in my review was theoretical and in need of further investigation. However, one area that did have a considerable body of evidence, albeit across other behaviours, was on the intention-behaviour discordance observed for individuals with a stronger habit (e.g., Danner, Aarts, & de Vries, 2008; Ji & Wood, 2007). Evidently this was an important area of enquiry, and in some ways could be seen as a corner stone of a strong habit.

Given the importance attributed to the intention-behaviour relationship, we then assessed whether sugary drink habits do limit control over sugary drink consumption. Gardner, Corbridge, and McGowan (2015) identified that although most behaviour prediction studies do reveal a moderating effect of habit (i.e., intentions are weaker predictors of behaviour among individuals with a stronger habit) this finding is based on research that measured congruent habits and intentions (i.e., habit strength and intention strength to perform the behaviour). As a result, the findings are relevant for understanding the protective benefit of good habits (i.e., behaviour continues in the face of reduced motivation to perform the behaviour). However, this does not necessarily answer the question 'do individuals with a bad habit have less control over their unwanted behaviour?' To answer this question, researchers need to capture intentions to avoid the behaviour. From the two previous studies that measured this, neither found a moderating effect of habit on the intention-behaviour relationship, suggesting that individuals may have greater control over their habitual behaviour than previously thought (Gardner et al., 2015; Gardner, Abraham, Lally, & de Bruijn, 2012). In exploring this for sugary drink consumption we analysed data from a small cross-sectional study, and found intentions to avoid sugary drink to be less predictive of consumption among individuals with a stronger habit, in other words, participants who habitually consumed sugary drink seemed to have less control over their drink behaviour relative to individuals with a weaker/no habit (Chapter 3).

If individuals with a sugary drink habit do have less control over their behaviour, then this could limit their responsiveness to intention-based interventions, after all, if their intentions are not driving their behaviour, then there may be little benefit in changing, supporting or protecting intentions (Danner et al., 2008). Numerous scholars have already noted that habit could reduce responsiveness to intervention (Cohen & Farley, 2008; de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; Gardner, 2014; Verplanken & Wood, 2006), however, when reviewing the literature in this space, it became apparent that there are limited investigations directly testing this proposal for any behaviour and for any type of population-level intervention. The research that had been conducted generally found support for the idea that individuals with a stronger habit are less responsive to intervention (e.g., Orbell & Verplanken, 2010, study 2) or to events that should encourage alternative courses of action (e.g., Fujii, Garling, & Kitamura, 2001; Neal, Wood, Wu, & Kurlander, 2011), although not all studies revealed this effect (Matthies, Klöckner, & Preibner, 2006). In response, I assessed whether sugary drink habits moderated the intervention effect of DOiT (an 8-month school-based obesity prevention program) on sugary drink consumption, and of an educational poster in an online experiment on drink choices. In both studies, habit did not moderate the intervention effect, in other words, individuals with a stronger habit of drinking sugary drink showed the same responsiveness to the intervention as compared to individuals with a weaker/no habit. Together, these findings suggest that efforts to reduce population level consumption of sugary drinks may not be constrained by habit to the extent expected from the review (Chapter 2) and often indicated in the broader literature (e.g., Verplanken & Wood, 2006).

If having a strong sugary drink habit does not restrict your ability to follow-through with an educational message, then concerns about the influence of habit are overstated. The implications of this are considerable. Much of what was discussed in the narrative review (Chapter 2) was based on the assumption that habit would restrict responsiveness to intention-based interventions. Indeed, this was arguably the main reason we viewed habit theory as a useful theoretical framework for informing the development and selection of public health interventions targeting sugary drink consumption. However, if habit does not restrict responsiveness to intervention then there is little benefit in selecting interventions based on their potential to overcome the influence of habit. This is not to say that strategies outlined in chapter 2 will not be beneficial (delivering interventions during periods of context destabilisation has shown to increase the effect of interventions) but given our findings it is difficult to claim that the benefit is attributable to overcoming the influence of habit.

6.2. Limitations and recommendations from chapters 2 – 4

The finding that habit does not moderate the intervention effect (Chapter 4) but does moderate the intention-behaviour relationship (Chapter 3) poses a theoretical challenge. If having a strong habit reduces your control over the behaviour, then how did individuals with a strong habit modify their behaviour in response to the intervention? Perhaps one way to resolve this dilemma is to acknowledge the limitations of my research. In our investigation of the influence of habit on the intention-behaviour

relationship, we utilised an extremely small sample within a cross-sectional study design. Either of these factors could lead to spurious results. In our investigation of the influence of sugary drink habits on responsiveness to educational interventions, there were a range of factors that could have reduced the influence of habit, thereby leading to the 'null' findings. For example, in the school-based obesity prevention program, students where encouraged to use behaviour diaries and to develop implementation-intentions, both are strategies known to overcome the influence of habit and neither are reflective of a typical education campaign. In the online experiment, participants made decisions based on hypothetical scenarios, which may have inadvertently brought attention to their behaviour, thereby empowering their intentions to overcome the influence of habit. In other words, in both of these studies, there were factors that could influence the results in a way to make it appear that habit does not influence responsiveness to educational campaigns.

Another potential limitation of my research was the use of secondary data, which was collected for purposes other than what I have used it for. Perhaps the most notable example of this was the study involving DOiT, a school-based obesity prevention program. The researchers conducting the study were mindful of keeping the survey to a reasonable length, and so in prioritising measures to meet the needs of their objectives, only 3 items from the 12-item Self-Report Habit Index were used. It follows that a more purpose built study (i.e., for examining the influence of habit) would place greater importance on the need to accurately capture habit strength. A more tailored study would also examine a more standard educational intervention, one that does not contain unwanted elements (i.e., elements known to overcome the influence of habit – implementation intentions – and not representative of an educational strategy – changes in the school cafeteria).

Taken together, it is evident that more research needs to be conducted in order to draw strong conclusions about the influence of habit on control over sugary drink consumption and on individual's responsiveness to intention-based interventions targeting this behaviour. To answer these questions scholars could employ more sophisticated research designs. For example, together these questions could be answered within a mediated moderation analysis (see Figure 1 below) via a randomised-control trial assessing the impact of personalised health information. In this example, participants would complete a baseline measure capturing habit strength. Sometime after the implementation of the intervention, a follow-up measure capturing sugary drink consumption and avoidance intentions could be administered to all participants. If the intervention was found to be effective, and this effect was moderated by habit strength, we could then assess whether intention is a stronger mediator of the intervention effect among individuals with a weaker habit (and a weaker mediator of the intervention effect among individuals with a stronger habit). This would provide strong evidence that habit reduces an individual's responsiveness to intervention *because* it reduces the control over their

behaviour (see Muller, Jud, & Yzerbyt, 2005). Efforts to identify the influence of habit on responsiveness to intervention will play a considerable role in developing habit theory and to better inform intervention development, and so I strongly encourage greater activity of research in this area.





6.3. Learnings from chapter 5

In addition to exploring the influence of habit on individual's behaviour and on responsiveness to intervention, in this thesis I also assessed the measurement of habit. As with all psychological constructs, habits are inferred from the measures we use to capture them. In habit theory, this nearly always involves administering experienced automaticity measures or behaviour frequency × context stability measures (Gardner, 2014). Both of these approaches are grounded in the same theory of habit, but differ in terms of where in the habit process they focus. Behaviour frequency × context stability measures capture the conditions conducive to habit (i.e., frequent behaviour performed in a stable context) (Ouellette & Wood, 1998) while experienced automaticity measures capture the automaticity that guides the habitual response (Verplanken & Orbell, 2003). If both of these are valid measures of habit, then we would expect them to correlate in meaningful ways.

Across three studies we investigated the relationship between behaviour frequency × context stability measures and experienced automaticity measures in the domain of sugary drink consumption (Chapter 5). Because behaviour frequency × context stability measures are created by multiplying scores from a behaviour frequency measure with scores from a context stability measure, we were able to deconstruct the measure (behaviour frequency alone and context stability alone) and reconstruct a new measure that should be especially poor at capturing habit strength (by reverse coding the context stability measure and then multiplying these scores with scores on the behaviour frequency measure). This left four measures: 1) behaviour frequency × context stability, 2) behaviour frequency, 3) context stability, 4) behaviour frequency × context variability. We then compared these

measures to identify which measures share the strongest relationship with experienced automaticity measures.

Across all three studies we found little support for a relationship between behaviour frequency × context stability measures and experienced automaticity measures. Instead, experienced automaticity measures consistently shared a negative relationship with context stability measures and the strongest relationship was with the behaviour frequency × context variability measure. Together, these findings suggest that individuals who report low levels of experienced automaticity tend perform the behaviour infrequently and in a fewer variety of situations, while individuals who report higher levels of experienced automaticity tend to perform the behaviour frequently and across a greater variety of situations. This pattern of behaviour does not align with the common view that habitual behaviour occurs in stable contexts and brings into question the validity of experienced automaticity measures and/or behaviour frequency × context stability measures, at least within the realm of sugary drink consumption.

This is the first attempt to critically examine the relationship between behaviour frequency × context stability measures and experienced automaticity measures for any behaviour, although, our findings are not in isolation. Close inspection of existing research in other behavioural domains also suggests that experienced automaticity measures share a stronger relationship with behaviour frequency measures and with context stability measures, than with behaviour frequency × context stability measures (Norman & Cooper, 2011; Tappe, Tarves, Oltarzewski, & Frum, 2013). Also, the link between experienced automaticity measures and context stability measures is not consistent, with some research finding a positive relationship (Norman & Cooper, 2011; Pimm et al., 2015; Tappe et al., 2013), others a negative relationship (Tappe & Glanz, 2013), and others no relationship (Grove, Zillich, & Medic, 2014; Naab & Schnauber, 2016). Taken together, it would seem that the discordance between experienced automaticity measures and behaviour frequency × context stability measures occurs across a range of behaviour, and is not restricted to our research on sugary drink consumption.

Unfortunately, it remains unclear why these two measures failed to show a meaningful relationship with each other. One explanation is that behaviour frequency × context stability measures do not accurately capture the conditions conducive to habit, although it is difficult to see how individuals who perform the behaviour across various contexts would more effectively build stimulus-behaviour associations compared to individuals who perform the behaviour in fewer different situations. Another explanation is that experienced automaticity measures do not accurately capture the automaticity arising from learned associations. There is growing debate about the degree individuals can report on automatic processes (Haggar et al., 2015; Orbell & Verplanken, 2015). Perhaps, when

completing experienced automaticity measures individuals rely on post-hoc explanations that align with pre-conceived ideas of what they believe habitual behaviour looks like (i.e., I drink sugary drink everywhere, therefore I must do it automatically). Alternatively, it is also possible that behaviour frequency × context stability measures and experienced automaticity measures capture different types of habit, with the former capturing habits that are stimulus driven and the latter measures capturing whatever type of habit is dominant for the behaviour, in the case of sugary drink consumption, it may be habits as defined as scripts or schemata that guide behaviour across situations (Verplanken, Aarts, Knippenberg, & Knippenberg, 1994).

Given the dominance of these measures across the habit literature, the implications of these findings are considerable. In using these measures, scholars have developed habit theory and sort to better understand human behaviour. In our own research into understanding the influence of habit on the intention-behaviour relationship, we relied on an experienced automaticity measure, and so our findings are dependent on the validity of that measure (although the presence of a moderation effect would suggest that the measure does capture habit). This was also the case when we examined the influence of habit on responsiveness to an educational poster. However, when exploring the impact of habit on responsiveness to a school-based obesity prevention program, we examined results using both measures and found similar results, and so it would seem that we can be more confident in those findings. A further implication pertains to the way we define habits when using experienced automaticity measures (i.e., context specific habits vs. generalised habits) at least when exploring sugary drink consumption. Our findings would suggest that when using these measures it is not appropriate to describe habitual behaviour with reference to context stability, as this does not reflect the patterning of the behaviour. Instead, when using these measures it would appear to be more accurate to describe generalised habits that guide behaviour across different situations. Of course, this depends on whether the experienced automaticity measures reliably gauged the automaticity of sugary drink habit.

6.4. Limitations and recommendations from chapter 5

In the space of sugary drink consumption, our findings across the three studies are clear and may be treated with confidence. However, all three studies exclusively investigated adolescent sugary drink consumption and so it is unknown whether these findings would hold across all age groups. Also, future research would do well to further understand the reasons for the discordance between experienced automaticity measures and behaviour frequency × context stability measures. This may involve comparing these measures to a proposed gold standard (i.e., response time measures) or conducting observational research to identify whether individuals with strong habits experience

action slips across a range of situations, or only in associated settings, thereby providing support for experienced automaticity measures or behaviour frequency × context stability measures, respectively.

Additional research areas of enquiry, outside of sugary drink behaviour, also include unpacking the mixed relationships observed between experienced automaticity measures and context stability measures. It remains unclear why some physical activity studies find a positive relationship between these measures (Pimm et al., 2015; Tappe et al., 2013), while other studies on physical activity find a negative relationship (Tappe & Glanz, 2013), or no relationship (Grove, Zillich, & Medic, 2014). Understanding the reasons for these mixed findings is likely to go a long way to understanding and developing both habit theory and habit measurement and so is important to the field in general.

6.5. Conclusion

In summary, this thesis explored the role of habit theory in sugary drink consumption, in an effort to better inform public health approaches targeting this behaviour and to help build habit theory more broadly. Taking a social psychological perspective of habit, I draw upon research across a wide range of behaviours and make a considerable contribution by exploring number of fundamental research questions in a new behavioural domain (i.e., sugary drink consumption). The topics covered are also important to the field of habit theory more broadly, both in terms of developing theory and application of theory into practice. Overall, we find that habit theory has great potential to inform sugary drink policy, but further research exploring the measurement of habit and the impact of habit on behaviour and responsiveness to intervention is needed.

6.2. References

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