Exploring the impact of environmental cues on fruit and vegetable consumption in young adults: A randomized controlled pilot

by

Hannah Rose
BA, Simon Fraser University, 2010

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Supervisory Committee

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Departmental Member

Abstract

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Supervisor

Dr. Ryan E. Rhodes (School of Exercise Science, Physical and Health Education, Faculty of Education)
Departmental Member

Objective: University students have low levels of fruit and vegetable consumption (FVC). There is a paucity of research about changing FVC in this population, including the specific use of environmental cues to influence behaviour change. The purpose of this research was to investigate the effect of a cue (a modified plate design and/or plate size) on FVC while exploring explicit cognitions and attitudes in first year undergraduates. *Methods:* This study utilized an experimental pre-post randomized control group design across six weeks, with two recruitment waves. First year full-time University students living off campus and consuming less than six servings of fruits and vegetables were eligible. Participants (n=39) were randomly assigned to intervention with an 8-inch dinner plate displaying recommended portion sizes, with an 8-inch dinner plate with no design, or a control group. All participants completed a food frequency questionnaire (FFQ), 24-hour food recall (24Hr), demographics, anthropometry and intentions toward FVC, with intervention groups receiving a lesson on Canada's Food Guide in addition to their plate. *Results:* Eight out of twelve outcome measures had meaningful time by group effect sizes (η^2>0.06). For fruit frequency (per day), the effect was statistically significant (p=0.03). Adherence to plate use varied (design plate: 0.69±2.38 to 4.23±5.55 times per week; plain plate 3.39±7.31 to 12.80±7.89 times per week) but was low in the designed plate condition (average use: 2.46±3.88 times per week). Baseline intention, affective and instrumental attitudes, perceived behavioural control, subjective norms and automaticity did not predict FVC.

Conclusion: An environmental cue in the form of a modified dinner plate may significantly influence fruit and vegetable consumption in young adults. Change occurred despite low plate use, which appears to indicate that the role of the plate was more explicit; participants may have become more consciously aware of portion size because of the plate cue. It also appeared, based on effect sizes, that affective attitudes, subjective norms and automaticity may have been influenced. This pilot study established the effect sizes needed to power a larger randomized controlled trial and fully test the impact of the environmental cue.

Keywords: behaviour economics, fruit and vegetable consumption, university students, environmental cues

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Dedication

I would like to dedicate this to the cave – where all the magic happened.

Chapter 1: Introduction and Literature Review

Introduction

A diet rich in fruits and vegetables has been shown to provide many health benefits, such as maintaining a healthy weight (Tohill, Seymour, Serdula, Kettel-khan, & Rolls, 2004) preventing cancer (Glade, 1999), and lowering depressive symptoms (McMartin, Jacka, & Colman, 2013). Unfortunately, it has also been shown that levels of fruit and vegetable consumption (FVC) in the diet are low, especially in university students (Avram & Oravitan, 2013; Pérusse-Lachance, Tremblay, & Drapeau, 2010; Unusan, 2006). This could be explained by the transition of moving from home to go to university, gaining independence or increased autonomy of food choices (El Ansari, Stock, & Mikolajczyk, 2012). This transition can negatively affect a person's life, both physically and psychologically (Lloyd-Richardson, Bailey, Fava, & Wing, 2009; Price, Mcleod, Gleich, & Hand, 2006). Thus it seems important to understand how to intervene in this critical life stage to mitigate the changes and their potential immediate and long-term impact on overall health and well-being.

This in depth review of the literature provides the foundation for the current research by focusing on previous research addressing: the impact of fruit and vegetable consumption on overall health, the determinants of health in university students, how a student's intentions influence eating behaviour and the application of Behaviour Economics through environmental cues, to influence eating behaviour. Finally, this review will overview methods of collecting valid and reliable dietary information.

Physical Benefits from High Fruit and Vegetable Consumption

Low FVC has been shown to be a predictor of many physical health outcomes. For instance a diet rich in fruits and vegetables has been shown to reduce the risk of diseases such as hypertension, cardiovascular disease and stroke, with a probable indirect effect on diabetes due to a decrease in weight gain (Boeing et al., 2012). There has also been research linking an increase in FVC to a decrease in prevalence of cancer (Freedman et al., 2014) and low consumption to obesity (Lin & Morrison, 1994; Tohill et al., 2004). A diet rich in fruits and vegetables has even been suggested as an aid in weight management. A study showed that when a person ate more fruits and vegetables, they reduced their overall energy intake as they felt more satiated (Rolls, Ello-Martin, & Tohill, 2004).

Psychological Benefits from High Fruit and Vegetable Consumption

There are also psychological benefits to higher levels of FVC. For example, a study by White and colleagues (2013) showed that when individuals ate more fruits and vegetables, they reported being calmer, having more energy, and being happier both that day and the next day. Similarly, the odds of depression in a longitudinal study by McMartin and colleagues (2013) were lower among students who ate more fruits and vegetables: with an odds ratio at the first time point of 0.85 ($p<0.05$) and 0.87 overall (over five time points, from 2000 to 2009) ($p<0.05$). Other research has also supported this, showing that FVC as well as antioxidant consumption was lower in those who were depressed (Payne, Steck, George, & Steffens, 2012).

Determinants of Health in University Students

Overall physical and psychological health and wellness of young adults, those enrolled in University, is of particular concern. It is estimated that 65.1% of young adults, at least 20 years old, are either overweight or obese (Hedley et al., 2004) and students can gain an estimated 3.5 to 7.8 pounds in their first semester of university (Holm-Denoma et al., 2008; Lloyd-Richardson, Bailey, Fava, &Wing, 2006). Labeled as the 'freshman 15', the university weight gain phenomenon is universal, which could be attributed to a change in diet, physical activity, and increase in sedentary behaviour (Holm-Denoma, Joiner, Vohs, & Heatherton, 2008; Pullman et al., 2009; Vella-Zarb & Elgar, 2010; Zagorsky & Smith, 2011).

Psychologically, stress and anxiety can also be increasingly prevalent in first year university and college students. Anxiety has been shown to increase in students when first entering university, regardless of history (Cooke, Bewick, Barkham, Bradley, & Audin, 2006). In 2006, 13% of men and 19% of women met the criteria for major anxiety disorders within the first year of university (Price et al., 2006). Anxiety may come from social networking and making new friends, managing the academic workload, as well as navigating the campus (Gibney, Moore, Murphy, & O'Sullivan, 2010). Depression can also affect students when starting a new life chapter and beginning university. It was shown that 7% of men and 14% of women met criteria for depressive disorders within the first year of university (Price et al., 2006). More recently, Engin and colleagues (2009) found that in the 2003-2004 school year, 2.4% of first year undergraduates had suicidal thoughts, and 11.2% had previously attempted suicide due to severe depression. Further research by Eisenberg and colleagues (2007) showed that rates of depression and anxiety decreased as a student aged, with 15.6% of undergraduate students being screened positive for depressive or anxiety disorders, compared to 13.0% positive screening in graduate students. With more than one study highlighting an association between fruit and vegetable consumption and physical and psychological health it seems important that fruit and vegetable consumption in this target population be addressed.

Fruit and Vegetable Consumption in Students

Health Canada recommends that adult (ages 19-50) males consume 8-10 servings, and adult women consume 7-8 servings of fruits and vegetables per day (Health Canada, 2011). However, currently the levels of FVC in adults are at an all-time low and especially low in university students (Avram & Oravitan, 2013; Pérusse-Lachance, Tremblay, & Drapeau, 2010; Unusan, 2006). In 2012, average daily fruit and vegetable intake in American young adults was 0.9 servings of fruit (excluding juice) and 1.8 servings of vegetables (excluding potatoes) (Larson, Laska, Story, & Neumark-Sztainer, 2012)**.** In Canada, it was estimated that two thirds of university students were not eating fruits and vegetables daily (Avram & Oravitan, 2013). Furthermore, research conducted by Perusse-Lachance and colleagues (2010) found that half of Canadian students and staff did not meet Canada's Food Guidelines for FVC.

Globally, prevalence rates for low FVC are similar and do not meet the recommendations of approximately 7-10 servings per day (depending on age and sex). Turkish students ate on average 3.67 servings of fruits and vegetables a day, and ate less when stressed (Unusan, 2006). A study regarding South African nursing students found that 49.7% of their students were obese and did not meet the countries guidelines for FVC. The students ate less than three servings of fruits and vegetables a day (Van den Berg, Okeyo, Dannhauser, & Nel, 2012).

Predictors of low FVC Among University Students

There are several possible reasons for low FVC in first year university/college students. The first year of university or college is a time that young adults become increasingly more independent. Many students take new responsibilities in managing their own meals and finances. Furthermore, there is a lack of parental oversight, either from young adults leaving the home, or spending less time at home (Zagorsky & Smith, 2011).

However, there are many social and economic barriers to eating healthy, such as a lack of time and money, social influences, a lack of a desire to cook, and reliance on precooked meal choices (Macdiarmid, Loe, Kyle, & McNeill, 2013). Furthermore, students tend to eat in ways that are most convenient and low cost (Unusan, 2006). These factors often limit healthy eating behaviour (Azagba & Sharaf, 2012; Pouliou & Elliott, 2010).

Further research suggests that living off campus can have an impact on fruit and vegetable consumption; those who live off campus were shown to eat 7% less fruits and vegetables than those that were living on campus (Small, Bailey-Davis, Morgan, & Maggs, 2013). Pelletier and colleagues (2013) found that 46% of students brought their own lunches to school at least three days a week. Furthermore, 45% of students that lived off campus would purchase food on campus at least 3 days a week, and were more likely to buy food if living with a roommate, than at home with their parents. This may be due to the fact that the environment can have an impact on dietary habits; as a university campus has many convenient and ready to eat meals which are frequently advertised and available (Liberato, Bailie, & Brimblecombe, 2014). Eating on campus has been associated with the consumption of meals that are higher in fat and sugar content and less frequent breakfast consumption (Pelletier & Laska, 2013). Furthermore, students who ate at fast food restaurants had the lowest mean consumption of fruits and vegetables in their diet (Yeh et al., 2010).

Fruit and Vegetable Interventions in University Students

Currently, there are many interventions that focus on increasing fruit and vegetable consumption. However, a systematic review on nutrition interventions targeting university students found that only 12/24 showed significantly improved dietary outcomes overall. Twelve of twenty-four studies addressed fruit and vegetables specifically, with one study finding significant improvement in fruit consumption, one finding significant improvement in vegetable consumption, and five finding significance in overall FVC (7 studies total) (Plotnikoff et al., 2015).

The studies that found significance in the study by Plotnikoff and colleagues used varying methods of intervention. There were three studies that used nutritional education as an intervention (Hager, George, LeCheminant, Bailey, & Vincent, 2012; Hekler, Gardner, & Robinson, 2010; LaChausse, 2012)). A study by Hager and colleagues (2012) used a semester long health and wellness course which covered nutrition and weight management, among other topics. They were assessed using a questionnaire which was based on the Center for Disease Control Behavioral Risk Factor Surveillance System Questionnaire (Center for Disease Control and Prevention, 2012). Results from this questionnaire taken during the intervention period showed that there was an increase in vegetable consumption by 4% ($F=36.7$, $p<0.001$). However, after a post-assessment, it was shown that 7% of students reported eating five or more fruits or vegetables daily.

Another nutritional education intervention was used by LaChausse (2012), an online interactive program which had modules relating to nutrition, exercise and weight maintenance. Participants were randomly assigned to the intervention, a weight management course, or a control condition. The course lasted 12 weeks and participants were instructed to visit the website for at least two hours a week. Results showed no significant main effect for time on fruit consumption ($F=2.78$, $p=0.097$) but did show a group interaction ($F=6.05$, $p=0.03$). Vegetable consumption increased significantly over time ($F=3.23$, $p=0.013$), and differently over time by group with the intervention groups showing greater increases ($F=4.72$, $p=0.04$).

Three studies in the systematic review utilized components of nutritional education with selected constructs of social cognitive theory, and were successful in increasing FVC (Brown, Nicholson, Broom, & Bittman, 2011; Evans & Mary, 2002; Ha & Caine-Bish, 2009). A study by Brown and colleagues (2011) used a "Viva Vegetables!" program which targeted four vegetables (onions, potatoes, salad greens and asparagus) over four months (January – April, 2009) and provided online video instruction in combination with taste testing, to enhance self-efficacy. There was only a significant positive change in asparagus intake out of four target vegetables ($p=0.016$).

The other study that showed success in increasing FVC among students was by Ha and Caine-Bish (2009), and targeted self-control using the social cognitive theory. The study administered nutrition classes to college students over a 15-week period, meeting 3 times a week for 50 minutes each time. Topics addressed included the importance of nutrition for prevention of cardiovascular disease, increasing FVC, choosing low fat dairy options, limiting usage of dietary supplements, and increasing physical activity. The intervention was a mixture of video recordings and lecture. Activities that were included that followed the social cognitive theory specifically addressed the environment, behavioural capacity and self-control. Results showed that FVC increased significantly at post-test ($p<0.005$) demonstrating that using the social cognitive theory to guide interventions may be useful (Ha & Caine-Bish, 2009).

Together, these studies demonstrated some benefit of increasing nutritional knowledge through educational interventions. Furthermore, there has been research suggesting that participants with an existing intention to eat healthier may respond differently and be more likely to change their behaviour. A study by Kelly and colleagues (2011) demonstrated a significant correlation between intention scores and fruit and vegetable consumption, among adolescents ($p<0.01$, $r=0.21$). In another study, participants were asked about their intentions to eat healthier, and seven days later performed a 7-day food recall to assess the impact of these intentions on FVC. Results showed that intention was significant in predicting FVC in first year university students ($B =0.47$, $p<0.001$) (Tomasone, Meikle, & Bray, 2015).

A final study in the systematic review by Plotnikoff and colleagues (2015) focused on the point of decision making for food consumption. Reed and colleagues (2011) conducted a pre-post-test on university students by providing motivational messages at a fruit and cookie station at a dining hall on campus. Students were then randomly selected by email to complete a questionnaire about whether the motivational messaging prompted them to purchase either the cookie or the fruit. Results showed that there was a significant mean positive difference in daily fruit consumption post baseline ($t=-2.800$, $p=0.023$) but there were no significant differences in cookie consumption between pre and post baseline ($p=0.226$). This study is novel in that it used marketing and economic strategies to shift a student's behaviour, which can be an alternative strategy to nutritional education. This approach is more coherent with the field of behaviour economics described below.

Behaviour Economics, Environmental Cues and Implicit Processes

As discussed above there are some interventions showing promise in increasing FVC, yet there are still many showing no significant effects. Some authors have emphasized that educational interventions that are focused on awareness and knowledge on their own have limited utility in influencing behaviour change (Campbell-Arvai, Arvai, & Kalof, 2012). Recently, there has been an emergence of literature on alternative approaches to addressing eating habits that move beyond nutritional education and food literacy, as oftentimes there is a gap between intention and eating behaviour (Olstad, Goonewardene, McCargar, & Raine, 2014). These approaches include environmental cues for behaviour and implicit processes.

Eating behaviour is thought to be based on subconscious thought. The concept of implicit processes suggests that intrinsic and extrinsic product attributes can implicitly influence behaviour. For example, Mai and colleagues explain that food choices are often based on implicit attitudes, which are unconscious and often out of a person's conscious control (Mai et al., 2011). They further suggest that product attributes, such as taste, texture, size and smell can intrinsically affect food preference and choice.

A further study showed that increasing a person's self-efficacy could not solely change eating behaviour, and implicit associations to food strongly moderate the influence of self-efficacy on intentions ($t=-2.960$, $p<0.01$) (Mai, Hoffmann, Hoppert, Schwarz, & Rohm, 2015). Extrinsic product attributes, such as packaging and branding, can also implicitly affect food decision- making (Mai et al., 2011). Implicit processes can be further explained through the field of Behaviour Economics.

Behaviour economics is derived from the prospect theory in psychology (Tversky & Kahneman, 1992) and from general economics (Thorgeirsson & Kawachi, 2013). Otherwise known as 'behavioural choice theory', the theory attempts to explain how humans make decisions (Epstein, 1998). It suggests that humans have preferences that are highly malleable and decisions often made based on relative judgments, and less often based on absolute judgments.

Humans have a limited ability to process information (Thorgeirsson & Kawachi, 2013) and as a person becomes more accustomed to certain behaviour, they are less likely to have a cognitive response, and more likely to perform the behaviour out of habit (Verplanken, 2006). To account for the limits to decision making, humans make short cuts to help with decision making, such as taste, smell, convenience or habit (Thorgeirsson & Kawachi, 2013). This can also be described as *bounded rationality.* Bounded rationality is further explained using the concepts of the dual process theory, and anchoring, described below.

Dual Process Theory. Dual process theory relates to how a human brain addresses decision-making, in two types of processes: intuitive (System 1) and reasoning (System 2). System 1 decisions are fast, effortless and driven by emotion. System 2 decisions are reasoned, usually slower and more deliberate (Kahneman, 2003). Nutritional interventions can therefore target System 1 decision making, which is most commonly used with eating behaviours. This is because system 2 processes require a lot of cognitive effort, and when a stressor or time constraint are present, more impulsive decisions are favoured by individual (Thorgeirsson & Kawachi, 2013).

One way to shift a person's System 1 decisions was tested in a study by Hanks and colleagues (2012). Students were prompted to choose healthier menu options by placing them at the front of the line in a school cafeteria. This environmental prompt increased healthy food purchases by 18% ($t=4.50$, $p=0.00$), and consumption of unhealthy foods decreased by 27.9% ($t=4.42$, $p=0.00$). The healthier options and their placement in the cafeteria can be described as anchors, as they help to default the choice a person will make into a healthier behaviour.

Anchoring. As stated previously, humans tend to make nutritional choices based on habit, by following System 1 processes. Furthermore, habituation theory states that responses relating to eating behaviour have been shown to be reduced with repeated presentations of visual cues (Epstein, Leddy, Temple, & Faith, 2007). If the habit created is a negative one, an anchor, or default option, can be used to place emphasis on a behaviour by making it the most obvious choice (Olstad et al., 2014).

Furthermore, a person's food choices are often made based on cost and options available. Sometimes alternative choices or environmental cues that emphasize qualities of an alternative choice in a persons' environment can shift their decision making, overriding the cost and availability factors of the original choice (Epstein, 1998).

There are many ways to address FVC by using default options, which change the external environment with prompts and visual cues. These can be subtle changes in the environment that influence positive behaviours, such as signage or placement of food in a school cafeteria (Nothwehr, Snetselaar, Dawson, & Schultz, 2013). These small changes determine an individual's choice of what to eat (Wansink & Sobal, 2007).

There has been evidence from observational studies showing success in inhibition of unwanted actions, by using external cues to anchor the behaviours. Another example using anchoring through environmental cues was shown in a study by Privitera and Creary (2012), which found that when apples were placed in opaque containers, students ate less than when they were visible. Proximity was also assessed in this study, and the analysis demonstrated a significant interaction between proximity and visibility, with more apples consumed when they were closer and more visible (r^2=0.37, $p<0.05$).

Musher-Eizenman and colleagues (2010) completed an assessment of children's eating behaviours based on proximity to a bowl of carrots and a bowl of crackers that were placed at varying distances. They found distance predicted how many carrots (r^2=0.27, β=-p.41) and crackers (r^2=0.14, β=-p.38) they consumed (Musher-Eizenman et al., 2010).

Another potential cue or anchor is portion size. Marchiori and colleagues (2014) examined the effect of portion size on food consumption and found that there was a significant interaction effect (p<0.01, n2-0.04) between food type and anchor. Portion size in this case was considered the anchor, and was considered a high anchor if the food item was double the amount usually consumed per person per eating occasion. A low anchor was if the portion size was half of the usual amount consumed. When comparing low to high anchored conditions, differences were significant for all foods, except for juice (p=0.14), with the high anchor having a greater effect on consumption (Marchiori et al., 2014).

Another method in which an environmental cue is used to shift consumption is through plate size. It has been suggested that individuals will consume more food if it is served on larger dinnerware, simply because of its larger capacity to hold food (Van Ittersum & Wansink, 2012). Interventions to date using plate size as a predictor for portion size support this suggestion (Sharp & Sobal, 2012). Wansink and van Ittersum (2013) showed that participants who chose a larger plate in an all-you-can-eat buffet, served up to 52% more than those with a smaller plate (η^2=0.48, p<0.05) and ate 45.1% more (η^2=0.25, p<0.05). Another study showed that people ate 129% more when eating chocolate (M&M's ™) from a large container than from a small container with equal portion sizes (Marchiori, Corneille, & Klein, 2012).

Conversely, a meta-analysis by Robinson and colleagues showed that plate size had no significant effect on food intake in five out of nine studies reviewed. Only three of the nine showed significant effects, and the remaining two found mixed results. The standardized mean difference in consumption for all the studies was -0.18 ($p=0.05$), denoting a small effect. They suggested that this was due to a large amount of heterogeneity across the nine studies conducted and indicated a need for more research in this area (Robinson et al., 2014).

Yip and colleagues assessed the benefits of a weight loss intervention, using two sizes of plates (19.5 cm vs. 26.5 cm) on a group of obese and overweight diabetic individuals. Results showed that there was a significant difference in weight loss for those in the intervention group, which used a plate in combination with an educational component ($p=0.002$) (Yip, Wiessing, Budgett, & Poppitt, 2013).

Further to these studies, Libotte and colleagues (2014) showed that although there was no significant difference in plate size in overall energy consumption based on plate size, there was a significant increase in vegetable servings when larger plates were used ($F=4.786$, $p<0.05$). Penaforte and colleagues (2014) found no significant differences in food consumption when individuals were presented with pasta and sauce in a 24 cm diameter plate versus a 9 cm diameter plate. However, a study using cereal bowls targeting preschool children found more positive differences, with participants eating 42% more cereal in a larger bowl than from a smaller bowl ($F=6.13$, $p<0.05$) (Wansink, Van Ittersum, & Payne, 2014).

A recent new area of research has incorporated visual representations of portion size directly on the plates. Sharp and colleagues (2012) conducted research incorporating drawing portion size on plates. Their study was quasi-experimental in design, and asked university students (mean age ≅ 20 years) to map the food they would consume on a plate. Participants mapped 26% more food on an 11” plate, than on a 9” plate ($p<0.01$). This showed that larger plates cued participants to map more food. However, there was no evidence elucidating what types of food they mapped on their plate. Interestingly this approach may have benefit when considering fruit and vegetable consumption. Sharp and colleagues (2014) used compartmentalized plates, where food was divided into three sections, and found that participants drew 46% more vegetables on larger plates (10.5 inches), than on smaller plates (9.5 inches).

Finally, some research has used this mapping to influence consumption. Bohnert and colleagues (2011) conducted a study in which 16 African American adolescents (mean age 12.94 years) were randomized to either nutrition classes, or a chance to design a plate, titled the Nutri-Plate. Those in the design group were allotted time to design a plate that visually represented recommended food group portion sizes. Because the sample was small for this study, adequate power was not achieved. However, it provided preliminary evidence to suggest that individuals who used the Nutri-plate filled it with less food (d=0.73), and ate more fruit (d=0.64), when compared to those using a normal plate.

Summary

It is apparent, based on the literature, that FVC is related to many physical and psychological conditions, such as obesity, stress, anxiety and depression. Young adults who are starting their undergraduate degree are at increased risk for these conditions, and unfortunately, also appear to be consuming very low amounts of fruits and vegetables. There are an abundance of reasons for why university students are not eating adequately, such as not having the skills to properly meal plan and living away from home for the first time. Environmental cues, such as those used in the theory of behaviour economics (typically referred to as anchoring) and research on implicit and explicit processes, can be useful in changing individuals to make alternative choice on the food they eat. Although there is research to date that has focused on plate size and portion size as environmental cues, there is limited research into designed plates that designate portion size (Bohnert & Ward, 2012; Sharp, Sobal, & Wansink, 2014; Sharp & Sobal, 2012). Further research about the use of external cues to influence portion sizes of fruits and vegetables and in young adults attending University is needed.   Thus the following manuscript based thesis outlines a study and analysis that addresses this need.

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Chapter 2: Manuscript

Introduction

A diet rich in fruits and vegetables can have significant positive health effects, such as: less weight gain over time (Rolls, Drewnowski, & Ledikwe, 2005), depression, anxiety, or stress (McMartin et al., 2013; Payne et al., 2012; White et al., 2013). However, in Canada, only 26% of the population meet the daily recommendation for fruits and vegetables (6 to 10 servings) (Black & Billette, 2013; Health Canada, 2011). A particular population at risk is first year University students, as the lifestyle change that accompanies entry to University can result in many physical and psychological health changes (Besser & Zeigler-Hill, 2014; Cooke et al., 2006; Price et al., 2006; Pullman et al., 2009; Vella-Zarb & Elgar, 2010). Avram & Oravitan (2013) estimated that two thirds of university students were not eating fruits and vegetables daily while others showed that those living off campus tended to eat 7% less fruits and vegetables than their on-campus peers (Yeh et al., 2010). Thus, interventions to promote FVC are warranted in this population.

There are currently many interventions targeting increasing FVC among University students through nutritional education, in the hope that students will respond by making informed choices on the foods they are eating (Downs, Loewenstein, & Wisdom, 2009). However, a systematic review showed that only half of the studies showed significant improvements in dietary outcomes, with five studies showing overall significance in FVC (Plotnikoff et al., 2015). This demonstrates that nutritional knowledge may be a necessary but not sufficient condition for instigating behaviour change (Campbell-Arvai et al., 2012). These interventions focus heavily on reasoned and intuitive thinking and increasing nutrition self-efficacy (Mai et al., 2015).

By contrast more reflexive means to behaviour change such as responses to environmental cues can be one method to influence healthy eating behaviour and increase FVC (Nothwehr et al., 2013). There is an emergence of literature that suggests an alternative way to address nutrition and food choices is through the use of intrinsic and extrinsic product attributes, which may implicitly influence behaviour (Burton, Creyer, Kees, & Huggins, 2006; Enneking, Neumann, & Henneberg, 2007; Finlayson, King, & Blundell, 2008; Mai et al., 2011). Environmental cues can both consciously and unconsciously affect behaviour, which can be evaluated based on implicit and explicit processes. Implicit processes are described as ways in which a person can unconsciously or automatically process information. For instance, a person can be influenced implicitly because of intrinsic quality of taste and less out of the conscious choice related to long-term health benefits. Extrinsic product attributes can be likened to cues, or stimuli, in the environment (such as changing container sizes in fast food restaurants or product placement of healthy food in a cafeteria line up) that if consistently reinforced, can begin to influence the way in which a person subconsciously behaves (Epstein, Leddy, Temple, & Faith, 2007; Roberto & Kawachi, 2014; Wansink, Just, Payne, & Klinger, 2012).

The use of environmental cues to examine implicit influence on behaviour change has been tested (Nothwehr et al., 2013; Wansink & Sobal, 2007). This approach is explicated by the theory of behaviour economics, which explains decision-making based on either deliberative or unconscious thought (Epstein, 1998), and typically addresses short-term gain, rather than long-term consequences. Similar to concepts of implicit behaviour, behaviour economics suggests that a person makes nutritional decisions often-time based on unconscious automated impulses (Mai et al., 2011). Alternative choices in the environment can influence decision making (Hanks et al., 2012; Olstad et al., 2014); implicitly changing behaviour independent of intentions.

To date there is little evidence about the impact of implicit and explicit processes, such as environmental cues, specifically on FVC by young adults (Epstein et al., 2007). Recently, research involving the size of plates (Wansink & van Ittersum, 2013) showed that larger plates cued greater consumption. This work was then extended to evaluate the addition of portion size design features on plates (see chapter 1 for summary) (Bohnert et al., 2011; Sharp & Sobal, 2012). Bohnert's pilot study added portion size designed plates and showed modest but significant results: increased fruit consumption (d=0.64), but less total consumption of food overall (d=0.73). This research was conducted with a younger population (mean age: 12.94 years). There has been minimal research regarding designed dinner plates, or the effect of introducing a smaller plate size with designed portion sizes to an adult population. Thus the purpose of this research was to pilot the approach, investigating the effect of a cue (a modified plate design and/or plate size) on FVC in first year university undergraduates, controlling for their explicit intentions towards eating healthy servings of fruits and vegetables. It was hypothesized that first year university students who used the modified dinner plate would significantly increase their FVC, compared to those using a plain dinner plate, or a control condition.

Methods

Research Design

An experimental randomized control group design was used with participants assigned to one of three groups: 1) intervention with an 8-inch designed dinner plate (see Figure 1), 2) intervention with an 8 inch plain dinner plate, and 3) control group. The intervention group with a plain dinner plate was used to assess the independent effect of change in plate size on fruit and vegetable consumption, as it has been shown to have an impact in many previous studies

(DiSantis et al., 2013; Marchiori et al., 2012; Robinson et al., 2014; Van Ittersum & Wansink, 2012; Wansink & van Ittersum, 2013).

There were two study waves: fall (September to December, 2014) and winter (January to March, 2015). Pre and post measurement was conducted at baseline and at 6-weeks following intervention period. The primary outcome was fruit and vegetable consumption, based on the Health Canada's Food Guide recommendations for portion size and quantity (Health Canada, 2011).

Participants were recruited from 41 first year undergraduate classes, posters and /or digital signage in each Department (n=44) and through in person recruitment in high traffic public areas. Participants were eligible if they were a first year full-time student at the University of Victoria (UVIC), lived off campus and ate between 0 to 5 servings of fruits and vegetables a day. This study adhered to ethical procedures and was approved through the University of Victoria (UVIC) Human Research Ethics Board (HREB) (Certificate 14-263).

Figure 1: Diagram of Modified Dinner Plate (8 inches)

(Ora Living, 2012)

Sampling

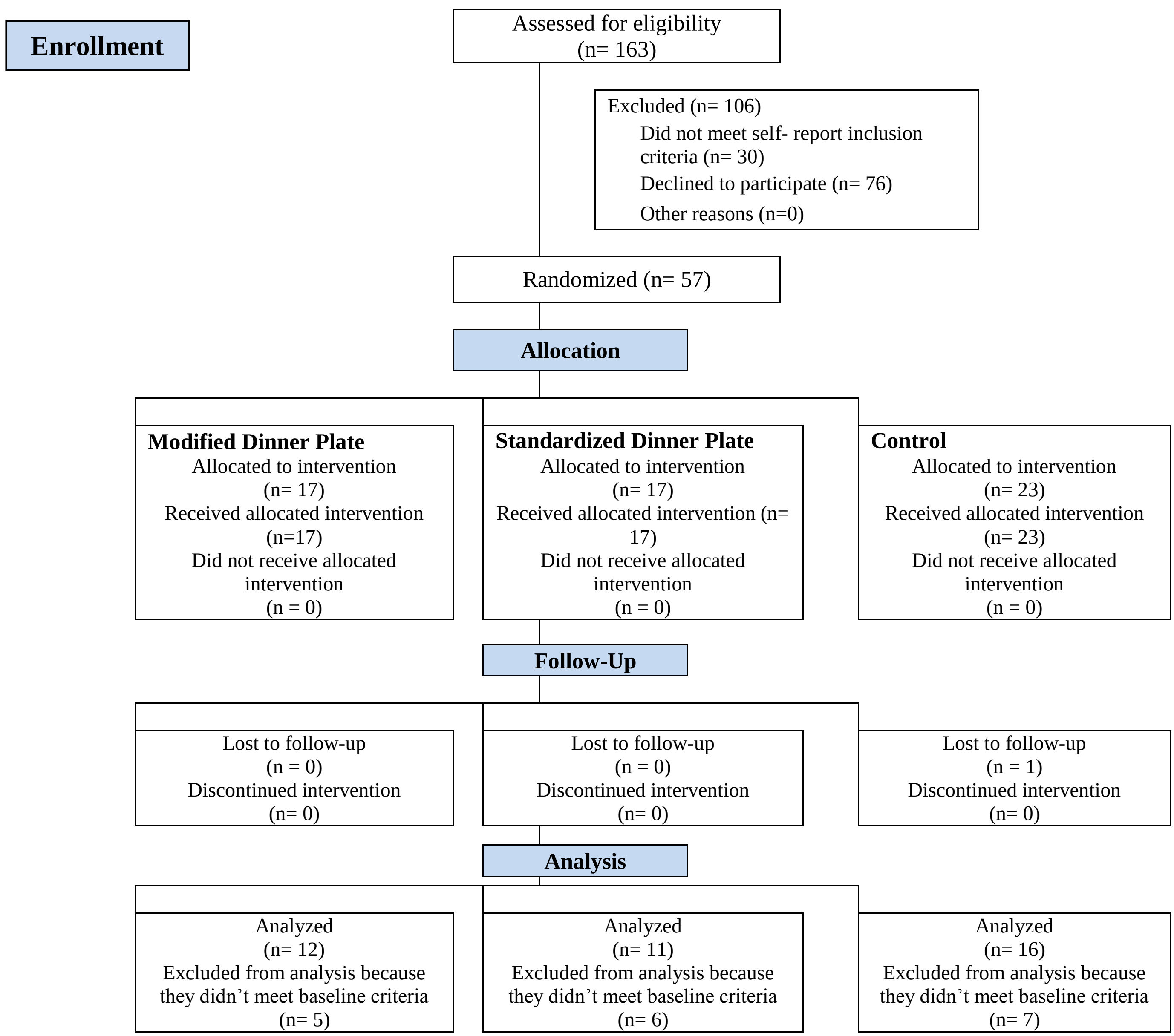
Sample size for a repeated measures ANCOVA with power set at 0.8, significance at $p<0.05$ and an effect size of F=0.5 omega was calculated using G*Power software program (Faul, Erdfelder, Lang, & Buchner, 2007). A conservative effect size was chosen based on a systematic review by Knai and colleagues (2006) that showed a typical change in vegetable portions can range from 0.3 to 0.9 servings per day depending on the population. Therefore, forty-two participants were needed.

Participants

A total of 163 individuals responded to the recruitment. Fifty-seven participants, 35 in the fall semester and 22 in winter (see Figure 1), reported consuming less than 5 fruits and vegetables a day and were assigned to group based on a pre-randomized sequence as they entered the study. The sequence was generated using the randomize function in Microsoft Excel for Mac 2011 and the research coordinator was responsible for allocation concealment. Based on pragmatic limitations of data collection, neither the researcher nor the participants were blind to group allocation. Seventeen participants were assigned to the modified dinner plate design group, 17 were assigned to the plain dinner plate design, and 23 were controls. Based on baseline assessment of fruit and vegetable consumption, only 39 were actually eligible and included in the analysis (see Figure 2) with 12 participants in the modified dinner plate design group, 11 participants in the plain dinner plate design, and 16 to the control group.

All assessments were conducted individually in a private assigned space in the research unit. Participants were contacted to schedule baseline appointment (where all research instruments were conducted) and immediately following they were provided with a brief lesson and the plate, and then contacted again at 6 weeks to schedule a follow-up appointment.

Figure 2: Flow Diagram of Participants



Instruments

Baseline Characteristics. To describe the sample a short questionnaire collected information about age, gender and ethnicity. Participants were also asked to report their current living situation, who typically shopped and cooked in the household, their living arrangement (lived alone, with a roommate or with family members), employment status, an estimate of the budget they allotted for food purchases and the size of their dinner plates at home. Dinner plate templates were provided (8 inches, 8.5 inches, 9 inches and 10 inches) to help estimate size at home. In addition, Body Mass Index (BMI) was calculated for each participant. Height in centimeters (±0.4cm) was collected using a portable stadiometer (model 242; Seca, Honover, MD) and weight in Kilograms (±0.2kg) collected using a digital scale (Seca, model 840).

Fruit and Vegetable Consumption. A combination of a food frequency questionnaire and a 24-hour food recall were used to assess FVC consumption. The food frequency questionnaire (FFQ) assessed usual diet and the 24-hour recall (24 –HR) provided a more detailed account of the number and type fruits and vegetables the participant had consumed in the previous day.

The FFQ measuring frequency (how often they typically consumed selected fruit and vegetables at different meal times per month) was adopted from the 2013 Behavioural Risk Factor Surveillance System Questionnaire, Section 11: Fruits and Vegetables, (Center for Disease Control and Prevention, 2012). The 24-HR was adapted from Day, Strange, Mckay & Naylor, (2010) and students were asked to recall what they ate at meals and for snacks from the morning of the previous day until the morning of the current day. Fruit juice was not counted in the total FV consumption for both measures and potatoes were also not counted in the 24-HR, following methods of Larson and colleagues (2012).

Intentions to control for the influence of explicit cognitions and attitudes. Participants' intentions toward FVC were assessed using a behaviour questionnaire based on prior fruit and vegetable research (Bassett-Gunter et al., 2013; de Bruijn, Wiedemann, & Rhodes, 2013). The questionnaire asked them to think forward six weeks and assess intentions on a five point likert scale from 1= strongly agree to 5 = strongly disagree, related to increasing fruit and vegetable consumption. Questions asked whether participants intended, were sure, were definitely motivated and were extremely determined to eat healthy each day in the next six weeks. Questions were scored based on a five-point scale, and averaged to find an overall score based on each construct. A reliability test, using Cronbach's alpha, assessed internal consistency for intention in the 8 items being asked on the behaviour questionnaire (Cronbach's alpha= 0.85).

Manipulation Check & Process Evaluation

As a manipulation check, intervention participants completed a brief follow-up survey about how often they used the plate. The control group was asked whether their diet and FVC had changed during the 6-week intervention period. Feasibility of the plate intervention was addressed using open-ended questions about the advantages and disadvantages of using the plate and whether participants would continue using it in the future.

Intervention

Modified Dinner Plate (Nutriplate™) Design group. Participants in the modified dinner plate group were asked to use a dinner plate designed by Ora Living, 2012 for 6 weeks (see appendix 1). The size of the dinner plate was approximately 8 inches in diameter. They also received a brief lesson on general nutrition and meal planning based on Canada's Food Guide (2011). This included introducing participants to recommended portion sizes of various food groups based on age and gender, examples of items considered in food groups, and recommendations to introduce small changes in diet. It was made clear that participants did not need to follow guidelines in order to complete intervention.

Plain design dinner plate group. As the modified dinner plate was smaller (8 inches) than a typical dinner plate used by adults (approximately 9 inches), some participants were asked to use a plain plate of similar size. The plain plate intervention also included a brief lesson on general nutrition, and meal planning based on the Canada Food Guide (2011).

Control group. Control participants were asked to continue with their current eating habits during the following 6-weeks and were not provided with additional nutrition information.

Data Analysis

The statistical program SPSS 2011 for IBM version 22 was used for all data analysis. Data were screened for completeness, missing data and normality. There was one drop-out participant who completed the first assessment but did not reschedule for the follow up. There was one instance where individual data was missing (n=1 question for a participant). We used intention-to-treat protocols for missing or absent data and carried the baseline value forward. Descriptive statistics (means, SD) were calculated and a one-way analysis of variance (ANOVA) was used to determine if there were differences between groups at baseline in regards to demographics, BMI, intention and fruit and vegetable consumption. A General Linear Model (GLM) Repeated Measures analysis of covariance (ANCOVA) was used to address the research question: to test for main effects of time and group and interaction effects on fruit and vegetable consumption while controlling for any baseline differences and the influence of intentions. As this was a pilot we determined *a priori* that an effect size of .06 would be considered meaningful; suggesting support for scaling up to a study with a larger sample.

Results

Baseline Descriptives

Baseline participant characteristics are displayed in detail by group in Table 1. Overall, the majority of participants were female (71.80%), between the ages of 17 and 24 years (mean age: 18.46±1.23 years) and had an average BMI of 23.30 kg/m^2 (±3.74 kg/m^2). The estimated average estimated diameter of home dinner plates was 23.56 cm (±1.96 cm) (9.28 inches), which did not differ significantly between groups (p=0.694). This aligned with previous research suggesting a common plate size (Robinson et al., 2010). One-way ANOVA scores showed that there were non-significant differences between groups on demographic variables or intention at baseline.

Table 1: Characteristics of participants at baseline

	Nutriplate (n=12) %/ Mean ±sd	Plain plate (n=11) %/ Mean ±sd	Controls (n=16) %/ Mean ±sd	Total (n=39) %/ Mean ±sd
Demographics				
Age (years)	18.08±0.29	18.18±0.75	18.94±1.73	18.46±1.23
Gender (female)	66.70	72.70	75.00	71.80
Ethnicity (Caucasian)	64.29	58.33	68.80	64.29
BMI (kg/m^2)	22.25±2.80	22.81±3.45	24.44±4.39	23.30±3.74
Employment				
• Unemployed	50.00	36.40	68.80	53.80
• Employed part-time	50.00	54.50	18.80	38.50
• Employed full-time	0.00	9.10	12.50	7.70
Household context and routines				
Eat breakfast at home (days)	6.67±1.15	6.00±1.61	5.56±2.28	6.03±1.83
Eat lunch at home (days)	5.42±1.31	4.91±2.39	4.94±1.44	5.08±1.69
Eat dinner at home (days)	6.33±0.49	6.09±0.83	6.00±0.89	6.13±0.77
Budget for food (incl. dining)	120.83±127.75	92.27±74.34	289.38±320.28	181.92±234.60
Plate Diameter	23.55±2.32	23.96±2.17	23.29±1.57	23.56±1.96
Primary cook				
• Family member	75.00	36.36	31.30	46.20
• Self	25.00	45.45	56.30	43.60
• Other	0.00	18.18	12.50	10.20
Primary grocery shopper				
• Family member	75.00	54.50	31.25	51.30
• Self	25.00	36.40	43.75	35.90
• Other	0.00	9.10	25.00	12.80
Living Situation				
• Lives with roommate	16.70	9.10	43.80	25.60
• Lives with family	83.30	63.60	43.80	65.10
• Lives at host residence (International student)	0.00	9.10	12.50	7.70
• With partner	0.00	18.20	0.00	5.10
Financial Situation				
• Tuition paid by scholarship	33.33	38.89	29.41	32.91
• Tuition paid by student loan	3.70	5.56	8.82	6.33
• Tuition paid by employment	25.93	22.22	23.53	24.05
• Tuition paid by parental/family support	37.04	33.33	38.24	36.71

• Other	0.00	5.56	0.00	1.27
Fruit and Vegetable Consumption				
• Fruit and Vegetable Frequency (per day)	3.39±1.42	3.21±1.69	3.09±1.60	3.21±1.54
• Fruit Frequency (per day)	1.13±0.94	1.24±1.02	1.27±0.92	1.22±0.98
• Vegetable Frequency (per day)	2.26±1.32	1.97±1.31	1.82±0.91	2.00±1.15
• Fruit and Vegetable recall (total)	3.71±2.64	3.41±2.73	3.67±1.86	3.60±2.31
• Fruit recall (total)	1.83±1.14	0.78±0.88	1.25±1.12	1.30±1.12
• Vegetable recall (total)	1.87±1.94	2.62±2.68	2.42±1.68	2.31±2.05

Baseline Fruit and Vegetable Consumption

Baseline means and standard deviations for fruit and vegetable consumption (FFQ, 24 hr recall) are displayed in Table 1 and 2. There were no significant differences in FVC between groups at baseline for typical (FFQ) or one day consumption (24 HR). A one-way ANOVA assessing mean differences in intention between groups at baseline was also conducted and showed no significance ($F=0.175$, $p=0.84$).

Changes in Fruit and Vegetable Consumption

Main effects and effect sizes for time and time by group for FVC as measured by the 24-HR and FFQ are reported in Table 3. The effect sizes were meaningful, ranging from medium to large while controlling for baseline intention. There were no significant time effects for any of the 24-HR outcome measures. Nor were there any significant differences in overall FVC consumption or Vegetable only consumption as measured by the FFQ over time, or for time by condition while controlling for intention. There was a significant time by condition effect for fruit only consumption while controlling for intention. In Table 2 (and graph data not shown) it appears that mean fruit consumption increased in the plate design group, stayed approximately the same in the plain plate group and decreased in the control group. However, post hoc pairwise comparisons between any two groups were not significant.

Table 2: Means and change scores for fruit and vegetable consumption (SD)

		Nutriplate (n=12)	Plain plate (n=11)	Controls (n=16)	Total (n=39)
		%/ Mean ±sd	%/ Mean ±sd	%/ Mean ±sd	%/ Mean ±sd
Fruit and Vegetable Consumption					
Fruit and Vegetable Frequency (per day)	*Baseline*	3.39±1.42	3.21±1.69	3.09±1.60	3.21±1.54
	Follow-up	4.56±2.81	3.21±1.57	2.83±1.53	3.47±2.10
Fruit Frequency (per day)	*Baseline*	1.13±0.94	1.24±1.02	1.27±0.92	1.22±0.93
	Follow-up	1.93±1.20	1.23±1.00	0.96±0.70	1.33±1.02
Vegetable Frequency (per day)	*Baseline*	2.26±1.32	1.97±1.31	1.82±0.91	2.00±1.15
	Follow-up	2.63±2.73	1.98±1.05	1.87±1.17	2.13±1.76
Fruit and Vegetable 24 HR recall (total amount)	*Baseline*	3.71±2.62	3.41±2.73	3.67±1.86	3.60±2.31
	Follow-up	5.31±3.36	4.01±2.02	2.88±1.75	3.95±2.57
Fruit 24 HR recall (total amount)	*Baseline*	1.83±1.14	0.78±0.88	1.25±1.12	1.30±1.12
	Follow-up	2.18±2.07	2.37±1.57	1.34±1.06	1.89±1.60
Vegetable 24 HR recall (total amount)	*Baseline*	1.87±1.94	2.62±2.68	2.42±1.68	2.31±2.05
	Follow-up	3.13±2.60	1.64±1.71	1.53±1.15	2.05±1.94

Table 3: Repeated measures (ANCOVA) main effects - controlling for intentions

		F(35)	p-value	η^2
Fruit and Vegetable Consumption				
Fruit and Vegetable Frequency (per day)	*time*	0.45	0.83	0.00
	time by condition	1.58	0.22	0.08
	time by intention	0.00	1.00	0.00
Fruit Frequency (per day)	*time*	1.92	0.17	0.05
	time by condition	3.71	0.03	0.18
	time by intention	1.42	0.24	0.04
Vegetable Frequency (per day)	*time*	0.41	0.53	0.01
	time by condition	0.23	0.80	0.01
	time by intention	0.63	0.43	0.02
Fruit and Vegetable recall (total amount)	*time*	0.02	0.88	0.00
	time by condition	1.88	0.17	0.10
	time by intention	0.00	0.95	0.00
Fruit recall (total amount)	*time*	3.89	0.06	0.10
	time by condition	2.75	0.07	0.13
	time by intention	2.08	0.16	0.06
Vegetable recall (total amount)	*time*	1.16	0.29	0.03
	time by condition	2.69	0.08	0.13
	time by intention	0.99	0.33	0.03

Manipulation Check & Process Evaluation

Plate use and reasons for using or not using the plate are displayed in Table 4. Participant use of the designed plate design was low, 2.46 (±3.88) times per week on average, with many using it as little as 0.69 (±2.38) times per week. Plain plate use was higher. Reasons for plate use are displayed in Table 5. The most common reason for use cited by participants in both the modified and plain dinner plate groups was functionality and the most common response for not using it was forgetting or not eating at home. More than three quarters believed it changed what they ate. Only one third of control participants' reported that their diet had stayed the same from when they started the study, with 25% reporting an increase in their fruit consumption, 12.5% reporting an increase in their vegetable consumption, and 6.3% reporting an increase in serving sizes. Despite this self-reported change the FVC measures did not support this assertion as there were no significant differences in any of the control group's FVC measures.

Table 4: Process Evaluation - frequencies of reasons for plate use by intervention group

	Nutriplate (n=12) %/ Mean ±sd	Plain plate (n=11) %/ Mean ±sd
Plate Use (times per week)		
Average use	2.46±3.88	7.80±7.48
Minimum use	0.69±2.38	3.39±7.31
Maximum use	4.23±5.55	12.80±7.89
Reasons for Use (percentage of participants)		
Functionality	41.70	63.60
Convenience	16.70	45.50
Style/Attractiveness	16.70	18.20
Practicality/Usability	25.00	45.50
Influenced healthy eating behaviour	25.00	18.20
Novelty	8.30	27.30
Perceived benefit of research project	33.00	54.50
Parental influence	8.30	0.00
Reasons for non-Use (percentage of participants)		
Forgot	66.70	72.70
Did not care	8.30	9.10
Did not serve its function (needed bowl)	41.70	54.40
Found alternatives	8.30	9.10
Did not eat at home	66.70	90.90
Social/cultural interference	16.70	27.30
Other	16.67	27.27
Likelihood of Future Use (yes)	41.67	63.64
Intervention influenced behaviour (yes)	75.00	81.82

Discussion

This novel pilot study was designed to examine the effect of environmental stimuli in the form of a cue, a modified dinner plate design, on FVC in young adults attending University and to establish appropriate effect sizes for a larger randomized controlled trial. The results were promising showing that the intervention produced meaningful effect sizes and a significant impact on fruit consumption while controlling for baseline intention (an explicit process). The findings are discussed in the context of the literature and the study limitations following.

The results of this study provide some support for previous literature showing that an environmental cue, in the form of a dinner plate, can modify or shape behaviour (Sharp & Sobal, 2012; Van Ittersum & Wansink, 2012; Wansink & Kranz, 2013). However, this literature was largely focused on plate size, and suggested that the plate cue operated by affecting subconscious thought (Van Ittersum & Wansink, 2012; Wansink & Kranz, 2013). In fact, Mai et al. (2011) suggested that implicit processes were most commonly expressed with eating behaviours. Counter to these expectations, the environmental cue used (a portion sized diagram on the plate) may have engaged more of an explicit process.

The suggestion that the plate may cue or anchor an explicit process is supported by the manipulation check data from this study. The effect on FVC was greatest in the designed plate group but the adherence to plate use was low in that group (less than 3 uses per week) in comparison to the plain plate group use. It may be that one or two exposures reinforced the appropriate portion of a meal that should be dedicated to fruit and vegetables and that after exposure to the cue the response was more conscious and self-regulatory. Michie et al. (2011) found that self-monitoring was the most powerful technique to engender changes in physical activity and eating behaviour. The plate may represent a self-monitoring strategy. It seems likely that this may have been a successful form of self-regulation for those that intend to change. In fact, there are several theories that speak to use of behavioural processes that support moving individuals from intention to action including the transtheoretical model (Prochaska, Norcross, & DiClemente, 1994), Kuhl's (1984) action control theory, Fisher and Fisher's (1992a) information-motivation motivational skills model, Gohner's (2009a) motivation-volition model, Rhodes & de Bruijn's (2013) multi-process action control model and others. More information about these models can be found in a recent review by Rhodes and Yao (2015a). Future research would need to test this by also measuring self-regulation.

There were several strengths to this study. A rigorous randomized controlled-trial design was used to assess the differences in participants, compared to a control condition, which accounts for many threats to internal validity such as testing, history, maturation and selection bias (Thomas, Nelson, & Silverman, 2011). A one-way ANOVA showed that groups did not differ significantly at baseline. Furthermore, the intervention was careful in that it did not ask participants to track their use of the plate, but used a post-intervention questionnaire to examine plate use. This reduced the likelihood of contaminating the intervention with an explicit process, self-monitoring. Finally, this study controlled for baseline intention to isolate the effect of the cue.

It is likely that the limitations had the most noteworthy influence on the findings however. Firstly, participants were recruited as volunteers, and were not randomly sampled from the entire first year population. It may be that the study attracted individuals who were more cognitively interested in healthy eating. In fact the majority of the sample indicated that they intended to eat healthy at baseline and the mean FVC was well above the national average. Second, although a screening question was used at baseline many were unaware that they were consuming 6 or more fruits and vegetables per day leaving them ineligible for the study after baseline analysis which ultimately influenced the sample size. Third, participants' data was mostly self-reported, which is open to response bias (Thomas et al., 2011) meaning their fruit and vegetable consumption could have been under or over reported. Lastly, the findings from this study are delimited to those living off-campus, whereas a great number of first year students live on campus.

Students' overall heath could benefit from increased FVC. Research shows that a diet rich in FVC can lower stress and anxiety as well as reduce likelihood of obesity (Tohill et al., 2004) but that knowledge alone does not have a substantive impact on eating behaviour (Clifford, Anderson, Auld, & Champ, 2009). There has been success in increasing FVC by changing the size of plates (Libotte et al., 2014). Thus exploration of other environmental and behavioural strategies that facilitate FVC is important. This pilot study responded to this need and used a strong research design to explore the use of an environmental cue on this important behaviour. The intervention produced meaningful effect sizes, and one significant effect while controlling for explicit intentions. Post intervention surveys showed that the approach was feasible and that participants thought it had changed their behaviour. These results suggest that this type of intervention should be studied further with a larger sample and with a greater focus on measuring both implicit and explicit processes and on methodological issues such as adherence to the intervention protocols.

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Chapter 3: Further research on behavioural constructs

Introduction and Purpose

This study explored a new area of research, which is the impact of a key construct within behaviour economics, specifically an environmental cue, on behaviour change. The manuscript presented in the previous chapter showed that the strategy was promising having a modest and limited effect on FVC. There were some additional behavioural constructs explicated in the literature that have been shown to influence eating behaviour. These measures, described in more detail following, were included in the study to determine whether the intervention had an impact on these variables as well.

There is some research to support the inclusion of theories which explicate human behaviour, in order to pinpoint where intervention strategies are needed (de Bruijn et al., 2013). Many of the measures used in this study were structured around the theory of planned behaviour (TPB), which explains that behaviour is determined by intention (Ajzen, 1991). Intention, the motivation that spurs a person to engage in a particular behaviour (McEachan, Conner, Taylor, & Lawton, 2011), according to this theory is driven by the three social cognitive constructs: Attitudes (Instrumental and Affective), Subjective Norms, and Perceived Behavioural Control. Attitudes are defined as a person's perception of whether the behaviour is positive or negative. Subjective Norms are described as a person's perception as to whether they should engage in behaviour, based on the behaviour of those around them. Perceived Behavioural Control (PBC) is defined as the control one has over engaging in the behaviour (McEachan et al., 2011).

The theory of planned behaviour (TPB) has been shown as a sound theory through which to understand different health behaviours, such as eating behaviour. A meta-analysis by McEachan and colleagues (2011) showed that as a moderator, eating behaviour was predicted from TPB with a variance of 21.2%. However, dietary behaviour in adolescents was found to be poorly predicted (9.6% variance) compared to the adult population (26.7% variance).

Furthermore, previous research on fruit consumption has shown that there is a disconnect between a persons' intention to change, and their implementation of the new behaviour (Webb & Sheeran, 2006). This is often referenced in the literature as the *intention to behaviour gap*, which states that although a person can have a high intention to implement the behaviour, there are some individuals who may never adhere to the new behaviour (Rhodes & Yao, 2015b). Rhodes and Yao (2015b) furthermore explain that although intention is an important component for behaviour change, there are competing factors or forces that may interfere, such as time, motivation and attention.

Some more recent modifications to the TPB suggest that there is another component present in behaviour implementation: automaticity or habit, which also accounts for some behaviour change (Lally & Gardner, 2013). This is supported by the literature on behaviour economics, which suggests that a person can behave without much forethought. What distinguishes habit from anchoring or implicit/explicit cues, however, is that a habit is formulated based on previous behaviour, and develops from fluid and stable repetition of the behaviour (Verplanken, 2006).

Therefore, it is important to understand if these constructs were impacted. Thus the purpose of this secondary analysis was to determine whether an environmental cue, in the form of a modified dinner plate design, changed habit, intentions, perceived behavioural control and attitudes in first year university undergraduate students when compared to a same size regular dinner plate and a usual practice comparison condition. It was hypothesized that these constructs would not be significantly influenced by the environmental cue conditions.

Methods

The research study followed the previous methodology outlined in Chapter 2. In combination with the other questionnaires, participants indicated their attitudes and intentions while eating, using a behaviour based questionnaire (Bassett-Gunter et al., 2013; de Bruijn et al., 2013; Gardner et al., 2012). The questionnaires asked them to think forward six weeks and assess how they intended to eat, according to particular categories (intention, affective attitudes, instrumental attitudes, subjective norms, perceived behavioural control and automaticity). The responses of participants were based on a five-point scale: from 'not likely', to 'very likely'.

Data Analysis

The statistical program SPSS 2011 for IBM, version 22 was used for the data analysis of behavioural constructs. Data was screened for completeness, missing data and normality. Refer to chapter 2 to understand how drop-outs or loss to follow up was handled as previously described in chapter two. A one-way analysis of variance (ANOVA) was used to determine if there were differences between groups at baseline. A further repeated measures analysis of variance (ANOVA) assessed group, time and interaction effects of the behavioural constructs between baseline and follow-up assessments.

Results

One way ANOVA scores showed that the behavioural constructs did not differ significantly among groups at baseline. The main effects from the repeated measures ANOVA can be seen in Table 5. There appeared to be no significant changes in any of the constructs over time, or based on group. However there were several group by time interaction effect sizes of note that may result in significant effects in a larger sample, notably for the affective attitudes, subjective norms and automaticity variables (see Table 5).

Table 5: Repeated measures (ANOVA) main effects

		F(df)	p-value	η2
Intention	*time*	3.22(16)	0.08	0.08
	time by condition	0.35(16)	0.71	0.02
Instrumental Attitude	*time*	0.83(16)	0.37	0.02
	time by condition	0.93(16)	0.41	0.05
Affective Attitude	*time*	1.33(16)	0.26	0.04
	time by condition	2.96(16)	0.07	0.14
Subjective Norms	*time*	0.54(16)	0.47	0.02
	time by condition	2.01(16)	0.15	0.10
Perceived Behavioural Control	*time*	1.18(16)	0.28	0.03
	time by condition	1.04(16)	0.37	0.05
Automaticity	*time*	1.47(16)	0.23	0.04
	time by condition	1.27(16)	0.29	0.07

Discussion

There were no significant changes in instrumental attitude, affective attitude, subjective norms, perceived behavioural control or automaticity over time or between groups from baseline to follow-up. However, for affective attitude, subjective norms, and automaticity effect sizes were all over 0.07, suggesting that perhaps with a greater sample size, significant time by group interaction effects may have shown up. Thus, this pilot study provides a foundation for a larger randomized controlled trial.

In assessing plate use (see chapter 2, specifically Table 4), there was a greater adherence to the plain plate group compared to the patterned plate group. There could be several reasons why only fruit frequency showed a significant difference in time by condition after assessing these behavioural constructs and understanding plate use.

Affective attitude and subjective norms had high effect sizes in time by condition differences, whereas other components of the TPB did not. Because of the intention-behaviour discordance shown in the literature, action control could be a more suitable framework for examining FVC and the impact of cues. The framework suggests affective attitudes and subjective norms as the two most prominent domains, and classifies individuals into four quadrants (de Bruijn et al., 2013). These quadrants are classified as: those who intend and act, those who intend but don't act, those who do not intend but act, and those who do not intend and do not act. A further developed framework, the Multi Process Action Control Framework (MPAC) expands this model even further to suggest that intention is more of a choice, and that individuals can choose to act, or not act (Rhodes & Yao, 2015b). According to this framework, the results from chapter 2 indicate that high affective attitude was a more plausible explanation for FVC because participants may have enjoyed eating the fruits and vegetables, or they may have had a goal in mind that would have resulted in higher FVC (Custers & Aarts, 2005; Ryan & Deci, 2007). Because subjective norms may have been influenced by the intervention according to the higher effect sizes, there could have also been an interaction between plate use and the influence of family, friends and peers. Since the majority of participants lived at home (65.1 % overall, with 83.3% in the Nutriplate group), it could be that a parental influence was engaged by the participant using the plate in front of them.

Since automaticity also had a promising effect size, it is possible that the plate design reinforced the appropriate dedicated size for fruit and vegetables. After the exposure to the plate was reinforced, it is possible the response became automatic.

Future research regarding the explicit action of the plate design to better understand the influence on these behavioural constructs is needed. There are a few other theoretical models that could be used to extend the research on behaviour economics in this group of participants. Apart from the MPAC framework, Gohner and colleagues (2009b) developed a model titled the Motivational-Volition Process model (MOVO), which integrates components of previous models, with an emphasis on goal intention, which includes the strength of the goal setting, and the self-concordance of the goal (how appropriate the goal is to a person's interests and needs). Further to this model, Fisher and Fisher (1992b) developed the Information-motivation Motivational Skills model, which describes three components that successful aid in behaviour change (or in their case, AIDS prevention). These are information on the behaviour (including prevention of a bad behaviour), motivation to change existing behaviour, and behavioural skills. These models have important components that could further be assessed to understand the influence on the undergraduate student's motivation, goal setting, and nutritional knowledge that could influence their FVC.

The findings relating to automaticity, on the other hand, can supplement findings that FVC is an implicit process, as cued behaviour may eventually become habituated. However, there is a need for more self-regulated constructs to be examined to understand if the influence of environmental cues alone can shift behaviour. TPB may not be an appropriate method for accounting for these findings, however some of the other behavioural models and frameworks can aid in discovering whether FVC in first year university students is indeed primarily an implicit process, or whether explicit processes are more influential.

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Chapter 4: Conclusion

There are many factors that could influence eating behaviour in first year university students, specifically regarding fruit and vegetable consumption, such as: convenience, cost, habit, taste and interest. There are some promising research studies exploring the benefits of using environmental cues to anchor particular health behaviours, with a focus on plate size and shape. The research presented in this dissertation will add to the existing literature that suggests that an environmental cue may have an impact on eating behaviour in first year university students. The main results from both analyses suggest that the environmental cue (in the form of the portion designed dinner plate) may have influenced FVC but there are also results that suggest other behavioural aspects were influencing consumption. Although there was minimal support to show that one particular design of plate (a smaller plain plate versus a patterned plate) was superior to the other, it is interesting to note how plate use levels was not related to actual consumption of fruits or vegetables. Further research focused specifically on understanding the intentions present while using a plate, and their impact on eating behaviour is needed.