

Examining the Use of Food Cues: Nudge based approaches to increase the purchase of  
vegetables among young adults in B.C.

by

Matheus Mistura  
B.Sc, Universidade Regional de Blumenau, 2012

A Thesis Submitted in Partial Fulfillment  
of the Requirements for the Degree of

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University of Victoria

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## **Supervisory Committee**

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## Abstract

Vegetable intake is an important contributor to overall health, as vegetables are characteristically high in nutrient density and fibre and low in caloric density. In the student transition from high school to the university years vegetable consumption tends to deteriorate, potentially influencing both immediate and longer term health outcomes. Based on the recognition in behavioral economics that environmental factors can influence behavior, either explicitly or implicitly, nudge interventions where environmental factors are manipulated to influence choice have emerged as potential contributors to public health behavior change goals. Evidence of their impact is mixed and the breadth of strategies and settings in which they are tested are limited. It was important to test nudge strategies with young-adults in real world cafeteria settings. The purpose of this quasi-experimental study was to evaluate the impact of a contextually feasible evidence-informed nudge intervention on food purchasing behavior in a University residence cafeteria. A priming nudge in the form of fresh vegetables offered at the steam/hot food table, combined with a salience nudge (signage) was tested.

A single-case A-B-A-B design was adopted over 12 weeks in the fall term with 2 periods of baseline (A phase) and 2 periods of intervention (B phase). Staff portion servings were observed visually during the lunch and dinner service (4 hours/day total) and the proportion of hot table purchases with a vegetable serving added was the outcome variable. Visual inspection was used to evaluate the impact of the intervention and was supported by an analysis of: trends, measures of central tendency (mean, medians), overlap in data points, variability and latency. Wilcoxon Signed Ranks test was also used to determine if ranking of proportions was associated with phase. Visual inspection showed a positive change in trends when the Nudges were in place, followed by a change in direction when they were withdrawn, although these shifts were

more apparent for females and during the first presentation of the nudges, The more indepth analysis showed lack of stability in the baseline, high variability in each phase and a high percentage of overlapping data. As a result of the high variability and lack of visible trend changes in the second A-B phase the visual inspection results should be reviewed with caution. A latency effect was also not readily apparent. Wilcoxon Signed Ranks test showed that proportions of vegetables served were not significantly associated with phase overall and for either females or males only. In this case, the nudge intervention did not impact the vegetable purchasing patterns of university students. Observations and staff anecdotes highlighted other environmental conditions like menu choices, staff encouragement, timing in the term and student finances that may also be influencing choices. This research adds to a very few number of interventions testing the application of nudge theory in a real world setting. More research in real world environments is needed.

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## Chapter 1: Introduction and Rationale

### Introduction

Vegetables and fruits (VF) are a key food group in Food Guides across the globe, due the fact that they are high in nutrients, fibers and bioactive compounds while still being low in energy density (Ministry of Health of Brazil, 2014). Consumption levels below 200g of vegetables per day can increase chances of mortality, morbidity and malnourishment (Keating *et al.*, 2011). According to the World Health Organization (WHO), poor nutrition is one of four modifiable behaviors that influence the risk of chronic disease, specifically that of cardiovascular disease and some types of cancer (Rolls *et al.*, 2004; Andreyeva & Luedick, 2014). The consumption of five or more servings of fruits or vegetables (V&F) can also promote satiety thus reducing the risk of overweight and obesity, a further contributor to chronic-disease risk (Rolls *et al.*, 2004; Andreyeva & Luedick, 2014). The importance of VF consumption is highlighted by the WHO estimates showing that 2.8% of deaths worldwide were attributable to low VF consumption (2014). Despite the consistency of national recommendations and the evidence of their importance, there remains a deficit in the consumption of VF worldwide including among young people.

Despite a tendency to increased consumption of vegetables during adulthood, only 9% of US men and 13% of US women achieved the daily US recommendation for consumption (Kimmons *et al.*, 2009). In Canada, where the average is higher, only 37% of people reported eating 5 or more servings of fruit and vegetables (Garriguet, 2009) while in a population of Spanish adults, 74% had an intake higher than 400g or V&F/day for both men and women. They also had a higher intake of vegetables (more than 200g of vegetables per day), and consequently

lower all-cause mortality and cancer (Agudo et al, 1999). This intake is higher than most other European countries as the population of Spain tends to comply with a Mediterranean diet (Agudo et al, 1999). However, in both the Canadian and Spanish studies, the same trend appeared as adults aged, the consumption of vegetables increased.

The adult prevalence of vegetable consumption is mirrored in younger populations such as adolescents and young adults. In fact, healthy behaviors like vegetable and fruit consumption, appear to be inadequate even within students that are enrolled in health related courses. A Brazilian study that aimed to evaluate physical activity levels and dietary intake habits among post-secondary students from medicine, physiotherapy, nursing, nutrition and physical education schools showed that 75% of the students had low VF intake (<5 servings/day according to the Brazilian guideline) (Marcondelli, Costa & Schmitz, 2008). The same pattern was found among adolescents in an 11 country comparison trial in the Eastern Mediterranean region; where only 19.4% of adolescents (13 – 15 years) reported consuming more than 5 servings of V&F (Al Ani, Al Subhi, & Bose, 2016).

The consumption of VF during adolescence is low but in contrast to increasing trends later in adulthood, during the transition from adolescence to young adulthood it tends to deteriorate even more (Larson et al., 2012). A study of young adults attending University found that 78.1% consumed less than 5 daily servings of fruits and vegetables (Peltzer, et al, 2014). The mean average for vegetable consumption was 1.8 servings daily (Larson et al., 2008). Unfortunately, young persons with unhealthy eating habits tend to maintain these habits as they age (Kelder et al., 1994), This worldwide scenario highlights the importance of developing strategies to try to increase the VF consumption in this specific population.

Interventions to increase the intake of V&F have long been a public health nutrition priority; varying from nutritional education to state level policy including price incentives for consumers and producers (Andreyeva & Luedick, 2014). Explanatory models such as the Model of Community Nutrition Environment by Glanz and colleagues (2005) that divides food environment into community, organizational, consumer and information levels represent a broader social ecological perspective recognizing both the complexity of food related decisions and the contribution of the environment to those (Glanz, Sallis, Saelens, Frank, 2005). Researchers have suggested that multi-strategy interventions, that include approaches such as increasing accessibility, variety and incentive are the most effective way to approach children's health behaviors and that interventions should be extended to the school, community and home environment over longer time frames to enhance their impact (>12 months) (Stochla, Smiths, & Roblin, 2016; Knai, Pomerleau, Lock & McKee, 2005).

This conclusion is supported by a meta-analysis of complex behavioral interventions showed that behavior change techniques used in studies to change adult eating behaviors (n=53) produced a small to moderate pooled effect size (.31) (Michie, Abraham, Whittington, McAteer and Gupta, 2009). Another systematic review by Pomerleau, Lock, Knai & McKee (2005) showed that the response of adults at higher risk of disease was slightly better with a range of increase in V&F consumption between 0.3 (for men with angina) to 4.9 servings/day (within patients with recent myocardial infarction). The same review showed that face-to-face and Internet-based approaches had the same efficiency and workplace interventions effects ranged from an increase of 0.13 to 0.7 portions/day. Similarly systematic reviews of interventions to increase fruit and vegetable consumption among children also showed small to moderate impacts ranging from .14 to .99 of a portion/day (Knai, Pomerleau, Lock and McKee, 2006; deSa and

Lock, 2007). With consistent but modest effects of a variety of interventions on eating behaviors researchers have begun to explore other approaches to behavior change.

Most people make many choices regarding their eating every day. When they wake up, they have to decide whether they will take breakfast or have something to eat later, or, if they will eat at home or eat out, etc. These decisions are influenced by factors such as preferences and access to alternatives (Bickel & Vuchinich, 2000). Eating behavior is extremely complex due to different personal, environmental and policy factors. Adding to this complexity is the high frequency of daily food related decisions, which occur in distracting everyday environments and can lead to mindless eating that becomes resistant to change (Askew, Fisher & Yaroch, 2009; Wansink, 2007). Thus, environmental interventions that influence daily food related decisions have gained importance; as they have the capacity to shape dietary behaviors (Olstad, Raine & Nykiforuk, 2014) and provide opportunities for individuals to make healthier choices (Bandura, 2004). One approach that highlights potential mechanisms through which environmental interventions could operate is behavioral economics.

### **Theoretical Framework**

Behavioral economics is referred to as an area of economics research concerned with predicting and controlling human behavior, specifically the judgement and decision-making processes of a person or a group (Kagel & Winkler, 1972; Ariely, 2009). Behavioral economics combines the behavioral models of psychology with the decision models of economics to try to anticipate human decisions (Just & Wansink, 2009).

Within an individual's daily food related decisions there may often be an intention to eat healthier, but somehow, due to convenience, availability, or taste, people choose less healthy

options. This intention-to-behavior step is shaped by two systems: a) cognitive (explicit processes), where all the options are weighed and the most appropriate is chosen based on personal factors and b) non-cognitive (implicit processes) where choices are usually made quickly and triggered by environmental cues (Olstad et al., 2014; Marteau et al., 2011).

Behavioral economics theory suggests that altering the environment within which choices are made, including enhancing the salience of cues, makes it possible to modify behaviors and improve wellbeing and social welfare (MindSpace, 2010).

In recognition of the importance of the environment, a new approach to leading individuals to the choice that is in their best interest from a health perspective has been proposed. This approach is based on behavioral economics (Thaler & Sustain, 2008) and is popularly known as ‘nudge theory’. It is described by academics as “libertarian paternalism”; the provision of choices that favor particular outcomes (Dows, Lowenstein & Wisdom, 2009; Olstad et al. 2014). Thaler and Sustain defined nudges as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives”. (p. 6)

As a newly developed behavioral economics concept, nudges have not been studied widely and thus more application and analysis of their impact on diet behavior and food choices is required (Qiming, 2014). Nudges related to nutrition and dietary change interventions have tended to occur in public settings such as cafeterias and have focused on changing portions plate/bowl size (Wansink et al., 2006; Wansing & van Ittersum, 2013; Rolls et al., 2007); changing or labeling caloric content within servings (Yamamoto et al., 2005 Kling et al., 2016; Wisdom et al., 2010); and changes in product positioning (Wansink & Hanks, 2013; Kroese,

Marchiori & Ridder, 2015; Chapman & Ogden, 2012). Most studies (6/9) have shown a positive impact of the nudge strategy.

In order to classify the different nudge intervention types, the Mindspace program (2010), identified 9 categories of nudges. These nudge types included: messenger nudges, incentives, nudges about norms, default nudges, salience nudges, priming nudges, affect nudges, commitment nudges and ego nudges. Thereafter, Blumenthal-Barby & Burroughs (2012) condensed these into 6 different nudge classifications (see Table 1) including Salience & Effect nudges; Priming nudges; Ego & Commitment nudges; Messenger & Normative nudges; Incentives; and Default nudges.

Table 1. *Nudge classification categories and definitions according to Blumenthal-Barby & Burroughs (2012).*

Category	Explanation	Example
Salience & Affect	Personal and vivid explanations are used to influence behavior and decisions. Reactions will be elicited primarily through emotional associations in response to the nudge.	Signage and imagery; Color coded labels; nutrition information.
Priming	Subconscious cues are used to influence	Placing healthy foods first on a

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	behavior, which may be physical, verbal or sensational, and are changed to nudge a particular choice.	buffet; Eye-level positioning.
Default	“Go with the flow” of pre-set options. Easiest option. Consumers tend to choose default options as it simplifies decision-making.	Changing the default side order to vegetables instead of fries and to water instead of pop.
Ego & Commitment	To achieve long-term behavioral change by using promises, contracting, self-esteem and self-image. Nudge them to make choices consistent with their commitment or promise.	Using Smartphone apps or websites to commit people to achieving their goals (weight-loss, exercise, etc)
Incentives	Behavior change occurs when incentives are used to reinforce a positive	Providing a coupon for each day that

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	choice, or punish a	vegetables were
	negative choice.	selected
Messenger & Norms	Other people are used to	Providing
	establish a norm, as	messages that
	consumers are influenced	illustrate the norm
	by comparing themselves	e.g. “Most of Us
	to others. Alternatively,	wear seatbelts” ;
	people of status are used	or providing
	to communicate with	celebrity
	consumers, as consumers	endorsements
	are influenced.	

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Considering the number of non-cognitive decisions (utilizing implicit processes) which can be made in food service environments (e.g. smell, appearance, portion size, price) (Altman, 2012) and are based on short-term gain, the use of nudge intervention approaches has been explored there more thoroughly than in other settings. However, the literature remains sparse and has largely focused on food/menu positioning, location rearrangement, special labeling and availability (Cohen et al., 2015; Olsen et al., 2012; Olstad et al., 2014; Olstad et al., 2015; Grabenhorst et al., 2013; Thorndike et al., 2012).

While research in hospital and school cafeterias is growing, research targeting university students and real-world university cafeteria services is needed. A few studies aimed to nudge young adult university students by changing food position and/or manipulating utensil sizes (Rozin et al 2011; Chapman & Ogden 2012; Kleef, Otten & van Trijp, 2012). Less accessible

salad bars decreased the intake of vegetables (Rozin et al., 2011) but unexpectedly, there was a decrease of healthy items purchased when they were positioned by the checkout to prime their purchase (Chapman & Ogden, 2012). Kleef, Otten & van Trijp, (2012) tested shelf arrangement with a sample of 158 undergrad students and showed that assortment had no impact on food choice, but when the majority of the snacks were healthy a healthy choice was more likely to be chosen. This study was conducted in a controlled laboratory setting however.

In the context of mixed results, a lack of variety in nudge types studied, and limited real world trials it appeared important to test different nudge strategies with young-adults in a real world cafeteria settings. A partnership between the BC Ministry of Health and the University of Victoria food services provided the opportunity to address this research need. The purpose of the trial was to implement a contextually feasible nudge intervention and evaluate its impact on food purchasing behavior in the University residence cafeteria. A priming nudge in the form of fresh vegetables offered at the steam/hot food table, combined with a salience nudge (signage) was tested.

The research addressed the following research questions.

### **Research Question 1:**

Will a cafeteria-based NUDGE intervention (priming nudge using fresh vegetables plus a salience nudge in the form of signage) increase the quantity of vegetables purchased by young adults within a cafeteria at the University of Victoria?

### **Hypothesis 1**

A priming + salience nudge intervention in the form of fresh vegetables offered at the steam/hot food table for lunches and dinners will increase the quantity of vegetables purchased by young-adults at cafeterias located at University of Victoria.

**Sub-hypothesis**

We hypothesize that vegetable purchasing in response to the intervention will differ between females and male students.

**Considerations****Assumptions.**

- The sample is representative of UVIC undergraduate students consuming at least 3 meals a week on campus.
- Staff will be able to implement the nudges consistently in the real-world cafeteria service environment.
- Increases in vegetable purchases lead to increases in consumption.

**Delimitations.**

The study is delimited to young adults ages 18 – 34 years old, registered as undergraduate students at UVic and taking most of their meals on campus. Staff and older students were not counted in the sample observations.

**Operational Definitions**

The following operational definitions were used to guide the research.

*Undergraduate student*

An undergraduate student was defined as any individual, aged 18-34 years, who was registered at the University of Victoria. They could live either off or on campus, either alone or with one or multiple roommates but eat some or all of their meals on campus. Adults that appeared visibly older than the age group were excluded from the sample.

**Cafeteria.**

A location that offers multiple foods and food preparation/sales stations.

**Nudge.**

A nudge was defined for the purposes of this study as “*any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not*” (Thaler & Sustain, 2008, p. 6).

**Vegetable purchase.**

The amount of vegetables purchased was assessed by researcher observation and was based on the typical portion served in the cafeteria upon request. A portion of vegetables represented approximately  $\frac{1}{4}$  of a standard cafeteria plate or a scoop/mound the size of one fist.

## Chapter 2: Review of the Literature

Changes in the dietary patterns of many populations have occurred globally due to the convenience and easy access to energy-dense diets high in fat, particularly saturated fat, and low in unrefined carbohydrates food (WHO, 2002). These dietary changes, associated with a decrease in energy expenditure due to sedentary lifestyle have led to an increase of chronic diseases like obesity, diabetes mellitus, cardiovascular diseases, hypertension, stroke and some kinds of cancer (WHO/FAO, 2003).

According to the new *Dietary Guidelines for Americans* (2015), over the past century, the diseases related to nutrient deficiencies have decreased and many infectious diseases have been conquered. However, as infectious disease rates have dropped, the rates of non-communicable diseases, specifically, diet-related chronic diseases have risen, due in part to changes in lifestyle behaviors. In Canada, the obesity rate has increased over the past years, with 2003 estimates of obesity at 57.3% and 41.3% for men and women, respectively, and 2014 estimates at 61.8% and 46.2% respectively (Statistics Canada, 2014).

There are different factors that can lead an individual to overweight and obesity and chronic disease risk. The fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended (Mahan, Escott-Stump & Raymond, 2013). According to the WHO (2017): “Changes in dietary and physical activity patterns are often the result of environmental and societal changes associated with development and lack of supportive policies” . Worldwide obesity has more than doubled since 1980 and in 2014 there were more than 1.9 billion adults classified as overweight and over 600 million of those were obese. (WHO, 2015). Obesity can also be a precursor to other chronic diseases like diabetes, cardiovascular disease and some cancers (CDC, 2015). These conditions are among the most common, costly,

and preventable of all health problems. In 2012, 117 million people in the US had one or more chronic health conditions (Ward, Schiller & Goodman, 2014). One of four adults had two or more chronic health conditions and 86% of all US health care spending in 2010 was for people with one or more chronic medical conditions (CDC, 2015).

Even though there is a high prevalence of obesity, chronic diseases and some forms of cancer, and these conditions have a negative impact on the health care system, there are several mechanisms through which dietary behaviours and consumption of certain foods and nutrients can prevent and/or act as auxiliary treatment of these conditions. The diversity of vitamins, minerals and other bio compounds in vegetables can play an important role in general health. For instance, it is known that vegetables rich in potassium and magnesium and those rich in nitrate can reduce high blood pressure. Folate may be a cardio-protective nutrient as well (Food for Health, 2003).

Most of the studies in the literature to date have analyzed the impact of vegetables and fruits (V&F) combined on chronic disease risk rather than with vegetables isolated. Frequently the benefits of consumption of vegetables are equated with those of fruit intake, since both food groups are similar in micronutrient profile. However, fruits are higher in caloric density and naturally occurring sugars. Thus, studies that combined V&F were included in this review.

An English study analyzed the benefits of V&F for population level all-cause mortality and demonstrated that those who ate between one to three portions of fruit and vegetables a day showed significantly greater survival than those eating less than one portion per day. This relationship was stronger when V&F consumption was greater than 7 portions/day (Oyebode, 2014). Farvid and colleagues (2016) also observed that total fruit and vegetables consumed

during adolescence was related to lower levels of breast cancer, especially consumption of those V&F rich in  $\beta$ -carotene (Farvid et al., 2016).

One of the principal steps to achieving a healthier diet is the consumption of an adequate amount of vegetables. *Canada's Food Guide* (2011) suggests that a person should consume 6-10 VF servings (at least  $\frac{1}{2}$  cup of vegetables and 1 cup of leafy vegetables) in order to attain the essential nutrients for a healthy diet. Interestingly, among young adults (19-35 year olds), only 35% of males and 45% of females reported eating 5 or more servings of fruits and vegetables per day (Statistic Canada, 2011). As previously noted, the consumption of vegetables is especially important due to their high nutrient density and low caloric density. Vegetables contain significant levels of bioactive compounds that impart benefits beyond basic nutrition (Mahan, Escott-Stump & Raymond, 2013). These compounds can act as antioxidants, vitamins, minerals, and/or fiber and studies demonstrate reduced risk of cardiovascular disease, type II diabetes, non-gallstone related acute pancreatitis, various cancers and cognitive decline, when vegetables are consumed in proper amounts (Veer, Jansen, Klerk & Kok, 2000; Mozaffarian, 2016; Kaur & Kapoor, 2001; Appleton et al., 2016). A shift to a higher consumption of vegetables, over the long term, will decrease the caloric density of the diet and is one of many suggested strategies needed to promote weight-loss and reverse the current high prevalence of obesity and chronic disease (Rolls, 2009).

According to Statistics Canada (2014), roughly 40% of the Canadian population reported consuming 5 or more servings of V&F a day. This data is worrisome if compared to the prevalence from 2009, where 45% of the population reached the minimum recommended portion requirement for V&F. The consumption of an adequate amount of V&F is higher among people aged 55 or older than it is among younger people (Perez, 2002).

Eating patterns have been changing over the last 30 years. The contribution of daily calories from snacks increased by 30% between 1977 and 1996 in children age 6 – 11 years (Jahns, Siega-Riz, & Popkin, 2001). This may have displaced the consumption of variety of non-packaged foods, like V&F. This is problematic as research has shown that foods that have been eaten less often during childhood have less chance of being liked and consumed, with the opposite true as well (Cook & Wardle, 2005). These findings, in combination with the information that being overweight during childhood and adolescence is correlated with adult obesity (Biro & Wien, 2010), reinforce the importance of V&F choices during youth and their potential importance for future habits and disease prevention.

The prevalence of obesity among young adults more than doubled in the past 30 years (Fryar, Carroll & Ogden, 2013). It is estimated that 65.1% of young adults, are either overweight or obese (Hedley et al., 2004). The greatest increases in risk of being overweight or obese and diet-related chronic disease seem to occur in persons between the ages 18 and 29 years (Cluskey & Grobe, 2009). This transition period between adolescence and adulthood is also a common age for college attendance. The transition from high school to college represents a time for young adults that involves behaviour adaptation for a new environment, with changing peers and support systems. It is frequently accompanied by dramatic and inappropriate weight gain (Wengreen & Moncur, 2009). Research conducted by Wengreen and Moncure (2009) showed a significant increase ( $p < 0.001$ ) in body mass index and weight (~ 1.5kg) in the first term of post-secondary education and 23% of students gained more than 5% of their baseline weight within the term. (Wengreen & Moncur, 2009). Other studies have shown an estimated weight gain during the freshman year ranging from 76.57g/week to 158.3g/week (Matvienko, Lewis &

Schafer, 2001; Levitsky, Halbmaier & Mrdjenovic, 2004; Hovell *et al*, 1985; Nelson, Story, Larson, Neumark-Sztainer & Lytle, 2008).

An elevated use of fast food restaurants, high intake of soft drinks (including a high exposure to food marketing directed to this population), skipping breakfast, lower consumption of fruits and vegetables, using media during meals and purchasing food on campus are related to unhealthy dietary patterns in young adults as compared to other age groups and behaviours established during this time could potentially initiate life-long weight struggles and associated health problems (Racette, Deusinger, Strube, Highstein & Deusinger, 2005; Huang, Song, Schemmel & Hoerr, 1994; Laska, Hearst, Lust, Lytle & Story, 2014; Niemeier, Raynor, Lloyd-Richardson, Rogers & Wing, 2006).

In regard to health it is also important to note that the amount of calories is only one contributing factor, food variety is also considered a factor in good health. People who consume a better food variety are more likely to adhere to nutrition guidelines requirements (Ducrot *et al.*, 2017). In fact, Haberman & Luffey reported that 76% of University students ate the same food day after day and this average was higher when comparing students living on campus (85%) with those living off campus (76%) and those living at home (62%). Alarmingly their data also showed that 82% of the students ate less than 5 – 9 portions of V&F/day.

Other factors that have an impact on the health of university students is increased stress, lack of sleep and depression (Regestein *et al.*, 2010; Trockel, Barnes & Egget, 2010). Stress has also been associated with unhealthy diets, inactivity and other health behaviors among university students (Vella-Zarb & Elgar, 2010).

It is clearly important to target young adults who are making substantive transitions in their lifestyle and have low vegetable and fruit consumption. It is also clear that effective

interventions are needed (Swinburn, 2008). The desire to control appetite and eat healthier food options in an environment where the availability of cheap, caloric dense and palatable food is predominant calls for the attention of stakeholders and policy makers to face this challenge (Sassi et al., 2009). Choice architecture and other related behavioral economics concepts have emerged in the last decade as potential tools to alter human behavior in favor of healthier choices and that are also capable of reaching a big population (Ariely, 2010).

### **Behavioral economics**

Behavioral economics combines the behavioral models of psychology with the decision models of economics to highlight how biases in perception, memory, or thought processes may influence purchasing decisions (Mullainathan & Thaler, 2000). The theory of behavioral economics suggests that human behavior is based on two different systems of thinking; system 1 which is the automatic system and System 2, which is considered the reflective system. Automatic thinking refers to implicit or unconscious decision-making. Automatic decisions are typically fast and not controlled by the individual. In the second system, which is reflective, decisions are accompanied by self-awareness, are controlled and made at a slower pace (Thaler & Sustein, 2008; Kahneman, 2015).

To solve a mathematical problem, develop a strategic plan or write a thesis about nudging, higher mental effort operations are required. That is where the system 2 is required, in situations where all the options and considerations should be weighed to decide on the best option. This process is achieved through a slower and controlled process. In contrast to system 1, system 2 is flexible, goal-directed and represents more control over the decisions (Kahneman, 2012; Hofmann, 2009). This system is inefficient when it comes to decisions that are made on a

daily basis (like what you want to eat in your university cafeteria, or how to tie your shoes properly) because it requires all of the person's attention, preventing any other processing (Marteau, Hollands & Fletcher, 2012).

Picking up a snack on the way to class, tying shoes or grabbing a coat to go outside require less mental effort than solving a math problem. This is where System 1 is most often engaged. This processing system is considered fast, automatic, effortless and associative, where we act without reflection (impulse) and the decision-making process is triggered by the environment and what surrounds us (Kahnemann, 2002; Marteau, Hollands & Fletcher, 2012). This fast-paced decision process has almost no behavioral resistance and allows humans to make daily, predictable decisions in a smooth, unconscious manner, that avoids engaging time consuming cognitive processes. On the other hand, it is inflexible and not connected with conscious desire (Kahnemann, 2002; Marteau, Hollands & Fletcher, 2012).

Comparing both systems, the automaticity of the system 1 processes will certainly result in shorter response times when compared to the more reflective system 2 processes. Another distinction between both systems is implicit vs. explicit processes. The more explicit (e.g. engaging recollection/ memory/knowledge) the process is, a higher activation of system 2 will occur. Conversely, an implicit memory operates unconsciously, therefore relying more on the automatic system for decision-making (Alós-Ferrer & Strack, 2013).

Individual decision-making is often irrational or biased by emotional reasons. Most daily decisions are made in a fast-pace environment where intuitive decision making with minimal conscious effort is common and makes use of heuristics. Heuristics are simple rules-of-thumb based on common sense and used to solve a problem quickly (Albar & Jetter, 2009). At this

moment, dual-process theory has an important role in explaining decision-making behaviors (Marchiori, Adriaanse, De Ridder, 2016).

Considering the role that heuristics play in decision-making, interventions to influence choice behavior are justified (Altman, 2012). Based on this line of thinking, individuals could be nudged towards healthy/rational but automatic choices. Behavioral economics can be used to change the choice architecture (i.e. the environment), guiding people to make voluntary decisions that they would like to make, even though, due to bounds on their rationality and human error, they fail to make (Oliver, 2013).

The behavioral economics approach has helped to identify the behavioral triggers that lead to the selection and consumption of healthier foods and healthier quantities of food (Just & Wasink, 2010). Recently, this has been represented by the more popularized concept Nudge. This concept was proposed by Thaler and Sunstein (2008) in their book, “Nudge: Improving decision about health, wealth and happiness”. The concept of nudging is framed within behavioral economics and the fact that implicit and explicit cues can influence choice by changing the manner in which options are presented to people. According to the authors, nudges can be defined as: “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives” (Thaler & Sunstein, 2008, p. 6). They suggest nudges are behavioral triggers not meant to replace, for example, stricter forms of environmental interactions like food policy or restrictions. Rather, nudges complement regulation by moving society incrementally in a direction that might benefit all (Oliver, 2011).

Nudges are based on a libertarian paternalism approach (Thaler & Sunstein, 2008).: libertarian because the concept implies that, in general, people should be free to do what they

like and free to opt out of undesirable arrangements if they want to do so, and paternalism because the choice is constrained (Thaler & Sunstein, 2008). The constraint is perceived as legitimate because individuals do not always make the most appropriate choices and often make decisions they would not have made if they had paid full attention and possessed complete information, unlimited cognitive abilities, and complete self-control (Thaler & Sunstein, 2008).

Choice architecture has a significant influence on the decision-maker and it can influence choices in different ways, by varying the presentation order of choices or alternatives, the product attributes and ease of use, or the selection of defaults (Johnson et al., 2012). While it is tempting to think that choices can be presented in a neutral way, the reality is that there is no neutral choice architecture (Vlaev, King, Dolan & Darzi, 2016). For different reasons, such as fear, laziness or lack of attention, many people will make a choice which requires less effort. These conditions imply that for a given choice, there is a default option; there is an expectation that people end up with this option, whether it is the best option for them or not (Thaler, Sunstein & Balz, 2010).

Another factor that is closely linked with behavioral economics and affects food-related decisions is the food environment. According to Wansink (2004), food environments are related directly to the way that the food is presented and the form that it is served. Different sizes of packages, salience of specific foods, portion and plate sizes and positioning are considered determinants within the food environment (Wansink, 2004). These environmental triggers are nudges that play an important and often dominant role in food choice, eating patterns, and ultimately, energy intake. These were categorized by Glanz, Sallis, Saelens & Frank (2005) into four main domains:

“(1) *Community food environments*; this refers to food outlets location and type,

hours of operation and accessibility and the effect on the population living nearby. (2) *Organizational food environments*; defined as homes, schools, worksites, university, and health care facilities and affect defined groups such as families or students. The home environment is set as the most complex environment, having strong social influence. (3) *Consumer food environments*; referring to the availability of healthy options that they will encounter within a retail food outlet. Price, promotion, placement and nutrition information are relevant characteristics, and (4) *Informational food environments*; this is considered an independent domain where media and advertising are affected by public policies and can operate in national or regional level” (Glanz, Sallis, Saelens & Frank 2005, p. 331).

### **Nudging & choice architecture**

To illustrate the application of choice architecture and food environment concepts as well as their impact on the purchase of healthier food options the literature on behavior economics based environmental interventions is overviewed next. This overview focuses on environmental interventions at the level of the individual (micro; e.g. size of bowls, signage) rather than macro level (proximity of a farmer’s market in the community). Blumenthal-Barby and Burroughs (2012) developed a framework/typology of different types of nudges including: Salience & Affect; Priming; Default; Ego & Commitment; Incentives; and Messenger & Norms. The literature (see Appendix A) will be discussed in light of this framework.

#### **Salience and affect**

The definition of Salience and affect nudges according to Blumenthal-Barby & Burroughs (2012) is:

“Salience and affect nudges are used to change health behaviors and decisions considering that people are influenced by vivid examples, novel, personally relevant and explanation. The emotional associations elicited by these items remain readily available in memory and as a result powerfully shape decisions and behaviors” (Blumenthal-Barby & Burroughs, 2012, p. 4).

### **Nutrition label and traffic light**

Nutritional facts and traffic lights are an example of a salience and affect nudge. Their objective is to inform the consumers about the content, caloric value and its healthiness. Therefore, these strategies can mediate the consumption and influence choice when the nutritional facts are considered by the patron (explicit process). Cioff et al (2015), demonstrated that when caloric and fat content were labeled on meals and snacks, there was a reduction of 6.5% in caloric intake ( $p < 0.001$ ) and 7.4% in fat-content ( $p < 0.001$ ), respectively. There was also an increase in purchase of low-fat food and a decrease in purchase of high-fat content food. Similar results were found in a randomized control trial conducted by Wisdon et al (2010), where after describing the caloric content on sandwiches, side dishes and drinks at a fast food sandwich outlet, and on meals where these were combined, a reduction in the total caloric load of food that was ordered was observed.

Another salience strategy, called traffic light labeling, “translates” the nutrition information into simple color- coded labels and makes it easier to identify the healthier choice (Dunford et al., 2017). Because of its simplicity, traffic light labeling may be a more effective means of encouraging healthier selections compared to calorie labeling (Borgmeier & Westenhoefer, 2009). The implementation of traffic light labels in a recreation centre concession demonstrated an overall increase in sales of healthy products (green lights) by 55% and decrease

in the sales of red lights by 30% (Olstad et al, 2015). Traffic labels have also been found to directed a patron's purchasing towards the healthier options and increase awareness of healthiness foods, when the traffic labels were noted by the patron, thus providing evidence that labels played an important role during the decision-making (Sonnenberg et al., 2013).

Levey et al (2012) observed the same results in a hospital cafeteria study as Olstad et al (2015), such that, after labeling foods and beverages according to the traffic light system, there was an increase of green purchases by 6.6%(CI 5.2– 7.9%) and a decrease of red purchases by 11.2% (CI -13.6 % to -8.9%). They also found a 5.6% increase in purchasing of green label beverages (CI 3.5– 8.1%) and a 23.8% (CI -28.1% to -19.6%) decrease in red labeled beverages.

More recently Filimonau, Lemmer, Marshall, & Bejjani (2017) assessed the impact of a menu re-design by adding nutritional, caloric and environmental credentials, using green, amber and red for nutritional value. A patron survey suggested that calories didn't impact the food choice but nutritional value, price and food provenance were taken into consideration when making the food choice.

### **Sizes and portions**

Portion sizes have increased and consequently increased the caloric intake when food is offered in restaurants under a non-proportional price increase (Young & Nestle, 2002). Vermeer, Alting, Steenhius & Seidell, (2009) conducted two studies and compared proportional pricing (price calculated based on 250ml of pop and 6 pieces of nuggets) vs. value size pricing (e.g. have the large size for \$0.30). The first study was conducted in a fast food restaurant, and proportional prices for chicken nuggets and soft drinks were tested. For soft drinks, proportional pricing reduced the likelihood that overweight/obese people would choose the largest size (OR = 0.07, P = 0.04 CI 0.01–0.83). For chicken nuggets, men seemed more likely to choose the reference size

when confronted with proportional pricing (OR = 3.35, P = 0.06, CI 0.96–11.73) while for women, proportional pricing decreased the likelihood of choosing the reference size (OR = 0.41, P = 0.04, CI 0.18–0.94) (Vermeer, Alting, Steenhuis & Seidell, 2009).

The second study, in a worksite cafeteria, compared large hot meals of 500g each vs. a reference small hot meal of 300g each. The results showed that 86.2% of the participants chose the reference size and that proportional pricing led to an increase in reference size purchasing of 13.5% (P=0.05). A logistic regression analysis showed no significant main effect nor interaction effects for pricing strategies in the general population, but an impact in the overweight population (Vermeer, Alting, Steenhuis & Seidell, 2009).

Reinders and colleagues (2017) investigated if an increase in the amount of vegetables (from 75g to 125g) in a dining restaurant, accompanied by a decrease in the amount of meat served (-12.5%) affected consumption and customer satisfaction. The intervention increased the consumption of vegetables by plate (115.5 vs. 61.7,  $p < .001$ ) and overall (178 vs. 137,  $p < .001$ ) while decreasing the consumption of meat (183 vs. 211,  $p < .001$ ). A follow-up customers questionnaire showed that there was no difference in satisfaction with the visit, although during the intervention, the satisfaction with the main dish was lower (M = .08 vs. M= .18,  $p < .05$ ).

In a school canteen, the offer of pre-portioned options and a self-service option for V&F, resulted in no significant difference in the use of a salad bar or portioned options (Adams et al 2005). However, when a greater variety of V&F were offered, a greater consumption of V&F was demonstrated ( $F = 2.83$ ,  $p \leq 0.05$ ).

### **Other Salience examples**

Beyond nutritional labeling, traffic lights and portion sizes, salience nudges can also be vivid examples of what the customer will purchase and eat. For example, to call the attention of

military personnel towards healthier eating options in the military canteen and hopefully change VF, water and fitness meal consumption, Winkler, Streber, & Filipiak-pittroff (2016) applied multiple nudges (fitness menu display / piece of fruit offered as dessert / water offered in a green container and placed in several positions / healthy message posters, etc). The outcomes showed that the purchase of water (+16% / +7.5%), fruits (+37.5% / + 29%), and fitness meals (+4% / + 1.1), were significantly higher in the short term while the consumption of salad was higher in the medium term (+5% / +9.5%).

Pre-ordering meals can be another efficient salience and affect strategy to avoid mindless choices based on hunger; they create a commitment with the person who ordered the meal (Thaler & Susnstein, 2008). Stites and colleagues (2005) found that in an overweight pre-ordering lunch whilst looking at the nutritional value of food choices and receiving mindfulness training sessions resulted in orders that were 144kcal less ( $p= 0.001$ ) and 8.8 grams lower than those in a comparison group. In a school, pre-ordering lunch with environmental cues (MyPlate recommendation while ordering) resulted in an increase of orders of fruits (51.4%), vegetables (29.7%) and low-fat milk (37.3%) when compared to a simple pre-order without nudges (Miller, Gupta, Kropp, Grogan & Mathews, 2016).

### **Priming Nudge**

One of the ways that has been used to change health related behavior is priming. This is based on the concept that actions are influenced by subconscious cues, where these cues are used strategically, as primers to health behaviors (Blumenthal-Barby & Burroughs, 2011, p. 6) (see Table 1). One example of a priming nudge that has been tested with success is food rearrangement and positioning (Blumenthal-Barby & Burroughs, 2012).

### **Food positioning and rearrangement**

When examining the nudge literature, food positioning and rearrangement appears to be one of the most tested nudges likely due to the ease feasibility of the implementation process; which involves only rearranging foods to new positions or order. Food positioning has been well tested in the literature with several positive results.

A crossover study performed in a coffee shop frequented by students and young professionals changed the position of beverages on the menu and compared the beverage sales when they were placed at the beginning or the end of the menu vs. placed in the center of the list. The results showed that beverages placed at the beginning or the end of the list were more than twice as popular (59% greater sales,  $p < .01$ ) when compared to those placed in the center of the list (Dayan & Bar-Hill, 2011).

Similarly, a randomized control trial by Wansink and Hanks (2013), changed food positions at a conference breakfast and tested the positioning of healthy food first and in sequential order on the buffet line. Healthy foods were selected more often when offered first. In total, the first three foods a person encountered at the buffet comprised 65.7% of their total plate. Serving the less healthy food first led diners to take 31% more total food items ( $p < 0.001$ ). The same pattern of results was found when comparing a regular buffet vs. placing the V&F components at the beginning of the buffet (Bucher et al., 2016). As well, when eight V&F from a mixed salad were separated into 8 different bowls, a higher consumption of V&F was observed in the intervention (separate FV) group ( $p = 0.005$ ) (Kongsbak et al., 2016). This was in addition to a lower consumption of pasta ( $p=0.003$ ) and a lower caloric intake overall ( $P= 0.010$ ), even though the grams of salad purchased were not different ( $p = 0.326$ ) (Kongsbak et al., 2016).

Hanks et al. (2012) increased the accessibility of healthy foods by displaying only healthy foods in one of two lunch lines in a self-serve high school cafeteria. This increased the sale of

healthy foods by 18% and reduced grams of less healthy foods sold by 28%, compared to the control condition (where both healthy and unhealthy items were displayed in the two lunch lines). In a natural breakfast buffet setting, Wansink and Hanks (2013) manipulated the order of the same seven dishes in two buffet lines: one from healthiest to least healthy and the reverse. People were randomly assigned to one of the two lines and filled two thirds of their plate with the first three dishes. Those who reached the healthy items first served themselves more fruits and yogurt than those who reached the unhealthy items first.

Just and Wasink (2010) tested a daily situation in a school cafeteria where students waiting in line to pay for their lunch were exposed to a wide array of grain-based snacks, chips, granola bars, and desserts. When these foods were replaced with healthy items such as a wide array of fruits, the sales of fruits increased, the sales of unhealthy snacks decreased and there was no change in the cafeteria revenue (Just & Wasink, 2010). More recently, Wilson, Just, Swigert, & Wansink (2016) researched the impact of healthy bars positioned in the dessert section of a food pantry. When the bars were positioned first in the dessert line, there was a proportional selection of 0.337 (95% CI = 0.272, 0.406) vs. 0.231 when placed at the back (95% CI = 0.189, - 0.0231)  $p < 0.01$ . The proportion was higher when the bars were in front of the line and on their original box (0.525, 95% CI = 0.391, 0.657)  $p < 0.001$  when compared to unboxed front/back condition.

Comparing positioning in the middle and at the sides of a laboratory based cafeteria intervention, two trials tested placing low calorie bars in a middle of side position (Missbach & Konic, 2016). In the first study, conducted in a laboratory setting, low calorie bars were positioned in the middle of a tray with other snacks options, and compared when the same bar was positioned either on the left or right. In the middle placement intervention condition, the bar

was selected 36.7%. When positioned to the left, the same bar was selected 13.3% (Missbach & König, 2016). In contrast, the second study showed no difference in the middle/side positioning ( $p=0.35$ ) In this study a low/high depletion of self-regulatory resources condition was tested to determine its effect on food choice but this depletion also didn't favour the middle-position (Missbach & König, 2016).

In contrast another study by Kleef, Otten & van Trijp (2012), showed that the effect of assortment structure ( $p = 0.68$ ), shelf arrangement ( $p = 0.10$ ) or the interaction ( $p = 0.26$ ) made no difference on total snack sales. Nor did the arrangement when healthy snacks were positioned on the top or bottom of the shelf or when the assortment had 75% of healthy snacks vs. 25% of unhealthy snacks. However, the sales of healthy items increased when the arrangement was constantly 75% healthy snacks (Kleef, Otten & van Trijp, 2012).

Beyond positioning and arrangement, other priming strategies have been examined. Cohen et al., (2015) evaluated short and long-term effects of chef-enhanced meals and extended exposure to choice architecture on healthier school food selection and consumption in 14 schools. The students were exposed to one of four intervention conditions, either having a chef cook during the serving time period or a Smart-café intervention (vegetables placed at the beginning of the lunch line, fruits presented in attractive containers and at the checkout and placement of white milk in front of chocolate milk), a combination of both interventions or a control/no change condition. Fruit servings were greater in the Chef Program only when compared to controls (0.17; 95%CI, 0.03-0.30cups/d). The Smart-café condition had no significant effect on fruit consumption. The odds of vegetable selection increased in the Chef program, Smart-café and the combined interventions when compared to controls. At 7 months follow-up the researchers found significant increases in healthier food selection and consumption

in schools in the combined intervention as well as in those with the chef only intervention. This study showed no difference when choice architecture was implemented alone, affirming the importance of nudges as supportive strategies that are perhaps not powerful enough to change behavior when used alone (Cohen et al., 2015).

Another priming nudge implemented in a local supermarket setting was the distribution of a healthy recipe under 2 conditions, one recipe had healthy related words (e.g. “good for you”) and the other had unrelated healthy words (e.g. “try it out” or “new recipe”). The results demonstrated that when people paid more attention to the recipe, there was a strong interaction between the prime message and weight status (reduced the purchase only for the overweight patron vs. control ( $M = 0.34$  vs.  $M = 5.14$ ,  $p = 0.001$ ) and a decrease of 74% for unhealthy snack purchases in the intervention group (Papies et al., 2014).

Few studies have examined the influence of nudges in different environments. Olstad, Goonewardene, McCargar & Raine (2014), tested the impact of two different nudges (descriptive menu and taste sample combined with a 30% discount as an economic incentive) in a publicly funded recreation facility and found no difference in the sale of healthy foods. This was not consistent with other research. For instance, Wansink et al (2016) tested the use of a descriptive menu (such as “Grandma's zucchini cookies” or “succulent Italian seafood filet”) on sales of target foods and the results showed that sales of targeted (healthy and unhealthy) items in a University faculty cafeteria increased by 27% when they were given descriptive menu labels.

### **Other nudge interventions**

There is some evidence supporting the use of incentives as a nudge. For instance, in a study where participants received \$1 for each healthy item bought during their grocery shopping, the intake of vegetables by families increased (Kral, Bannon & Moore, 2016).). At a more macro

level the accessibility of unhealthy food has been examined with convenience store presence within 0.5 miles in non-metropolitan areas showing that proximity increased the odds of unhealthy dietary habits (Lind, Jensen, Glümer & Toft, 2016).

It is clear that there is yet limited evidence on the effectiveness of a broad range of nudges across a variety of settings and target populations. There are also mixed findings in the literature, indicating a need for more research.

From 30 quantitative studies reviewed for feasible nudges, 7 had negative or null results (Vermeer, Alting, Steenhuis & Seidell, 2009; Kleef, Otten & van Trijp, 2012; Olstad et al, 2014; Adams et al., 2005; Olsen et al., 2012; Dave et al., 2015; Chapman & Ogden 2012 A). In an attempt to understand the mixed results, a dual-process theory approach was used, whereby cognitive and non-cognitive nudges were separated. From 10 studies that used reflective nudges, 4 had negative results (40%). Only one study out of 15 that used automatic nudges had a negative result (6.7%), and of 8 studies using a blended approach (mixing automatic and reflective nudges) 2 studies had negative results (25%).

Nudges are based on choice architecture, where the context where individual decisions are made is modified without affecting the freedom of choice. Nudging relies mostly on heuristic-based decisions, where a spontaneous answer to a problem is presented and triggered by environmental and contextual cues (Codagnone et al., 2014). Usually decisions made by this System 1 approach can have better outcomes, improving efficiency without compromise quality (Milkman, Chugh & Bazerman, 2008). Considering a food environment, choices are made quickly and usually take less than 1 second to make (Cohen & Lesser, 2016). This may be one of the reasons why, to date, nudges using implicit cues have had more positive results than reflective or blended nudges.

Given the identification of young adults as a target population with low vegetable consumption and evidence of successful nudge interventions in different settings, the main goal of this project was to increase vegetable purchase and consumption in young adults within a University cafeteria and to extend the literature by testing nudges that have not been tested fully in this setting (priming and salience-based nudges). The research was conducted in a real-world environment to address real world intervention gaps in the literature.

## **Chapter 3: Methods**

### **Research Design and Timeline**

This study utilized a quasi-experimental single case A-B-A-B comparison design. In order to measure the effectiveness of the intervention, data was collected for two periods of baseline (A-phase). The first one to describe the current level of vegetables purchased and the second A phase to describe if the behaviour continued without the intervention or returned to baseline (essential for demonstrating control) and two periods of intervention (B-phase) to describe the impact of the intervention upon presentation and re-presentation and provide greater confidence in the intervention efficiency (Kazdin, 1982; Rilley-Tilman & Burns, 2009). The 4 phases were conducted during the Fall term of 2016 over a 10 week period, beginning on September to avoid the first few weeks of the fall term and the exam period where student use of the cafeteria is not typical. Each baseline period lasted 2 weeks while each intervention phase was 3 weeks in length.

### **Ethics**

This study was approved through the UVIC Human Research Ethics Board (HREB) under the Protocol Number 15-445.

### **Sample Site and Target Population:**

The study was conducted in the University residence cafeteria that mostly serves undergraduate students (aged 18-34 years) registered at the University of Victoria. This location was chosen based on the feasibility of intervening and measuring. Other cafeteria options did not offer full service (multiple food options and stations) where vegetable offerings could be enhanced and/or were run more like a food court with individual restaurants. Adults that appeared visibly older than the age group were excluded from the observations.

### **Intervention**

Formative research was conducted to identify feasible, efficacious and relevant nudges. We adopted a model for NUDGE development (See Figure 1) based on “A Practitioner Guide to Nudging” by the Rotman School of Management (2013) and considered inputs from the literature on effectiveness, self-reported information about student preferences, behaviours and purchasing influences and focus groups with cafeteria staff and food service managers.

### **Student Survey**

Student surveys were sent out to 1st year resident students (n = 340) to identify self-reported influences on vegetable purchasing behaviour. Students (aged 18-34 years) were recruited via e-mail sent by the Residence Services and using a face-to-face approach during lunch times (11:30 am – 1 :30 pm) in the University Food Court. The web-based survey was composed of 24 questions and 14 sub-questions and addressed the main factors that affected students’ food choices when at the University cafeteria. The survey was divided in 4 sections (self-reported frequency that a list of factors/reasons influenced decisions to purchase vegetables (how frequently these influenced); B – A ranking of the top 3 reasons for purchasing vegetables; C – Other influences on on-campus vegetable purchasing decisions. And; D - demographics).

A total of 340 students answered the survey, 94.9% of the students lived in residence. From the students living on residence building, 76.2% were on the standard meal plan, 8.7% on a full plan and 15.1% on a light meal plan. More females (65.2%) answered the survey compared to male (34.8%). The survey was answered predominantly by first year students. 28.3% of the students reported having dietary restrictions of some kind; 14% were vegetarian/vegan and 21% reported to be on a dairy/gluten free diet.

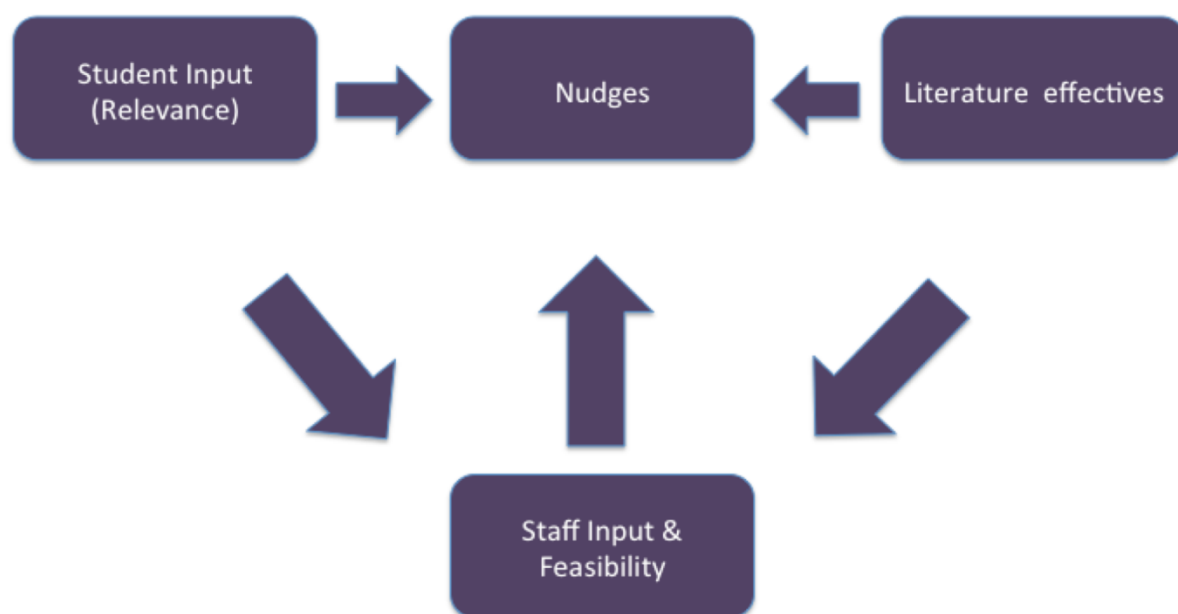
Self-reported VF consumption was self-reported by the students who answered the survey. The average intake of fruit was 2.7 servings/day (SD = 1.9) and 3.4 vegetable servings/day (SD = 3.3). When considering potatoes as a vegetable, the average of V&F intake was 6.1 servings per day (SD = 4.3) but when potatoes were excluded the average was 4.6 servings of fruits and vegetables per day.

The top factors/reasons reported by student's as influencing their vegetable purchase were "Appearance of freshness", "Healthiness", "Taste" and "Combination meals (having vegetables included in their meal)"

### **Focus group**

The results of the survey and literature review identified nudge ideas were presented to the director and dietitian of food services. Once a selection of nudges were approved, managers and staff of University of Victoria Food Services were recruited for two focus groups. Both Managers and Staff were asked to identify facilitators and barriers to implementation of a selection of NUDGES (they could also generate their own ideas) and prioritize the NUDGE strategies (they each could identify their three top choices based on feasibility and understanding of student purchasing patterns).

The Food Services Director, managers and dietitian (n=15) considered 21 nudge ideas, 13 of which were considered feasible according to the limitations of the facility (Table 2). The interventions were judged to be easy to apply, having minimal impact on the workflow and low cost. These 13 nudges ideas were then presented to the staff (n=8) focus group whereby 8 were selected as feasible. Finally the Director reviewed the final selection and approved two.



*Figure 1.* Framework guiding the three-steps taken to identify feasible, relevant and efficiency of proposed Nudge interventions.

Based on the formative work, the nudge involved altering the properties of the food by enhancing “freshness” and “appearance” of the vegetables (priming) served with meals. This was implemented by adding an option of fresh vegetables to the existing cooked vegetable option in combination with an environmental cue (salience) in the form of a small poster displayed to highlight the addition of the fresh vegetable option.

The location selected to test the nudges was the hot table, where students typically purchase cooked meals (excluding fried foods like burgers and French fries which were served elsewhere). The hot table meal is normally composed of 2 entrées options costing \$5.95 CAD\$/serving, two to three options of side dishes costing \$2CAD/portion and cooked vegetables are typically one of the side dishes. The hot table has the same basic composition for both lunch and dinner, but the food offered for the two meals differs.

During busy lunch times, a second section of the hot table was set to meet the demand. The addition of the fresh vegetable was placed either as the last option of the first section or in-between the first and second section. Placement decisions were pragmatic (based on how the hot table was oriented and functioned, e.g. fresh vegetables couldn’t be placed over the steaming units) and made by staff. The signage was placed at the eye-level of the students on the top of the hot table counter (Figure 2, 3 and 4).



*Figure 2.* Signs utilized during the nudge intervention at a university cafeteria setting.



*Figure 3.* First section of the hot table buffet with the interventions installed.



*Figure 4.* Second section of the hot table with the interventions installed.

## Data Collection

### Measurement.

The primary measure was a count of the number of students who purchased either one of the vegetables options (Crudités and cooked vegetables) and a count of the number of students that did not choose vegetables. The cafeteria had a standardized serving of two scoops for a vegetable serving. This serving size is the equivalent of a vegetable serving ( $\frac{1}{2}$  cup or 125ml) within the Canadian Food Guidelines (Health Canada, 2007).

### Procedures.

Research assistants observed vegetable purchases during both the lunch and dinner time periods (2 hours per period = 4h/day). The primary researcher conducted 80% of observations and other occasions were conducted by a trained research assistant. After piloting the procedure

and/or training, the researcher stood in a junction area where the hot table and serving activities were fully visible (2.5 m distance) and the students had to walk by the observer on the way to the cash register. Every time that the staff served the vegetables, it was counted and considered as one serving and recorded on the tracking sheet (Appendix B). Every time a student went to the hot table and didn't receive a serving of vegetables they were counted. To avoid inconsistency research assistants spent one 2 hour orientation day (each assistant was trained individually by the lead researcher). There were no identified issues with the counting procedures during the orientation day and therefore assistants were scheduled for identified times.

### **Data Analysis**

To avoid overestimation of vegetable purchases based on cafeteria daily attendance, the proportion of vegetables purchased was calculated for each meal daily and then plotted. Visual inspection is an accepted method of analysis in single case designs, especially where ascending and descending trends are observed between phases, making traditional repeated measures analysis impossible (Kazdin, 1982). Plots were generated for the overall sample and for females and males separately to support visual inspection. To further explore the data, two visual inspection strategies were implemented. First, the plots of the daily proportions during each phase were superimposed with a line representing the means for the phases. Second, the trend lines for each phase were calculated and superimposed onto the data plots to allow for trend analysis.

Fisch (2001) recommends further procedures to enhance the results found with visual inspection. As a result, the analytical approach utilized by Vandermeer, Beamish, Milford, & Lang (2015) was used. Specifically, descriptive statistics were generated including means, means proportion, standard deviations, median, range and variance. These allowed assessment of

variability, latency and overlap between phases. A key proposed variability measurement was the amount of data overlap shown as the variable percentage of nonoverlapping data (PND) (Rilley-Tilman & Burns, 2009). This measure can be used in single-case research (Scrugs, Mastropieri & Casto, 1987). Nonoverlapping data refers to the points during baseline that did not reach any or some of the points during the intervention phase (Kazdin, 1982). According to Scrugs & Matropieri (2010), if the PND is higher than 90%, it is considered a very effective intervention, 70 – 90% is considered effective, and 50 – 70% is considered questionable. Anything below 50% is considered ineffective.

The Wilcoxon Signed Ranks test was then used to determine if the proportions differed significantly across the phases. The WSRT can be used to evaluate a baseline and an intervention phase (A-B) when a single measure is used to draw the baseline/intervention response (Fisch, 2001). All the calculations were made using IBM SPSS 23 and Microsoft Excel 2016 software products.

## Chapter 4: Results

### intervention Efficacy

The purpose of this study was to explore the efficacy of a combination of an implicit/priming nudge (increasing the variety of vegetable at the hot table in an university cafeteria setting) and an explicit/salience nudge (placing signage to highlight the addition of the fresh vegetables) and their impact on the purchase of vegetables within an University cafeteria. This chapter presents the research results.

### Descriptive Analysis

Descriptive results, which support data interpretation for the overall sample and females and males, are shown in Table 1 and displayed visually in Figure 2.

Table 2. *Descriptive statistics across the four phases overall and divided by sex.*

	<b>Median</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Range</b>	<b>Variance</b>
<b><i>Overall</i></b>					
baseline	26.32	25.81	3.38	19.86 – 30.8	11.42
intervention	28.89	26.51	4.17	19.56 – 32.96	14.72
re-baseline	27.01	26.28	2.63	21.57 – 29.71	9.55
Re- intervention	26.74	26.13	3.77	18.77 – 30.45	13.63

***Female***

baseline	26.1	25.3	3.78	18.47 – 31.56	14.3
intervention	28.16	28.05	3.7	21.92 – 34.12	13.69
re-baseline	25.4	25.33	4.4	16.81 – 31.15	19.34
re-intervention	27.9	26.65	4.25	17.29 – 31.53	18.08

***Male***

baseline	26.1	26.24	3.6	20.73 – 32.52	12.97
intervention	26.45	26.8	4.02	17.91 – 32.14	16.18
re-baseline	25.82	26.4	2.81	20.93 – 29.76	7.9
re-intervention	25.68	26.4	3.68	19.86 – 30.55	13.54

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**Visual Inspection**

The visual inspection of the means in Figures 2, 3 and 4 showed that introduction of the intervention (B1), withdrawal(A2) and reinstatement of the intervention (B2) did not have an effect on the mean proportion of vegetables purchased between phases for the overall sample, nor for the females and males seperately.

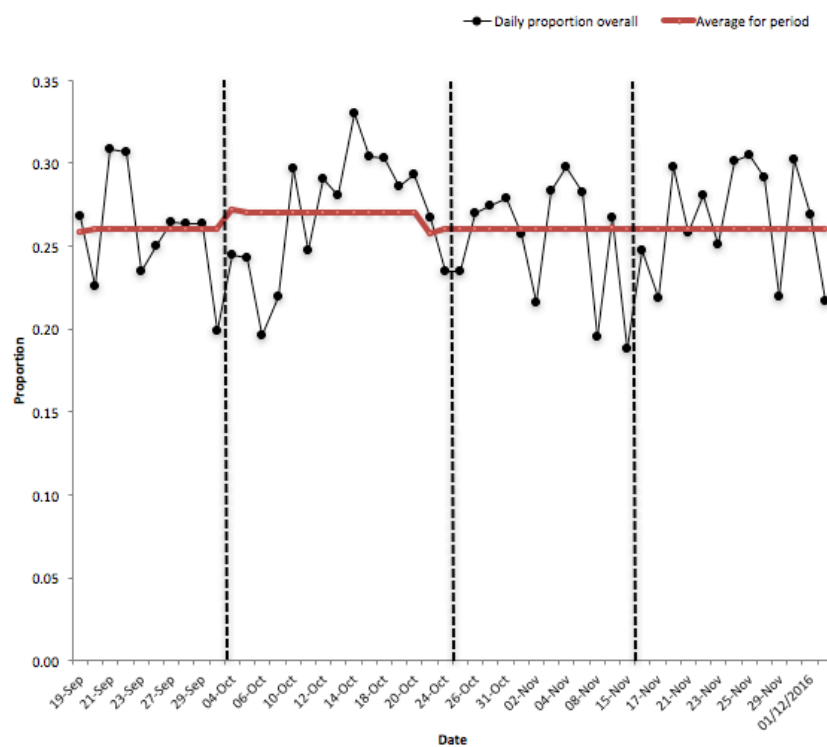


Figure 5. Daily vegetable purchase proportion and means per period in overall sample.

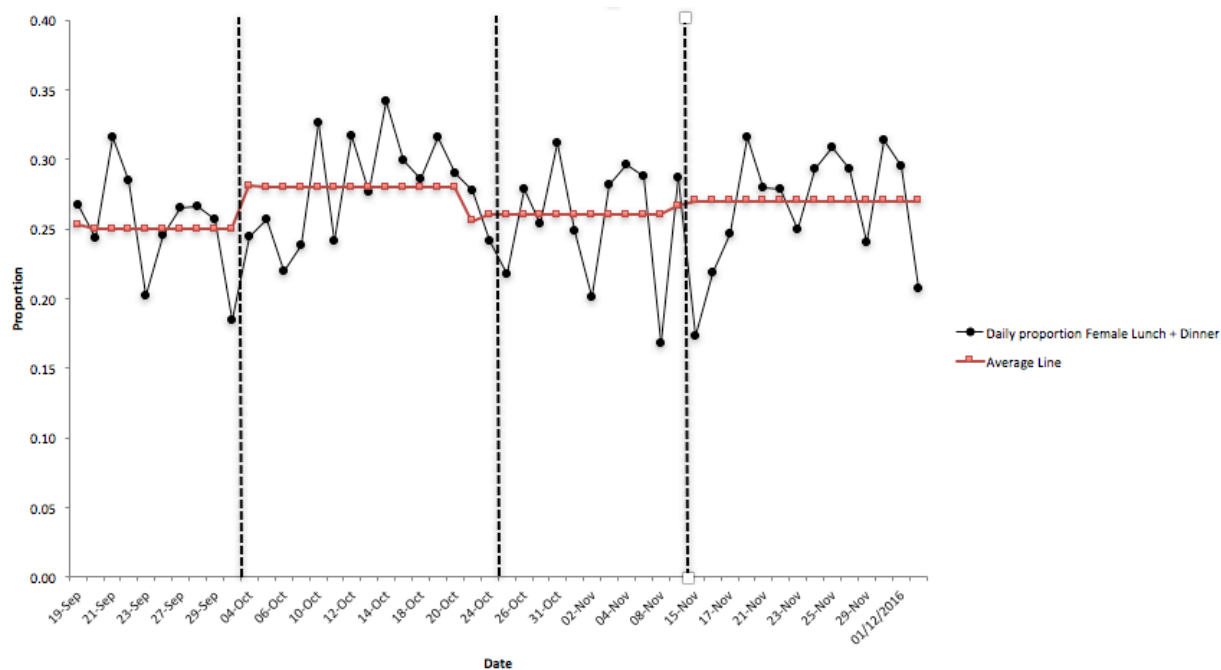


Figure 6. Mean proportion of vegetables purchased by young-adult females during lunch and dinner in a university cafeteria.

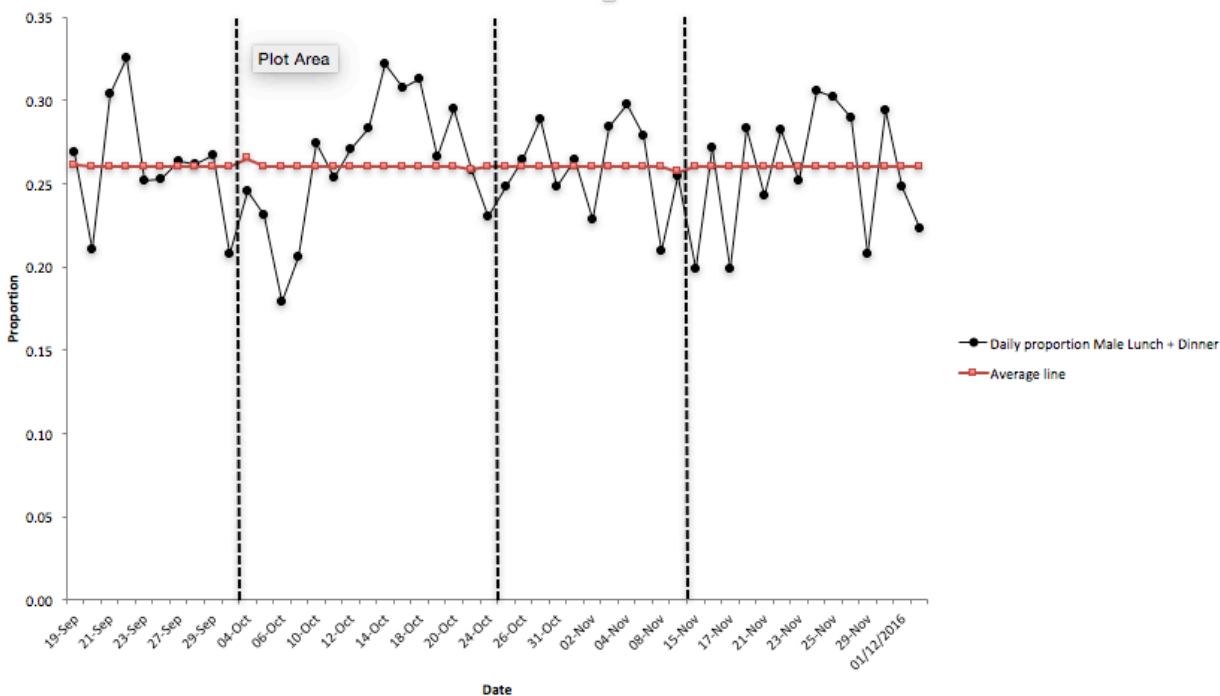


Figure 7. Mean proportion of vegetables purchased by young-adult males during lunch and dinner in a university cafeteria.

The results of the trend analysis are shown in Figures 5, 6 and 7. As demonstrated by visual inspection and depicted in these figures, there were changes in trend lines during the first intervention period compared to baseline and withdrawal phases; overall and for females and males separately. During the intervention phases (B), the trend line for the purchase of fresh and cooked vegetables was positive, different from the descending trend during baseline, and this reversed during withdrawal. These trends appeared to happen for both male and female, but the positive trend in the female sample was more pronounced when compared visually to the male sample.

Although the first A-B phase showed changes in the trend, the visual trend differences between the second A-B phase were not marked and thus control over the outcome variable was not fully demonstrated visually. Other factors outside of the intervention components (such as available funds on their meal plan, inter-site competition, academic calendar, pricing) could be contributing to this first ascending trend (Rilley-Tilman & Burns, 2009).

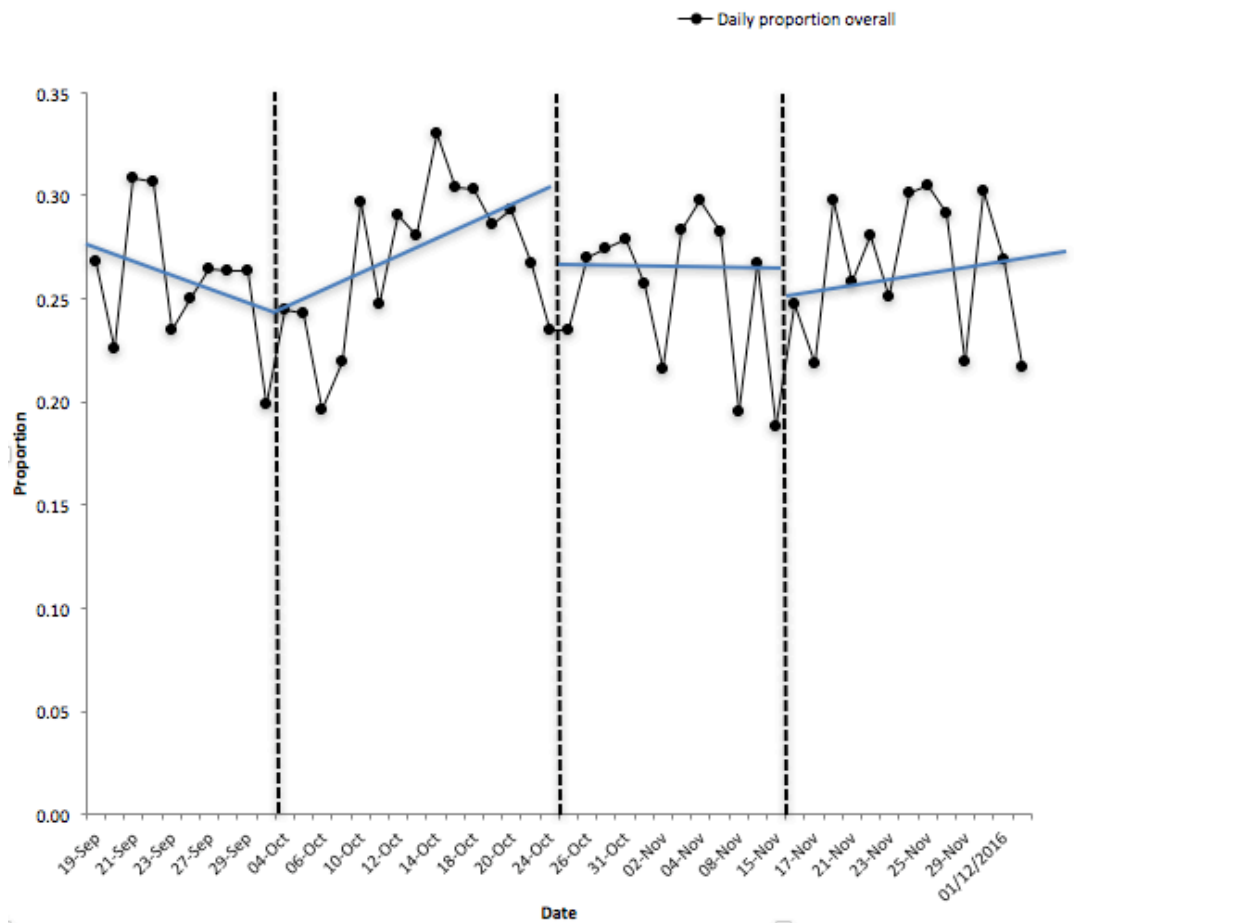


Figure 8. Proportion of vegetables purchase and trend lines across all periods for overall young adults in a university cafeteria.

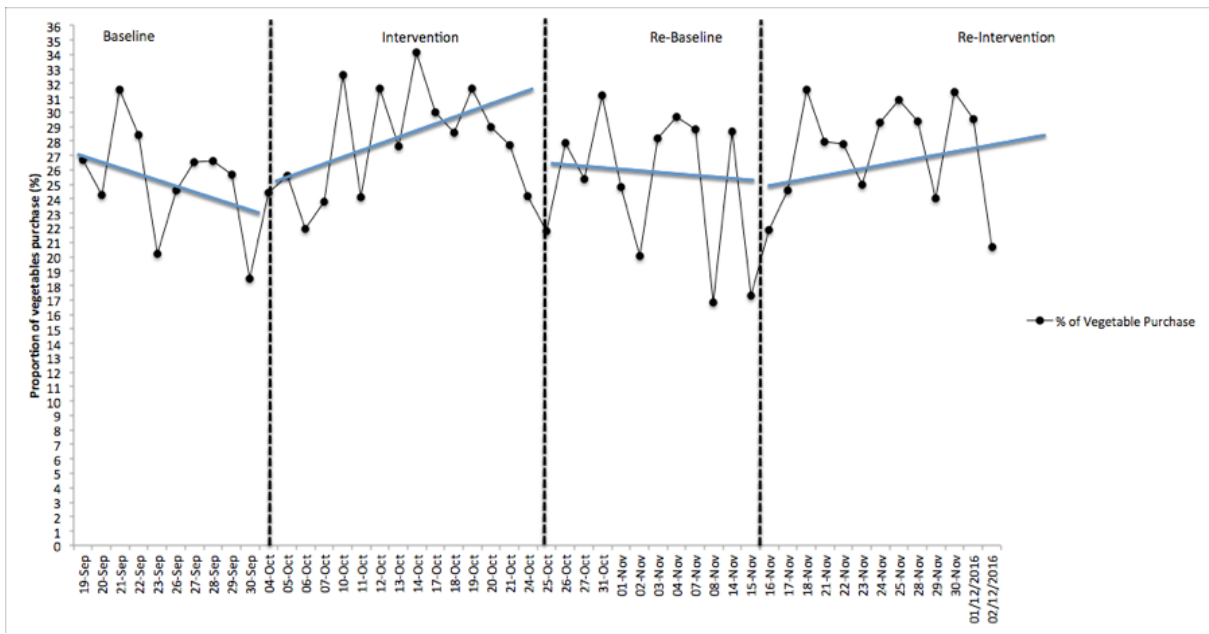


Figure 9. Proportion of vegetables purchase and trend lines across all periods for female young adults in a university cafeteria.

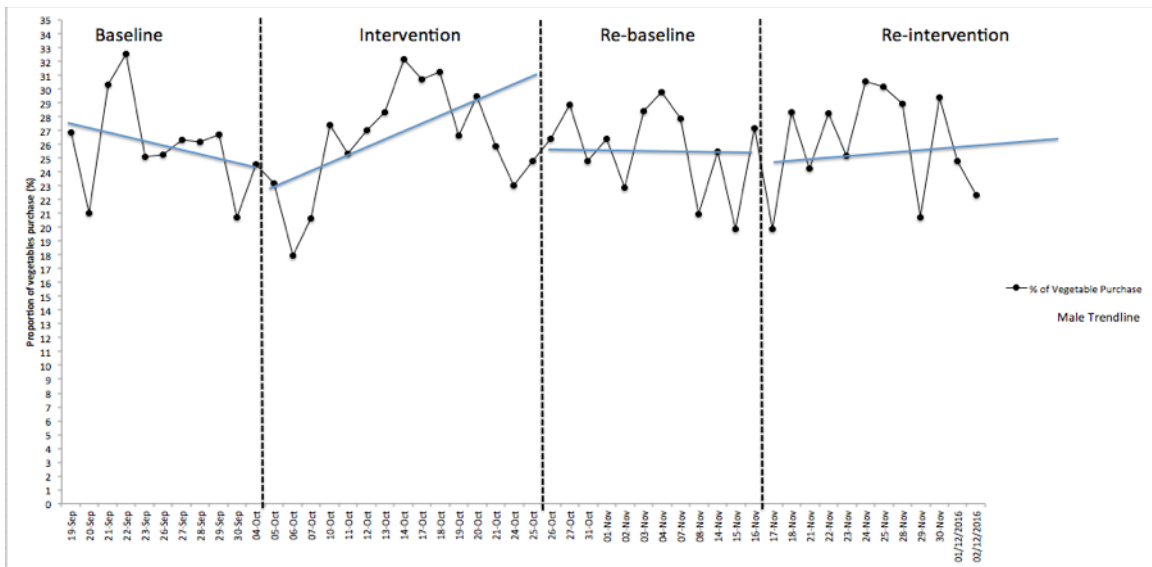


Figure 10. Proportion of vegetables purchase and trend lines across all periods for male young adults in a university cafeteria.

### **Further analyses: Variability, Overlap and Latency**

Variability is related to the amount of range of the sample (Rilley-Tilman & Burns, 2009). Table 2 and Figures 2-4 show high variability in the overall sample and by sex visually and in terms of standard deviations and range.

Another variability measurement was the amount of data overlap shown as the variable percentage of non-overlapping data (PND) (Rilley-Tilman & Burns, 2009). According to Scrugs & Matropieri (2010), if the PND is higher than 90% it is considered a very effective intervention, 70 – 90% is considered effective and 50 – 70% is considered questionable. Anything below 50% are ineffective. Overall, between the first baseline and intervention phase the PND was 7.7% for the re-baseline and re-intervention it was 0% (all data overlapped). For males only the first baseline and intervention phase had 0% non-overlapping data. For both males and females the period between re-baseline and re-intervention there was 13.33% PND and the most substantive amount of non-overlapping data was during the first baseline-intervention phase for females only; equalling 30% PND.

The latency of change refers to how immediate the levels changed after the introduction of the intervention (Rilley-Tilman & Burns, 2009). In this case, the variability in the data made judging latency of intervention challenging as shown in Figures 2-4.

The final analysis made was the Wilcoxon signed-rank test (WSRT). The WSRT showed that the addition of the nudges for 10 weeks did not elicit a statistically significant change in the ranking of the proportion of vegetables purchased from baseline to intervention, intervention to re-baseline, and re-baseline to re-intervention ( $Z = -.459$ ,  $p = 0.646$ ;  $Z = -.561$ ,  $p = 0.575$ ;  $Z = -.051$ ,  $p = 0.959$ ).

Table 3. *Analysis of the Wilcoxon Signed-Rank test results across 3 phases.*

Condition	Baseline-intervention	Intervention-re- baseline	Re-baseline-re- intervention
Overall	$Z = -0.459, p = 0.646$	$Z = -0.561, p = 0.575$	$Z = -0.051, p = 0.959$
Female	$Z = -0.968, p = 0.333$	$Z = -0.746, p = 0.445$	$Z = -0.051, p = 0.959$
Male	$Z = -0.255, p = 0.799$	$Z = -0.153, p = 0.878$	$Z = -0.051, p = 0.959$

## Discussion

There is still much that it is unknown in the behavioral economics and choice architecture field and this study extends the evidence base on nudge-based interventions; adding to a limited number of nudges trials delivered in the University setting and emphasizing vegetables. Modifying environments to highlight or cue a specific behavior has been highlighted as an effective way to alter behavior favoring positive health outcomes, but evidence showing the impact of nudges alone is weak (Marteau et al., 2011). This study adds to the literature on ‘real world’ nudges by testing the impact of feasible evidence-based nudges (priming and salience) on the vegetable purchasing patterns of young adults enrolled in University.

The multiple analyses conducted in this study failed to support the presence of an intervention effect for the priming + salience nudge. Although visual inspection showed changes in the direction of trends with each presentation and removal of the intervention, this pattern appeared to weaken in the second phases. Visual inspection also showed high variability in the data, which was confirmed by descriptive measures of variability (standard deviation and range) and by an analysis of overlapping data. There was substantial overlap and even complete overlap between some phases. The percentages of non-overlapping data in this study would suggest that the intervention was ineffective based on Scrugs and Matropieri’s (2010) guidelines. Variability (or lack of stability) during the baseline period challenges the use of the A-B-A-B design and visual inspection (Kazdin, 1982). The high variability in proportions day-to-day made it impossible to determine if there was any latency effect and the Wilcoxon signed-rank test showed that the nudge interventions did not elicit a statistically significant difference in the ranks for proportion of vegetables sales between phases. These results, although counter to the hypothesis generated from the literature, are not out of step with the literature.

Friis et al (2017) tested the effects of three nudges, priming, a healthy default and perceived variety, in a lab setting buffet dinner. Only the 'healthy default' nudge (salad in 200g jars versus the salad tray in the buffet) resulted in an increase in vegetable intake. The priming condition (Making the environment greener) and perceived variety (different display of salad on the buffet) promoted a reduction in caloric intake but further examination showed that this was due to a lower intake of red meat, and there was no increase in vegetable consumption (Friis et al, 2017).

A pre-post experimental study aimed to increase the provision of healthy products (low-fat, fruits and vegetables) to increase their purchase in a worksite cafeteria showed that, despite the addition of the nudge, the consumption of vegetables decreased by 4%. In the same study, when the products were labeled, there was even a greater decrease ( 8% ) in the purchase of vegetables (Steenhuis et al., 2014). Finkelstein and colleagues (2011) compared a calorie content on purchased meals nudge in a fast-food restaurant in Washington State after a calorie labelling policy was enacted. The labelling resulted in no difference in the purchasing behavior of customers when compared to customers in non-policy county restaurants (Finkelstein et al., 2011). Another cross-sectional study that looked into calorie labels in fast-food chain restaurants had a similar outcome, with an observed overall change of 18 kcal per/meal (Dumanovsky et al., 2011).

In this real world setting experiment, the intervention seemed to visibly lose efficacy over time, with minimal changes in trends in the second phase compared to during the first phase. The nudges might have lost their impact due to students' familiarity with the addition of the fresh vegetables, lack of variety in the fresh vegetable offering and/or the placement of the signage. In fact, Sunstein (2016) suggested that when people are exposed to the same signage over time, it

may lose its efficacy through reductions in salience or meaningfulness. In a future intervention, refreshing the nudge by using different images and other fresh vegetables, may increase the sales of vegetables.

Other factors were elucidated by cafeteria staff anecdotally and included the tightening money situation of students over the term. Budgetary concerns may have resulted in the purchase of less expensive but satiating foods over less satiating vegetables which were \$2.00/serving. Pollard, Kirk & Cade (2002) suggested that price is the main factor that affected choice in lower-socioeconomic groups, like students. In the case of this study the portion served at the hot table might have been perceived as less valuable when compared to the salad bar, that it is operated per kilogram. Stressful events such as exams, finals and end of the term may have also influenced students' choice and binge eating (Freeman & Gil, 2004; Sulkowski, Dempsey & Dempsey, 2011),.

Additionally pragmatic considerations (e.g. distance from the steam unit) led cafeteria staff to place the vegetables trays at the end of the food offerings rather than the beginning. This may have influenced the results as previous research has shown that food positioning affects food choice (Bucher et al., 2016). Usually, items placed at eye-level, first in line or within arms reach are more likely to be picked rather than foods placed in the middle/end of the line. For instance, Wansink et al., showed that altering food positioning in a buffet influenced choice; where the first items in a buffet line were most likely to be picked (2013). For packaged food, choices differed when healthy snacks bars were placed in the middle of a tray vs. on the sides of the tray where they were chosen more frequently (Keller & Bucher, 2014). Although Missbach & König (2016) conducted a lab-based experiment that found the opposite, positioning in the

middle vs. sides in a laboratory experiment did not affect snack bar preferences in either a low or high depletion condition.

Further issues that were encountered in this real-world setting were things like menu composition. Specifically, the menu composition was two entrees, usually an animal protein, two side dishes, one option of cooked vegetables, and during the intervention period, the crudités. Often the colour of the entrée was similar to the vegetable offering. Also, each item was purchased individually so the price was \$6.95 for each entrée + \$2 for each option of side dishes and vegetable. This may have jeopardized the purchase of healthy food, since overall, when people have low cognitive resources to decide what the best option is they have a tendency to purchase the most calorically dense food (Tal et al., 2016). Furthermore, purchasing each item separately has been shown to decrease the purchase of vegetables, while a combination of products with a fixed single price (such as an entrée + vegetable) increases the purchase of vegetables (Carroll, Samek and Zepeda, 2016). This can be explained by the use of heuristics; humans tend to evaluate the most important item, in this case the entrée, and then the “less” important item, the side dish (in this case, vegetables).

Other influences may have come into play as well. For instance, the staff were not blind to the research and this seemed to alter the behavior of some. The research team observed some staff either encouraging students to purchase vegetables or discouraging the students saying that they could purchase something fresher and cheaper at the salad bar.

More research is needed in this field and specifically in this population, where there is low VF consumption. Effective interventions that target VF consumption should be supported to try to mitigate this decrease and establish healthy eating habits throughout the lifespan.

## **Limitations**

The findings of this study need to be viewed in the context of a number of limitations. One of the main limitations was that it was not possible to observe whether students accessed V&F from other areas of the cafeteria. In the same cafeteria there was also a salad buffet and a grill, so the students could opt for the hot table where the interventions were happening or either of the two other options. Pragmatic limitations made it impossible to evaluate the servings of vegetables obtained elsewhere. It could be that the nudge primed students to pick up a salad. On the other hand the nudge was at the hot table and the outcome was a direct measure of choice at the hot table.

One limitation was the measure used, number of vegetable servings over total serves. This did not represent an accurate serving nor did it represent consumption. The staff had a standard serving size based on cafeteria training but they rotated areas and servings differed according to what was being served and the utensil being utilized (e.g. tongs vs. spoon). Observation was based on a standard plate and open to under or over estimation based on how the vegetable was served (e.g. stackable, spaced out)

Many of the limitations of this study were related to the practical limitations of the cafeteria context and associated measurement issues. First, there was no comparison venue to act as a usual practice control for the intervention, thus a single case A-B-A-B design was chosen. This research design is quasi-experimental and open to threats to internal and external validity such as history (events happening within the school term), testing (same intervention during the trial periods) and reactive effects of experimental arrangements (Real-world research does not produce the same results as controlled environments) (Thomas, Nelson & Silverman, 2015). Stability in the baseline was never attained and is important to establishing control in A-B-A-B

designs. Furthermore the measurement periods were constrained by term, which affected the number of data points available for measurement. As a strength, several approaches to analysis were adopted to assess whether control over the outcome could be established.

Second, within the periods, events like thanksgiving, mid-term and final exam periods and the funds remaining on the students' meal plans could affect purchasing patterns. The re-intervention period may have lost power, because the students were exposed to the same nudges twice during the intervention phases. Third, although students were blinded to the study purpose they weren't blind to the intervention conditions if they noticed the signage and the research team was visible. Staff and the research team were also not blind to the intervention condition.

Finally, the formative work to develop the nudge intervention determined that the research had to have minimal impact on staff workflow. Thus the intervention strategies were inserted into existing cafeteria measures and processes and may not have been strong enough (e.g. the fresh vegetable tray was in a tray inserted behind the main meal and thus a salience nudge was added).

### **Implications of the study**

This study contributes to the current research field of behavioral economics and nudge theory. Two nudge interventions were implemented in a real-world setting in a field that has not been well explored to date. Many lessons about those real world settings and measurement limitations were highlighted for future researchers. Although the results could not definitively rule out confounding factors and conclusions were limited by high variability, there were modest apparent changes in the trends between early phases. These changes suggest that further work using longer intervention and measurement time periods and a stronger set of nudges may be worthwhile. The feasibility of nudges in real world setting needs to be further explored.

Public health interventions targeting university student health behaviors are needed. The young adult age group is a challenging group to intervene with due to issues with rising to their attention. Nudges offer a viable way forward; requiring minimal resources nor educational or behavioral intervention. The relative power of the nudges over other powerful environmental conditions needs to be considered. It appears that combining nudges may be important to increase their salience and that control over their placement is crucial. Future research involving university students and cafeteria sites should ensure first position on the hot table. In addition to that, the placement of signage needs to be considered carefully to ensure it is eye level and in view when students are looking forward and down toward the food.

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## Appendix

### Appendix A

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Schwartz et al., 2012	Chinese fast-food restaurant	Customers	Verbal invitation to downsize the portion	Sales and number of costumers	CS 2 days of intervention	Increase downsize portion selection by 33% (CI 25.2% to 40.7%) decrease total meal calories purchased by 100 calories (CI 99.9%to 100.1%).
Dayan & Bar-Hillel 2011	Coffee shop Students and young professional	951	Menu items position & order of beverage: placed at the beginning or the end of the list vs. placed in the center of the list	Times that the products was ordered	Crossover experiment	Items placed at the beginning or the end of the list of their category options were up to twice as popular as when they were placed in the center of the list in 59% (P< 0.01)
Wansink & Hanks, 2013	Conference breakfast	124 conference attendees	Positioning healthy food first and in sequent order on buffet line	Items selected	RCT Attendees tallied in two separate seven-item buffet lines. The food was displaced in reverse order (Healthier to less healthier)	Healthy food was selected more when offered first (“first foods most” principle) In total the first three foods a person encountered in the buffet comprised 65.7% of their total plate. Serving the less healthy foods first led diners to take 31% more total food items (p,0.001).
Hansen et al, 2016	Conference for business leaders in Denmark	189 participants – control buffet 202 – intervention Buffet	Control Table: Brownie and whole apple intervention: Brownie cut in half and apple into four pieces	Remaining pieces of brownie and apple was counted in the end	20-minute break between two sessions at the conference; Assistants counted each visit to the buffet as well as total amount of visitors.	*30% reduction on the consumption of brownie on the intervention table; *84% of increase in the apple consumption on the intervention table.

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Bucher et al, 2011	Fake Food Buffet	53 men and 45 women	Increased vegetable variety	*Food questionnaire (hunger, food-frequency questions on offered food items and questions on food preferences and the authenticity of the replica foods) *Total energy from vegetables *BMI *Daily energy requirements	*Randomized experiment *Buffet w/ Pasta and chicken + carrots (A) or beans (B) or carrots and beans(AB) Weight of the food component of the meal	Increased caloric content derived from vegetables when both were offered ( $F^{(2,95)} = 23.776$ , $P = 0.000$ , $n^2 = 0.334$ ) – 141kj vs 104 and 84kj Relative energy of the meal derived from vegetables (10.9%) increased significantly compared with the one-vegetable condition (8% and 6.1%).
Vermeer, Alting, Steenhius & Seidell, 2009 (Study 1)	Fast-food restaurant	150 visitors	Proportional pricing vs. Value size pricing	Questionnaires with photos of different food sizes and drinks w/ the corresponding prices. The food sizes and prices differed depending the study condition *Hunger and thirsty – Visual Analogue Scale (VAS) *Dietary restraint and external disinhibition scales.	*Experimental Design *Proportional pricing (Experimental vs. Value size pricing (Control) for Soft drinks and Chicken nuggets	<b>Soft drink size choices:</b> *Overweight/obese, proportional pricing reduced the likelihood to choose the largest size (OR = 0.07, $P = 0.04$ , CI 0.01–0.83) <b>Chicken nuggets size choices</b> Men seemed more likely to choose the reference size when confronted with proportional pricing (OR = 3.35, $P = 0.06$ , CI 0.96–11.73). Women, was found with proportional pricing decreasing the likelihood to choose the reference size (OR = 0.41, $P = 0.04$ , CI 0.18–0.94) Overweight/obese, there was a trend of proportional pricing increasing the likelihood to choose the reference size

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
						(OR = 4.31, P = 0.07, CI 0.88–21.12).
Wisdom et al., 2010	Fast-food sandwich restaurant	638 diners; 18–86 years (mean 29 years); 61% male; 52% white; BMI 16–44 (mean 25); 41% overweight; 21% dieting	Calorie content on sandwiches, side dishes and drinks Daily calorie recommendation on sandwiches, side dishes and drinks Combined Altered placement of menu items – half of sandwiches on a ‘featured’ menu and ½ of sandwich items listed on a different menu (in envelope vs. next	Number of times sandwich selected (n) Total calories purchased (cal)	RCT 1 serving duration  2 servings	Decrease on total calories ordered  Decrease on total calories ordered  Healthy sandwiches featured and less healthy in envelope 44% more likely to order low-calorie// (CI 38.2–49.8%) Healthy sandwiches featured and less healthy on next page, 35% more likely to order low-calorie (CI 29.7–40.3%) BUT "calories purchased from other menu items/Less healthy sandwiches featured and healthy in envelope 44% less likely to order low-calorie// (CI 38.2–49.8%) Less sandwiches featured and healthy on next page
Levy et al., 2012	Hospital cafeteria	4642 hospital costumers / employees	Traffic light labels on all food and beverage	Purchases over time	CC 6 months 3 months of intervention	Increase of green purchases by 6.6%/ (CI 5.2– 7.9%) decrease red purchases by 11.2%/ (CI - 13.6 % to -8.9%) Increase green beverages by 5.6%/ (CI 3.5– 8.1%) decrease red beverages by 23.8%/ (CI -28.1% to -19.6%).
Sonnenberg et al., (2013)	Hospital Cafeteria		Traffic light food labeling	Survey Cash register data	One week intervention	Respondents identified health/ nutrition as an important factor in their

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
					Food and beverages served in the cafeteria were categorized into four groups (food entrée, food item, food condiment, or beverage). Items labelled in red, yellow, and green.	purchase (61% vs. 46%, $p = 0.004$ ) Respondents who noticed labels during the intervention and reported that labels influenced their purchases were more likely to purchase healthier items than respondents who did not notice labels.
Thorndike et al., 2012	Hospital Cafeteria	N/A	Food replacement: Healthy food and beverage placed at eye level and more water introduced *Traffic lights	Cash register data – programmed to identify the color label Change in sales of cold beverages	Phase 1: 3 month color coded labelling intervention Phase 2: Healthy food and beverage placed at eye level	Decrease green items by 0.5% (CI 0.0–1.7%) Increase yellow items by 3.9% (CI 2.7–5.1%) Decrease red items by 4.9% (CI 3.7–6.1%) Increase green beverages by 4.1% (CI 2.9– 5.3%) Increase yellow beverages by 1.1% (CI 0.0– 2.3%) Decrease red beverage by 11.4% (CI 10.2– 12.6%) Increase bottled water by 25.8% (CI 24.5– 27.0%) Decrease diet soda by 0.8% (CI 0.0–2.0%) decrease regular soda by 5.9%(CI 4.7-7.1%)
Thorndike et al., 2014	Hospital Cafeteria	Customers and 2285 hospital employees	Rearrangement of health items to become more accessible *Traffic lights	Sales data Proportion of items purchased by each employee	Longitudinal pre–post cohort follow-up study 3 month baseline 24 months follow-up	The proportion of sales of red items decreased from 24% at baseline to 20% at 24 months ( $p<0.001$ ), and green sales increased from 41% to 46% ( $p<0.001$ ). Red beverages decreased from 26% of beverage sales at baseline to 17% at 24 months ( $p<0.001$ ); green beverages increased from 52% to 60% ( $p<0.001$ ). Similar patterns were observed for the cohort of employees, with the largest change for red

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
						beverages (23%–14%, $p < 0.001$ ).
Kleef, Otten & van Trijp, 2012 (Study 2)	Hospital canteen Field experiment: Checkout shelf at a canteen hospital.	No direct sample for the intervention 92 hospital employees post-experiment survey	*Shelf arrangement: healthy snacks on top vs. bottom shelves) *Assortment structure: 75% healthy snacks in assortment vs. 25%	*Sales data (total number of snacks sold, the number of individual snack products sold and the number of visitors for that day.) *	*4 wk period *Each week one condition was applied *Shelf installed one week prior the conditions * Post-intervention survey	*No significant effects of assortment structure ( $p = 0.68$ ), shelf arrangement ( $p = 0.10$ ) or interaction ( $p = 0.26$ ) on total snack sales. *Significant main effect of assortment structure on healthy snacks ( $p = 0.01$ ) *Healthy snacks sold more when 75% of snacks were healthy.
Grabenhorst et al., 2013	Laboratory	13 participants, BMI 22-25	Labels describing taste or health benefits on pictures of pizza, snack bars, French fries, chicken breast and fruits	Number of times items selected	CS 1 day of intervention	Taste label increased selection. Health benefits label decreased less healthy foods ( $p = 0.03$ )
Kongsbak et al., 2016	Laboratory FoodScap	65 male university students aged between 19 and 29. Control group – 32 intervention group – 33	Control Buffet (meat, bread, pasta and a mixed salad) intervention Buffet (Same as control buffet but: (1) placing the V&F components at the beginning of the buffet and (2) separating the eight V&F of the mixed salad into	*Pre and post questionnaire * Video recording and visual data-coding tool *Intelligent Buffet (scale embedded in the buffet)	*Single day lunch meal experiment *Ad libitum buffet and return to the buffet an unlimited number of times	*Higher consumption of V&F in the intervention group ( $p = 0.005$ ); *Lower consumption of pasta in the intervention group ( $p = 0.003$ ); *No difference for meatball and bread; *Lower caloric intake by intervention group ( $P = 0.010$ ) even though the amount in grams had no difference between groups ( $p = 0.326$ )

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Stampfli & Brunner, 2016	Laboratory Sensory laboratory for a chip tasting	128 panelists	individual bowls. Giacometti's sculpture Piazza as screensaver	*Consumption volume (Chips waste) *Flavor and willingness to buy the chips (7-point Likert scale) *Remembering the screensaver Cognitive load: feeling of effort regarding (7-point Likert scale)	2 (cue vs. no cue) 2 (high vs. low cognitive load) between subjects design *Cue condition: Screensavers with thin, human-like sculptures by the artist Alberto Giacometti *Cognitive condition: memorize 10-digit number within 30s or 2-digit within 30sec	*Giacometti screensaver reduced the amount of chips ate (p=0.031) * The Giacometti effect occurred independently of the cognitive load
Kleef, Otten & van Trijp, 2012 (Study 1)	Laboratory experiment	158 undergrad students	*Shelf arrangement: healthy snacks on top vs. bottom shelves) *Assortment structure: 75% healthy snacks in assortment vs. 25%	*Questionnaire *Perceived freedom of product choice *	*Between-subject design *Participants assigned to one of the four conditions *Students asked to imagine that they were at the	*Higher probability of healthy snack choice when 75% of the assortment consisted of healthy snacks compared to conditions with 25% healthy snack assortments

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Olstad et al, 2014	Outdoor Community Pool	Full Sample Sub-sample (Purchases directly observed)	1) Signage w/ descriptive menu labels (N1) 2) Taste testing (N2) 3) 30% discount on healthy items (E1)	* Sales in the full sample of patrons * Revenues and gross profits * Caloric content * Sub-sample (Purchase, age estimative, sex and weight estimative)	university canteen around 4 o'clock in the afternoon. Which snack they would choose. *24 snacks available *Mixed Methods *Pre intervention (8days) *N1 (8 days each intervention) *N1 + N2 (8 days) *N1 + N2 + E1 (8 days) *Post intervention (8 days)	*Unhealthy profits > healthy profits ( $p < 0.0001$ ); * No difference between healthy and unhealthy items sales on the full sample; * Increase sales on healthy food sales ( $P < 0.01$ ) on the subsample when N1 + N2 added; * Increase was maintained when E1 added and during post-intervention; *Adults alone purchased more healthy items than when child were present ( $P < 0.001$ ).
Olstad et al, 2015	Recreation Centre	322 patrons completed the survey and 2101 transactions were registered	Traffic label lights to promote healthier food purchase	Survey Cash register data	*One week baseline and one week intervention *No change on the prices	*Significant main effect of treatment period ( $p < 0.01$ ), with an overall increase in sales of green (52.2% to 55.5%) and a reduction in sales of red (30.4% to 27.2%). *No decrease on the profits
Adams et al., 2005	School canteen	288 students in elementary school	Pre-portioned vs. self-service of V&F	*Food consumption *Food waste	Cross-sectional 4 elementary school 1 day in each school	The difference between average served portion size and consumption using a salad bar versus pre-portioned vegetables is not statistically significant. Greater variety was related to a higher consumption ( $F = 2.83, p \leq 0.05$ ).

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Olsen et al., 2012	School classroom	138 students from 9 to 12 years,	Different shapes and sizes of snack vegetables influenced liking or not.	Preference of serving style, liking of vegetables and willingness to participate in fruit and vegetable subscription	Experimental intervention	Size of vegetables did not matter ( $p = 0.95$ ), except for vegetables served whole or as chunks. The small-sized whole vegetables were liked less than the ordinary-sized chunks ( $p < 0.0001$ ). Slices and sticks were equally liked ( $p = 0.16$ ), and they were liked more than ordinary-sized vegetables served whole or as chunks ( $p < 0.0001$ ). Children preferred figures to slices and sticks ( $p < 0.0001$ ). The included vegetables were all liked during taste evaluations: carrot ( $81 \pm 2$ mm), cucumber ( $78 \pm 2$ mm) and red pepper ( $70 \pm 3$ mm) (mean $\pm$ SEM). Generally, children express high willingness to participate in fruit and vegetable subscription services during school.
Cohen et al., 2015	School: Elementary and Middle	14 Elementary and Middle Schools in 2 different districts (baseline) *2 Chef School *2 Chef + Smart café *4 Smart-Café *6 control schools	Chef Program (Non-nudge) Smart-Café intervention (Nudge) *Vegetable on the beginning of the Lunch line * Fruits disposed in attractive containers and at checkout *Replacement of white milk on front of chocolate milk	Consumption (Food Waste) – Identified number for trays; Weight 10 random samples of each food	*RTC * baseline (month 1) *Post implementation (Winter – month 5) *Post implementation (Month 9 – 10)	Chef Program: *3 months of exposure: <b>Odds of vegetable selection increased</b> (OR 1.75; 95% CI, 1.36 – 2.24) *7 months exposure: Odds of <b>fruit selection</b> increased Chef program (OR 3.08; 95% CI, 2.23 – 4.25;) Smart-café (OR, 1.45; 95%CI, 1.13-1.87), and chef + smart café (OR, 3.10; 95%CI, 2.26-4.25) <ul style="list-style-type: none"><li>• <b>Fruit serving</b> was only greater in Chef Program when compared to control (0.17;95%CI,0.03-0.30cups/d). Smart-café had no effect. No</li></ul>

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
						<p>effect (-0.00; 95%CI, -0.13to0.11 cups/d);</p> <ul style="list-style-type: none"> <li>• The odds of <b>vegetable selection</b> increased in the chef (OR, 2.54; 95%CI, 1.83-3.54), smart café (OR, 1.91; 95% CI, 1.46-2.50), and chef + smart café schools (OR, 7.38, 95%CI, 5.26-10.35).</li> </ul>
Dave, et al., 2015	School: Elementary school	N/A	<p>*Staff encouragement to select fruit and vegetables</p> <p>*Food labels</p> <p>*“Harvest of the Month” posters</p> <p>*School (morning announcement messages, prompts regarding cafeteria food selections),</p> <p>*Parents (school newsletter articles, parent listserve messages)</p>	# FV servings selected and the number of reimbursable meals served at each school were obtained as electronic text files.	Pilot Study	No significant differences in the number of fruits and vegetables consumed.

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Ensaff et al, 2015	School: Secondary schools canteen	2 elementary school 218,796 transactions and 980 students	Several Nudges (See Ensaff 2015 table and figure 1 on Appendix 1)	Pattern food selection notes and photographs taken during the observation visits, the canteen layout was sketched on a scale plan, to appreciate how students made their selections of different foods as they navigated the canteen.	baseline (29 weeks); intervention (six weeks); and Post-intervention (three weeks).	*Selection of designated food significantly increased during the intervention and post-intervention periods, compared to baseline (baseline, 1.4%; intervention 3.0%; post-intervention, 2.2%) $\chi^2(2) = 68.1, p < 0.001$ .  * Logistic regression modeling also revealed the independent effect of the intervention, with students 2.5 times as likely ( $p < 0.001$ ) to select the designated food items during the intervention period, compared to baseline.
Hanks et al, 2012	School: High School Cafeteria	Convenience Line for healthy items only	Each observation date was a different sample (362, 240, 262 and 220 students.)	*Food waste *Info Card (Gender, sport, lunch selected item)	Experimental Design  Control Period (8 weeks) – 2 days of observation (Consumption data)  intervention Period (8weeks) 2 days of observation (Consumption data)	*18% increase in sales on healthier food  *28% decrease of grams of less healthy food consumed.  *No changes on the consumption of healthier food  *Healthier foods consumed—in terms of total grams consumed—increased from 33% of total grams per student to 36.6% of total grams per student ( $p = 0.05$ )

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
						* Decrease from 27.6 to 22.8% on less healthy food consumed.
Kroese, Marchiori & Ridder, 2015	Train Station	3 snack shops Subsample of 91 costumers	Food repositioning. Snack Shop 1: Unhealthy snacks at checkout (Nudge) Snack Shop 2: Healthy snacks at checkout Snack shop 3: Nudge + disclosure condition (Sign "We help you to make healthier choices")	Product Sales (Only the nudge products) Customer opinion (Survey)	*One week baseline followed by 1 week intervention	*Increase in the sales of healthy snacks on both the nudge intervention ( $p = 0.00$ ; $p = 0.02$ ), with no difference between nudge and nudge + disclosure condition; *75% of the intervention costumers didn't notice anything different *87% said that the nudge didn't affect the food choice
Bevan et al, 2013	University Cafeteria	10 students (7 males 3 females)	Foodscape mapping of fruit and vegetables	*Foodscape mapping within the university "Personal influence" and "Food operator influence"	*Qualitative study; *Preliminary study.	*Personal influence -When vegetables are integrated into a dish they are more likely to be eaten and enjoyed "if it is in the dish you eat it anyway, but as I said some of the veg here are not attractive" -Freshness of vegetables. Not fresh vegetables, only frozen. Low variety, "only beans and sweet corn" -Time restriction *Food operator influence - Food availability -Quality and display: "[need] more attractive displays of food" "Often I find cauliflower, carrots, broccoli overcooked[...]. Quality does affect your appetite" "We offer fruit but often it's left" Manager -Food combination (e.g lasagna w/ salad, instead

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
						lasagna and chips")  Nevertheless, no "nudging" can control choice made by individuals, responsibility for healthy selection must always remain personal.
Rozin et al., 2011	University cafeteria (salad bar)	157	*Making food more difficult to reach by varying its proximity by about 10 inches *Changing serving utensils (spoon vs tongs)	Food consumption: Gram per person per meal	Crossover experiment	1. Less accessible salad bar position discourages intake of salad by 8.8% ( $p > 0.01$ ) 2. Decrease in food consumption when server with a pair of tongs when compared with a spoon (16.5%, $p < 0.01$ )
Chapman & Ogden 2012 A	University canteen	500 – 569 items sold	Fruit positioning by checkout vs. away from checkout	Items purchased	Within subject Crossover design	Decrease of healthy items when they were positioned by the checkout in -26.1% ( $p < 0.05$ )
Chapman & Ogden 2012 B	University canteen	121 – 152 items sold	Removing the choice of white baguettes	Items purchased	Within subject Crossover design	Restricting the availability of white baguettes resulted in a shift in purchases towards the healthier option by 93.5%
Cioffi et al, 2015	University Dining	50 "FreshTake" Meals and snacks that had nutrition label added (spring 2008)	Nutrition Labeling	*Caloric & fat content *Sales pattern *Food categories (Low fat, low calorie, High calorie, high-fat)	*Pre-labeling (Fall 2006, Spring 2007, Fall 2007) *Post-Labeling (Spring 2008, Fall 2008, Spring 2009) *Weekly sales data, (number of units sold on the	*6.5% of decrease on caloric content after food labeling ( $P < 0.001$ ); *7.4% decrease on fat-content after food labeling ( $p < 0.001$ ); *Increase of purchase in low-fat food ( $p < 0.001$ ) and reduce on high-fat content ( $P < 0.001$ ).

Author (Year)	Environment	Sample	Nudges Applied	Measures	Design	Results
Vermeer, Alting, Steenhius & Seidell, 2009 (Study 2)	Worksite cafeteria	143 visitors	Proportional pricing vs. Value size pricing	Same as study 1	semester, the week, and the dining location where it was sold). *Experimental design *Same as study 1 *Large hot meal (500g) vs. Small hot meal (300g)	*86.2% of the participants chose the reference size; *Healthy weight, proportional pricing led to an increase of 13.5% that chose the reference size (P=0.05) *Logistic regression analysis neither showed significant main effects nor interaction effects for pricing strategies.

Appendix B

**Fresh Veggies on the Hot Table Tracking Sheet**

Evaluator: Cassandra Lane Date: Oct. 13 2016

**DAILY MENU (record main dishes and all sides here from the chalkboard)**

- Chicken Vindaloo
- BBQ beef on a bun
- Curried Rice
- Roasted Potatoes
- Vegetables (cauli, flower + spinach)
- Raw vegetables

- Time that the table applies to:
- 11:15-12:15
  - 12:15 - 1:15
  - 4:50 - 5:50
  - 5:50 - 6:50

Gender	0 servings	Fresh veg	Cooked veg	Both fresh & cooked	Salad
Male	                               				
Female	             				

