Product Bundling as a Behavioral Nudge: Investigating Consumer Fruit and Vegetable Selection using Dual-Self Theory

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Abstract

The Center for Disease Control (CDC) estimates that at least 68% of U.S. adults aged 20 and older are overweight with BMIs of 25+. A major component of this problem is the decision to habitually consume high quantities of low-nutrient, high-calorie foods (NIH, 2012). This study uses an artefactual field experiment on food choice, conducted in a large Midwestern U.S. city during fall 2015, to explore whether product bundles (consisting of primarily fruit & vegetable (F&V) items) can serve as a behavioral intervention to increase F&V selection. Also of interest was determining whether shopping under cognitive load influenced both item and bundle selection using a dual-self framework, and whether bundles need offer a price discount.

Study participants shopped a grocery display under one of six different treatments, with differences examined among the proportion of items selected from three categories: Fruit and Vegetables, Junk Food/Snacks, and Protein/Dairy/Grains. The proportions of items selected by category were also analyzed using a fractional multinomial regression model. Results uncover that product bundles need not offer a price discount in order to effectively increase F&V selection. In fact, discounted bundles were counterproductive at increasing F&Vs when shoppers were under high cognitive load. Product bundles may be preferred by consumers as a means through which to lessen the cognitive strain of the shopping process, and could serve as a potential behavioral intervention to increase retail F&V sales.

Keywords: food choice, fruit and vegetable selection, product bundling, cognitive load, artefactual field experiment, dual-self theory

JEL codes: C91, D12, I12, Q13

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INTRODUCTION

The Center for Disease Control (CDC) estimates that at least 68% of U.S. adults aged 20 and older are overweight with BMIs of 25+. A major component of this problem is the decision to habitually consume high quantities of low-nutrient, high-calorie foods and beverages (NIH, 2012). Recent research on increased fruit and vegetable (F&V) consumption has been linked to obesity prevention (Epstein et al., 2001; He et al., 2004) and the reduced risk of cardiovascular disease (Hung et al., 2004; He, Nowson, & MacGregor, 2006; He, Nowson, Lucas, & MacGregor, 2007). Unfortunately for many Americans, a gap exists between the amount of F&Vs actually consumed and the amount recommended. In the U.S., approximately 22% of adults and 38% of adolescents self-report consuming vegetables less than 1 time per day (CDC, 2013).

Contributing to poor food consumption is that consumers often shop under cognitive load; that is while mentally strained. Park et al. (1989) concluded that grocery store shoppers can often find shopping cognitively stressful, especially when required to perform in-store information search activities. Prior studies have also shown that subjecting individuals to cognitive load increases the exertion of the reasoning system, thus restricting the system's ability to regulate decision making. This can lead to a 'dual-self': where different decisions are made when cognitively impaired than when not (Fudenberg & Levine, 2006; Mukherjee, 2010). For example, Shiv and Fedorikhin (1999) found that lessening cognitive resources made individuals more likely to select an unhealthy snack option, although only two food items were employed in the study. The effect of cognitive load on food choice however seems to have conflicting results in the literature. A recent study by Deck and Jahedi (2015) also looked at snack food choice, and found

no effect for cognitive load. Ward and Mann (2000) found that cognitive load resulted in individuals on a diet consuming more calories, while Zimmerman and Shimoga (2014) concluded cognitive load influenced those watching food advertisements to select an increased number of unhealthy snack foods. While there is evidence that cognitive load may influence food choice, no study has yet to examine this topic beyond the context of a snack-food only choice set featuring limited alternatives.

In looking to alleviate the potential effects of cognitive load, previous research has also shown that consumers may prefer bundled choices over individually priced options, as bundled products both reduce search costs and effort, and require less information processing (Harris & Blair, 2006). However, cognitive load was not directly manipulated in these studies. Therefore, the research presented here focuses on whether food choice under cognitive load influences one's decision to select unhealthy versus healthy foods, using a richer product set than previous studies and bundled products. We also test whether product bundling can serve as a behavioral intervention to both lessen cognitive effort and increase the selection of healthful fruit and vegetable (F&V) items. To the knowledge of the authors, exploring whether product bundles can nudge consumers to select a greater proportion of F&Vs is a question that has yet to be explored.

Therefore, the objectives of this research were to: R1) Identify whether product bundles (consisting of primarily F&V items) can serve as a behavioral intervention to increase F&V selection, R2) Determine whether shopping under cognitive load influences the types of food items selected, using an expanded product set, and R3) Uncover whether cognitive load influences bundle selection, and whether bundles need offer a price discount.

The research presented here aims to explore whether product bundling can serve as a behavioral nudge to increase fruit and vegetable selection, as well as whether limiting an

individual's cognitive resources influences food choice. To address these objectives, we conducted a food choice artefactual field experiment with 287 participants in a large Midwestern city in the U.S. during fall 2015. Subjects shopped a grocery display under one of six different treatments, some of which featured product bundles, with differences examined among the proportion of food items selected from three food categories: Fruit and Vegetables, Junk Food/Snacks, and Protein/Dairy/Grains.

BACKGROUND & LITERATURE REVIEW

Obesity, Health, and Fruit & Vegetable Consumption

The habitual consumption of high fat, high sugar, and low nutrient foods has been shown to contribute to obesity, and is related to other chronic health conditions such as high blood pressure, diabetes, cardiovascular disease and certain cancers (Hurt, Kulisek, Buchanan & McClave, 2010; NIH, 2012). Food related illnesses are often associated with being overweight (Hurt et al. 2010). Fortunately, fruit and vegetable (F&V) consumption in particular has been linked to the prevention of such diseases and detrimental health issues. A longitudinal study conducted by Hung et al. (2004) concluded that increased F&V consumption lowered an individual's chances of developing cardiovascular disease; similar conclusions have been made by He, Nowson, and MacGregor (2006), and by He, Nowson, Lucas, and MacGregor (2007).

An estimated 68% of U.S. adults are considered overweight; of this 68%, approximately 41% are considered obese with BMIs of 30+ (Ogden et al., 2010). Those with limited economic resources in particular often select energy dense, highly caloric, tasteful foods that are of low cost (Drewnowski and Specter, 2004). In order to curb high calorie diets in cost-conscious adults,

Drewnowski and Damon (2005) note that nutritional interventions seeking to alter current consumption behaviors are needed.

A set of *Dietary Guidelines for Americans* released by the USDA and DHHS for 2010 recommended adults consume 2.5 cups of vegetables and 2 cups of fruit per day. Unfortunately, the CDC estimates that many Americans fail to meet these guidelines (CDC, 2013). As F&Vs are a good dietary source of necessary nutrients, including folate, magnesium, potassium, dietary fiber, and vitamins A, C, and K, many Americans may also be at risk for nutritional deficiency (McGuire, 2011). Behavioral nudges designed to increase F&V selection may be one way to help lessen nutritional shortcomings, prevent obesity, and lower food-related chronic health conditions.

In 2011, the United States Department of Agriculture (USDA) replaced their prior MyPyramid nutritional guide with MyPlate, depicting the portions of one's plate that should consist of various food groups. Although MyPlate servings suggestions vary based on age, gender and amount of physical activity, the icon in general encourages consumers to fill half of their plate with fruits (20%) and vegetables (30%) daily (Post, Haven, and Maniscalco, 2011). Similar to the MyPlate initiative, Harvard University's Healthy Eating Plate also recommends a half plate full of F & Vs daily, although a higher ratio of vegetable to fruit consumption is encouraged (Datz, 2011). These new consumption guidelines can easily be translated into shopping suggestions or healthful nudges. Since one's purchasing decision is often the first step to healthier consumption, in-store behavioral interventions may be an effective way to reach a large population, thereby ending the cycle of eating habits that are detrimental to health.

Health Interventions and Behavioral Economics

Standard economic theory suggests that individuals who recognize the negative consequences of

eating low-nutrition, high-calorie food should then substitute healthier food options into their diet. However, as evidenced by the previously mentioned high incidence of obesity in the U.S., individuals regularly and predictably behave in ways that contradict this assumption. The economic framework of food choice assumes that an individual makes a tradeoff between the enjoyment of food eaten in the present, and the future health consequences of consuming that food. The ability to make this choice is also influenced by the availability of both information about diet, and information about the effect of diet on health.

For this reason, previous interventions by the USDA, the U.S. Department of Health and Human Services, and others to encourage consumption of nutritious foods have included providing advice about healthful food choices, and requiring nutritional labeling of packaged foods (Welsh et al., 1993). Unfortunately, evidence is inconclusive on whether such nutritional information actually improves food choice (Gould and Lin, 1994; Nayga, 2000a, 2000b; Variyam and Cawley, 2006; Chang and Just, 2007; Barreiro-Hurle et al., 2010; Roberto et al., 2010; Thorndike et al., 2012; Kiesel and Villas-Boas, 2013). One such explanation for this could be that food choice is perhaps a self-control problem, particularly influenced by the amount of cognitive resources available to the shopper at the time of purchase.

More direct methods to guide consumer food choices (and thus improve health outcomes and lower obesity rates) are possible using concepts from behavioral economics. Research by the Economic Research Service (ERS) suggests such concepts can be used to guide individual decision-making related to food choice, ultimately improving one's diet and health (Just, 2006; Just et al., 2007; Cawley and Ruhm, 2011). Behavioral economics incorporates a deeper understanding of the behavioral factors that shape food choice. Consumption choices are often determined by factors other than the price of the food item; for example, external cues including

food presentation, expectation of how the food tastes, or even the context of the meal all affect consumption (de Castro and Brewer, 1992; Cardello and Sawyer, 1992; Wansink and Deshpande, 1994; Wansink, 1996; Tuorila et al., 1998; Wansink, 2004). This approach is particularly beneficial as it can target the underlying motivation to choose unhealthy food in the first place. For example, behavioral economics has made inroads in understanding the link between present-biased time preferences and health behaviors (e.g., Fuchs, 1982; Ida and Goto, 2009; Sutter et al., 2013; Bradford et al., 2014; Courtemanche et al., 2015). Behavioral economics has also explored the role that incentives, linked to healthier choices, can play in food purchases (for an overview see Price and Riis, 2012).

Solutions such as increasing or "taxing" the price of unhealthy foods have been proposed; however, such solutions may decrease the welfare of lower-income populations, and changes in food prices would have to be large to have any significant effect (Kinsey and Bowland, 1999; Huang, 1999; Kuchler et al., 2005; Duffey et al., 2010). In the research presented here, we use product bundles (consisting of primarily F&V items) as an external cue to help guide consumption choices, and explore whether such bundles would need to offer an incentive (price discount) in order to influence purchase likelihood. Product bundles then may be able to serve as a behavioral intervention to help individuals avoid present bias, and ultimately make healthier food choices.

Product Bundling

Prior work has shown that consumers frequently prefer bundled choices over individual options, as the former both reduces search effort and requires less information processing (Harris and Blair, 2006). Additionally, Harris and Blair concluded that those consumers who are perhaps less motivated to process information exhibited the greatest preference for bundled choices. If bundled

choices include primarily fruit and vegetables, and individuals under cognitive load are more likely to choose bundled options as a means to lessen their cognitive effort (as Harris and Blair suggest), than product bundling could be an effective in-store behavioral intervention to improve food choice. However, prior studies concluding that bundle preference is motivated by a desire to lessen mental strain have failed to directly manipulate subjects' cognitive load.

While the justification behind preference for bundles remains an area in need of further research, it is a common marketing strategy routinely seen in the retail sector (Sett, 2014). Likewise, the bundling of complementary items is a common selling technique, where functionally related items are sold together at one advertised price (Estelami, 1999). Bundled products are routinely seen for electronics, as well as travel purchases; products may be offered as pure bundles (where components are only offered for sale as part of the bundle), or mixed bundles (where components may also be purchased individually) (Simon and Wuebker, 1999; Mantovani, 2013). In the food sector, bundled items are often seen at fast food establishments (i.e. McDonald's 'value meals') and restaurants (i.e. Applebee's '2 for $20'). In addition to familiarity, product bundling may also appeal to retailers as bundling's simplification of choices has been found to have a positive effect on purchasing likelihood (Iyengar and Lepper, 2000).

From a mental accounting perspective, Johnson et al. (1999) suggests that a consumer will exhibit more positive evaluations for a bundle of items, as opposed to the same items unbundled, in part because of the bundle's single stated price. Similarly, Sharpe and Staelin (2010) found consumers tended to rate bundled goods as being of an increased value due to the reduction in cognitive effort needed to mentally account for a single price versus several prices. The price of the bundle is viewed by the consumer as a single monetary loss, as opposed to a series of several losses if the same items were to be purchased individually. Following the seminal work of Thaler

(1985) on how individuals account for gains and losses, consumers may be more likely to purchase a bundled product because of the bundle's single price. This may especially be the case for those shopping with a set food budget, who perhaps are more sensitive to prices (and perceived losses).

By bundling F&V items together, in the long run, it may be possible to change consumers' taste preferences for these items, and thus increase consumer demand at the store level. We propose that the bundling of grocery items might particularly appeal to consumers who wish to constrain their choice set, and reduce the cognitive overload that comes from comparing and selecting numerous individual products. According to Story et al. (2008), grocery stores not only play an central role when it comes to food purchasing, but the availability and display of healthy products within the store is also a contributor to establishing healthy eating habits.

The retail promotion of product bundles could be an effective, relatively easy, and inexpensive display strategy to implement at the store level. Bundles may also reduce consumers' cognitive load by simplifying the shopping experience, and ultimately promote increased purchases of F&Vs. To the knowledge of the authors, no known work has yet to examine product bundling as a potential behavioral intervention to increase sales of fruit and vegetable items.

Cognitive Load and Food Choice

Exploring the effect of cognitive load on food choice is particularly relevant. The Food Marketing Institute noted that the average number of items for sale in U.S. supermarkets exceeded 43,000 per store in 2013 (FMI, 2013). Grocery shoppers then regularly have to search through a large number of products before making a purchasing decision, yet routinely shop under time pressures (Aylott and Mitchell, 1999). Work by Park et al. (1989) also found that grocery store shoppers usually shop under a time constraint, and can find shopping cognitively stressful when required to perform

in-store information search activities.

Numerous studies in economics, psychology, and others have focused on cognitive resources and their impact on preferences and decision making (for a few see Hinson et al., 2003; Franco-Watkins et al., 2006; Greene et al., 2008; Benjamin et al., 2013; Deck and Jahedi, 2015). Kahneman (2002, 2011) offers a dual-system framework as a means to explain how cognitive load directly impacts behavior. This dual system is composed of an intuitive (impulsive) system and a thoughtful reasoning system. Prior studies have shown that subjecting individuals to cognitive load increases the exertion of the reasoning system, thus restricting the system's ability to regulate decision making (Fudenberg and Levine, 2006; Mukherjee, 2010).

In particular, Fudenberg and Levine suggest that this 'dual-self' influences impulse control by making it harder to select the reasonable choice when subjected to cognitive load. We extend Fudenberg and Levine's dual-self theory to help explain when individuals may be more or less likely to choose healthful food choices such as F&Vs, and to test whether an intervention designed to lessen cognitive processing (product bundling) can offset the propensity towards not choosing reasonable, healthful choices when cognitively strained. The most commonly used technique to simulate cognitive load involves having an individual keep a 6-or-more digit number in their memory, while concurrently completing a separate decision task (Deck and Jahedi, 2015).

Prior research looking specifically at the effect of cognitive load on food choice has yielded conflicting results. Shiv and Fedorikhin (1999) found that lessening cognitive resources made individuals more likely to select an unhealthy snack option, and Ward and Mann (2000) concluded that cognitive impairment resulted in dieting individuals to consume more calories. Research by Zimmerman and Shimoga (2014) found cognitive load increased the selection of unhealthy snack choices when exposed to food advertising, but failed to find an effect under cognitive load for

when subjects were exposed to nonfood advertising. Lastly, more recent research by Deck and Jahedi (2015) failed to find evidence that cognitive load increased the selection of unhealthy versus healthy food choices. However, the study did not use snack items that were clearly identifiable as 'healthy' vs 'unhealthy'. For example: one could argue that when comparing wheat crackers and potato chips, both could be considered unhealthy; the same argument could be made when comparing pomegranate fruit strips and strawberry twizzlers. A contribution of Deck and Jahedi beyond Shiv and Fedorikhin (1999) is that the former employed an experimental measure (basic math problems) to check that their digit memorization task successfully manipulated cognitive load.

While there is evidence that cognitive load may influence food choice, no study has yet to examine this topic in the context of grocery shopping behavior, using an expanded product set beyond snack foods. As prior studies suggest that grocery shoppers routinely shop under cognitive load, exploring the effect of a potential behavioral nudge (product bundling) in its presence could yield more accurate and meaningful results.

THEORETICAL FRAMEWORK

We use a dual-system framework first developed by Kahneman (2002, 2011) to explain how cognitive load directly impacts food choice behavior. In particular, we extend Fudenberg and Levine's (2006) dual-self theory to help explain when individuals may be less likely to select the 'reasonable' (healthy) food choice. We also test whether product bundling can serve as a behavioral intervention designed to lessen cognitive processing, and thus increase the likelihood that the reasonable food choice is selected when cognitively strained.

Using this dual-self framework (Fudenberg and Levine, 2006) as well as prior work by List

et al. (2015) we define the total basket of food items that an individual selects from a given set of food choices. This total basket of items may include healthy F&V items, denoted by *f*, unhealthy junk food snack items, j , and other food items including non-meat protein, dairy, and grains *n* such that $(f, j, n) \in \mathbb{R}_+^L$ is the consumer's choice set. The consumer is constrained by their household income *w*, so that the shopper's grocery food budget set is defined as $B(w) = \{(f, j, n) \in \mathbb{R}_+^L : \langle p_{f,j,n} \leq w\}$. From List et al., the consumer's utility maximization problem is:

$$(f, j, n) = argmax_{(f,j,n)\in B(w)} U(f, j, n) \quad (1)$$

A behavioral intervention such as product bundling would be expected to move the consumer to a new level of utility U^k with basket bundle (f^*, j^*, n^*) where demand for $f^* > f$, $j^* \leq j$, and $n^* \leq n$, and where $k = 1 \ldots n$ for each treatment featuring bundles. It is likewise anticipated that under cognitive load, consumers may shift to a different level for utility U^k with basket bundle (f^{**}, j^{**}, n^{**}), where now demand for $f^{**} < f^*$, $j^{**} \geq j^*$, and $n^{**} \geq n^*$. In the absence of cognitive load or a displayed bundled option, the consumer remains at the original utility level U^0 with basket bundle (f, j, n).

The presence of bundled products is expected to increase the amount of f purchased over baseline levels. As demand for food is relatively inelastic, the number of *j* and *n* will as a whole decrease, although the proportions of decrease for each are unknown. Prices $p_{f,j,n}$ are held constant with the exception of treatments featuring discounted bundles, as we investigate during one time period only. For comparison purposes, consumers will shop under a given, identically set $B(w)$.

METHODOLOGY

Experimental Design

To explore the influence of cognitive load and product bundling on food choice, an artefactual

field experiment was employed. An artefactual field experiment involves inviting consumers to participate in a decision task where consumers know they are in an experiment (Harrison and List, 2004). List (2011) notes that artefactual field experiments are similar to standard laboratory experiments, but different in that they use participants from the 'market of interest'; in our case, grocery store shoppers.

A total of 287 subjects were recruited to participate in a single session lasting approximately 60 minutes. The experiment was conducted in a large Midwestern city in the U.S. during fall 2015. Subjects were prescreened, and excluded from the study if they were not grocery shoppers, were under the age of 22, and/or had any known food allergies. Participants were recruited through advertisements in local newspapers, various online sources, and at local community centers and a variety of grocery stores. The advertisements referred to the experiment only as a 'consumer study', in order to avoid sample selection bias. The show up rate was $5, and participants could receive up to $13 total, plus any food items that they selected during the session. If not going home right away, they could also arrange to pick up their food items at an alternate day/time.

The grocery display employed in the study featured 30 different food items, each appropriately sized for retail pricing at $1 to allow for comparison across foods. These items were evenly split into three food categories: Fruit and Vegetable Items, Junk Food/Snack Items, and Protein/Dairy/Grain Items. Each category consisted of the same proportion of perishable and/or frozen foods. The 30 food items featured in the study can be viewed in Figure 1. To better simulate a store environment and preserve product quality, the grocery display featured store shelving, as well as a commercial display freezer and cooler. This display infrastructure was provided in part by Louis' Groceries NFP, a grocery store that has partnered with the researchers on prior studies.

Participants were randomly assigned to shop a grocery display upon their arrival. After being

read the instructions, completing a brief quiz, and practicing each type of task featured in the study, they were given a $10 budget with which to shop the display. Subjects were told to use their entire budget as no change would be given, and instructed to walk through the shopping area and view each product prior to making their selections privately on a computer screen. They received their selected items at the end of the session, and were not permitted to use any personal money while shopping the store display.

In the shopping area, participants were shown one of three different store displays. Control consisted solely of the 30 different individual food items. Bundles-No Discount consisted of Control plus six different preassembled product bundles. Product bundles featured primarily F&V items, all of which were also sold individually in the store display, and were priced at "*5 items for $5"*. Bundles-Discount was a 20% discounted version with the six product bundles priced at "*5 items for $4"*. The product bundles used in the study can be viewed in Figure 2. Two of the bundles consisted of 5 F&V items, two consisted of 4 F&V items and 1 Protein/Dairy/Grain item, and the remaining two bundles consisted of 4 F&V items and 1 Junk Food/Snack Item, and 3 F&V items and 2 Protein/Dairy/Grain items respectively.

Individual food items and product bundles were pretested for general appeal with a group of 22 consumers prior to conducting the experiment. To simulate a more mentally straining shopping experience, half of subjects completed one of the three displays under a cognitive load condition, while the other half did not. The cognitive load condition consisted of memorizing a 7-digit number while shopping, and then later recalling the number at the end of the shopping task. This resulted in a between-subjects design of six different treatments for the lab experiment: 3 Displays X 2 Cognitive Load Conditions. The six different treatments can be viewed in Table 1.

Once subjects had completed the food selection task, after a short break, they next completed

a set of eight arithmetic tasks, adapted from the manipulation check used by Deck and Jahedi (2015). For these tasks, subjects were asked to multiply m_1 x m_2, where integer $m_1 \sim U$ (13…19) and integer $m_2 \sim U$ (5….9), following Deck and Jahedi. Half of these tasks were completed under high cognitive load, with a break between each section. Lastly, they completed a brief post-experiment questionnaire that featured questions about their eating habits and shopping behaviors, trait self-control, and standard demographics. Trait self-control was assessed using the Self-Control Scale developed by Tangney et al. (2004), in order to explore whether those lacking self-control were less likely to select healthy F&V items.

At the end of the session, one math task was randomly selected for payment; subjects received an additional $3 if they answered the problem correctly. Next, a task was randomly selected from all of the study tasks (food choice plus arithmetic). If the subject had completed the selected task under high load, they received an additional $5 if they had correctly recalled the 7-digit number, else they received an additional $0. If they had completed the task under no cognitive load, they received the additional $5.

Outcome Measures and Econometric Model

To determine the effect of the six treatments on the proportion of foods selected from each category, outcome measures are used. These include comparisons of differences in proportions between subjects using non-parametric Wilcoxon rank sum (Mann-Whitney) 2-sample tests. In addition, the effect of the various treatments, as well as other explanatory variables, on the proportion of each food category selected are modeled using a multivariate fractional regression model.

Following Papke and Wooldridge (1996), and Murteira and Ramalho (2014), we use a

fractional multinomial logit model fit by quasi-maximum likelihood. Our dependent variable is a vector of proportions such that $\mathbf{Y} \equiv (y_f, y_j, y_n)'$, the proportion of consumers' baskets bundles that are allocated to each of the three categories $k = f, j, n$. These three categories are exhaustive and mutually exclusive for purposes of this study. Thus, we are interested in their joint behavior, estimated simultaneously as the three categories are correlated and their selection is inherently bounded between zero and one. This joint behavior is explained by a set of explanatory variables $\mathbf{X} \equiv (x_1, x_2,\ldots x_n)$.

Murteira and Ramalho (2014) note that in estimating multivariate fractional response models, quasi-maximum likelihood estimation based on the Bernoulli distribution often handles boundary observations well. This is particularly useful in this case, as it is plausible that one may select all food items from a single category. Therefore, a final fractional multinomial logit generalized from Papke and Wooldridge (1996) is estimated using Stata 14.1:

$$B^k_i = \boldsymbol{X}' \beta^k + \varepsilon_{ik} \tag{2}$$

where B^k_i = {proportion of items purchased}, and $0 \leq B^k_i \geq 1$, with $\sum B^k_i = 1$. The food category equations then are identically specified, estimated simultaneously, and the omitted category for estimation purposes is n; $\boldsymbol{X}' = \{ \boldsymbol{T}_{ik}, \boldsymbol{Q}_{ik}, \boldsymbol{Z}_{ik} \}$, with i representing each individual consumer, and ε_{ik} is the error term with a zero mean across consumers. $\boldsymbol{T}_{ik}$ consists of treatment dummy variables *HighCognitiveLoad*, *Bundles Displayed,* *BundlesDiscounted,* and the interaction *HighCognitiveLoad*BundlesDiscounted*, which are 1 if the consumer was in the treatment, 0 otherwise. $\boldsymbol{Q}_{ik}$ includes additional explanatory variables for consumer i, which were obtained from the consumer's post-experiment questionnaire, and include *LackingSelfControl*, *AlreadyPlannedToPurchase*, and *FollowingSpecialDiet.* Lastly, $\boldsymbol{Z}_{ik}$ consists of demographic variables *Female*, *ChildrenUnder18*, *NonCaucasian*, *Age*, and *HouseholdIncome10K*, of which

the last two are mean centered. A description of model variables are provided in Table 2, and demographics of subjects can be viewed in Table 3. Our baseline treatment, where the consumer is not presented with a bundled option nor under high cognitive load, is captured by the intercept term.

Referring back to R1 (product bundles as a behavioral nudge), it is hypothesized that significantly higher percentages of F&V selection will be uncovered for consumers who are presented with product bundles (T2, T3, T5 & T6), compared to control treatments (T1 & T4). The effect of cognitive load (T4, T5, T6) is likewise expected to have a significant effect on the proportion of F&V items selected compared to no load treatments, in reference to R2 (whether cognitive load influences item selection). If more bundles are selected under high cognitive load, such an intervention may be useful in nudging stressed consumers towards higher levels of F&V selection. If no significant differences are uncovered between discounted and non-discounted bundle selection (T2 & T3, and, T5 & T6) it could be that consumers perceive value just from having the one stated price, and that no discount is necessary, referencing R3 (whether bundles need to be discounted, and whether their selection is influenced by cognitive load).

Bundles are hypothesized to have a significantly positive effect on the proportion of selected F&Vs (R1). The effect of high cognitive load is likewise expected to significantly influence the proportion of F&Vs selected (R3). Those who scored low on Tangney et al.'s (2004) self-control scale are hypothesized to select less healthful items, while the effect of following a special diet, and having already planned to purchase items included in the study, are indeterminate.

RESULTS

Treatment Comparisons

The average percentage of items selected from each of the three categories is presented by treatment in Table 4. Overall, subjects were selecting a relatively high percentage of F&V items compared to the other two food categories. The highest percentage of F&Vs were selected under T3 (Bundles-Discounted, No Load); on average 63.4% of subjects' overall selection were comprised of F&V items. In contrast, the lowest percentage of F&Vs (47.89%) and the highest percentage of junk food items (23.87%) were selected under T6 (Bundles Discounted-High Load).

Differences between treatments for all three categories can be viewed in Table 5. Shapiro-Wilk tests for normality were first performed on the percentage of items selected for each category. Results indicated the rejection of normality for all categories at better than the 1% level; therefore, non-parametric Wilcoxon rank-sum (Mann-Whitney) 2-sample tests were performed.

For F&V items, a 14.8% increase ($p=0.0012$) was observed between T3 (Bundles-Discounted, No Load) and T1 (Control, No Load) as was hypothesized under R1, resulting in a 13.72% decrease ($p=0.0001$) in Protein/Dairy/Grain Items. Although not statistically significant, a 5.91% increase in F&V items was observed for T2 (Bundles-No Discount, No Load) over T1, resulting in a 6.13% increase (p=0.0817) in Protein/Dairy/Grain Items. No significant differences were observed between T1 and T4 (Control, High Load), in contrast to our hypotheses under R2.

Comparing T5 (Bundles-No Discount, High Load) to T4, a 6.69% increase ($p=0.0629$) was observed in F&V items under T5 (Bundles-No Discount, High Load) as was hypothesized under R1, although no significant differences were uncovered between T4 and T6. Referring to R3, under no load, comparing discounted to non-discounted bundles, subjects under T3 selected

8.89% more (*p=0.0965*) F&V items compared to T2. Again, the majority of this shift in item selection was accounted for by a 7.58% decrease (*p=0.0972*) in Protein/Dairy/Grain Items. No significant differences were uncovered between T2 and T5, in contrast to our hypotheses under R2. Interestingly, 15.51% less (*p=0.0028*) F&V items were selected in T6 versus T3, with junk/snack food items accounting for 8.89% of this shift (*p=0.0760*) in proportions. For T6 versus T5, 8.28% less (*p=0.0466*) F&V items were selected under T6.

The percentage of subjects selecting bundles, by treatment, are reported in Table 6. The highest percentages are observed for T3, with 75.56% of subjects, and for T5, with 68.09% of subjects selecting one or more bundle. Differences in bundle selection between treatments can be viewed in Table 7. Significant differences are observed for all comparisons, with the exception of T5 and T6. An average of 28.5% more subjects selected at least 1 bundle under T3 when compared to T2 (*p=0.0046*). Likewise, 21% more subjects selected at least 1 bundle under T5 compared to T2 (*p=0.0273*), as hypothesized under R3. Of note is the difference between T3 and T6: 22% less subjects selected a bundle under T6.

Fractional Multinomial Logit

The results of the estimated fractional multinomial logit can be viewed in Table 8. For F&V items, the variables *BundlesDisplayed* and *BundlesDiscounted* both had a significantly positive effect on proportion selected, while *HighCognitiveLoad*BundlesDiscounted* and *LackingSelfControl* both had a significant negative effect. *HighCognitiveLoad* alone was not significant, although it does have a significant negative effect when interacted with *BundlesDiscounted*. None of the demographic variables included in the model had a significant effect on proportion of F&Vs selected; similarly, we failed to find a significant effect for the variables *AlreadyPlannedToPurchase* and *FollowingSpecialDiet*.

For Junk Food/Snack items, *BundlesDisplayed* likewise had a significant positive effect. The remaining treatment variables, as well as *LackingSelfControl*, were not statistically significant for Junk Food/Snack items. The only significant demographic variables were *Age* and *HouseholdIncome10K*, both having a significantly negative effect on proportion of selected Junk Food/Snack items. The nonlinear effects of Age^2 and $HouseholdIncome10K^2$ were not statistically significant for either item category, and thus excluded from the model. Education was also omitted as an explanatory for both category equations, due to high collinearity with *Age*.

Marginal effects were computed from the estimated coefficients, and are presented in Table 9. For F&V items, product bundles are estimated to increase selection by 3.87%, while discounted product bundles are estimated to have an 11.04% increase on proportion of F&Vs selected. When discounted product bundles are displayed under high cognitive load, the proportion of F&Vs selected decreases 16.23%. Those who scored low on the Tangney et al. (2004) self-control scale were estimated to select 6.21% less F&Vs, compared to subjects with higher self-control.

For Junk Food/Snack items, product bundles increased item selection by 3.3%. Interestingly, only one bundle featured a Junk Food/Snack item. However, this particular bundle was ranked third out of the six displayed bundles in terms of selection preference ranking. Those who had already planned to buy items featured in the study, prior to viewing the study items, selected 9.62% less junk food items. Likewise, those who indicated that they followed a special diet selected 11.45% less junk food items. For every year in age beyond the mean age of 30, subjects selected 0.76% less junk food items. Lastly, for every $10,000 increase in household income beyond the mean income of $60,254, subjects selected on average 0.62% less junk food items.

Manipulation Check for Cognitive Load

For the high cognitive load treatments (T4, T5, T6), subjects' recall accuracy for the displayed 7-digit number was assessed, and can be viewed in Table 10. Across treatments, recall accuracy was over 76%, with no significant differences in accuracy observed between treatments. Following Deck and Jahedi (2015), subjects' arithmetic performance was also assessed under both high and no cognitive load, and can be viewed in Table 11. If high cognitive load was successfully manipulated by recalling a 7-digit number, then subject performance should be significantly worse under high load.

On average, subjects were 8.54% less accurate ($p=<0.001$) when performing arithmetic under high cognitive load, compared within subjects using non-parametric Wilcoxon signed-rank tests for matched pairs. Significant differences in performance within subjects by treatment were also observed. No significant differences in high load accuracy were observed between subjects, between high load treatments and between high versus no load treatments. Additionally, no significant differences in accuracy disparities were observed between high load treatments, and between high versus no load treatments.

CONCLUSIONS

Overall participants selected a relatively high proportion of F&V items across treatments when compared to the other two categories in the study. One potential explanation for this is that equal number of items from the three categories were displayed in the study, and in close proximity. This is in contrast to the typical grocery store model, which often has varying amount of products from each category on display, located in separate sections of the store.

Looking at differences between treatments, the largest percentage (63.4%) of F&V items were selected when bundles were discounted 20%, and when subjects shopped under no cognitive load. Interestingly though, when the same discounted bundles were displayed to consumers shopping under high cognitive effect, the opposite effect is observed: the lowest percentage (47.89%) of F&V items are selected. While cognitive load alone does not appear to influence food selection in the absence of bundles, it does appear to negatively affect F&V selection through an interaction with discounted product bundles.

As grocery shoppers often shop under cognitive strain (Park et al., 1989), it is notable that a price intervention offered through discounted product bundles failed to achieve the desired effect of increased F&V selection for high load consumers. Product bundling alone does not have as large an effect on F&V selection as discounted bundles for no load consumers. For high load consumers though, product bundles need not offer a price discount to effectively increase F&V selection; in fact the evidence presented here suggests that bundles should not be discounted if shoppers are likely to be cognitively strained. This is perhaps helpful information for retailers, who could implement product bundles into existing store displays at little to no cost. There is evidence that product bundles may be preferred by consumers as a means through which to lessen their cognitive strain during the shopping selection process. Comparing non-discounted bundle selection between no load and high load conditions, 23% more bundles were selected by consumers under high load.

Another interesting result of this research is that while product bundling seems to have a relatively stable effect on F&V selection across cognitive load conditions, price discounts for bundles do not. Comparing no load and high load consumers, when discounted bundles were displayed, high load consumers selected 15.5% less F&V items and 8.89% more junk food items.

It may be that the added effect of a price discount when already operating with limited cognitive assets further depletes one's cognitive resources. This is particularly relevant for those shopping on a fixed grocery budget, such as was used for the purposes of this study. It is reasonable to assume that lower income consumers may already be under cognitive strain before even reaching the grocery store; while one might initially assume that discounted product bundles would appeal to such consumers, the opposite may be the case. This is particularly relevant as prior research reported by the USDA's Economic Research Service has indicated that low-income households eat on average less F & Vs compared to higher income households (Blisard, Stewart, and Jolliffe, 2004). Non-discounted product bundles then may be an effective nudge to encourage F&V selection among for those who may also be at a higher risk for food related health problems.

In conclusion, product bundles need not offer a price discount in order to effectively increase F&V selection, particularly as prior research has suggested that consumers are often cognitively strained while grocery shopping (Aylott and Mitchell, 1999; Park et al., 1989). Product bundles may be preferred by consumers as a means through which to lessen the cognitive strain of the shopping process. It is important to note that the bundles included in this study were preassembled for the consumer; more work is needed to explore the practical application of product bundles in the field. The results uncovered here suggest that product bundles (consisting primarily of F&V items) could potentially increase retail F&V sales, provided such bundles are preassembled for the shopper. Such bundles need not necessarily offer a price discount. Rather, busy consumers may perceive greater value from the effort-saving convenience and cognitive ease associated with bundle selection.

This study also provides interesting implications for better understanding potential marketing techniques designed to increase F&V selection and sales. Such an increase in F&V

sales could help combat high levels of obesity and diets of poor nutritional quality. An additional benefit includes the potential for increased profitability among grocery retailers, who are often faced with high perishability and low profit margins for produce items, compared to other food products.

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TABLE 1. Grocery Selection Treatments

Treatment	Grocery Display	Cognitive Load Condition	# of Subjects
T1	Individual Items Only (Control)	No Load	43
T2	T1 plus “5 for $5” Bundles (Bundles-No Discount)	No Load	51
T3	T1 plus “5 for $4” Bundles (Bundles-Discounted)	No Load	45
T4	Individual Items Only (Control)	High Load	58
T5	T4 plus “5 for $5” Bundles (Bundles-NoDiscount)	High Load	47
T6	T4 plus “5 for $4” Bundles (Bundles-Discounted)	High Load	43
		Total:	287

TABLE 2. Description of Variables

Variable Name	**Description**[1]
HighCognitiveLoad	1 if subject was in high cognitive load condition
BundlesDisplayed	1 if product bundles were displayed
BundlesDiscounted	1 if displayed product bundles were discounted 20%
*HighCognitiveLoad*BundlesDiscounted*	Interaction between *HighCognitiveLoad* and *BundlesDiscounted*
LackingSelfControl	1 if scored low on Tangney et al.'s (2004) self-control scale
AlreadyPlannedToPurchase	1 if subject had already planned to buy selected items elsewhere
FollowingSpecialDiet	1 if subject indicated following a special diet
Female	1 if female
ChildrenUnder18	1 if children under 18 years in the household
NonCaucasian	1 if not Caucasian
Age	In years
HouseholdIncome10K	Household income (in tens of thousands of dollars)

[1]All except *Age* and *HouseholdIncome10K* are dummy variables where the value is zero otherwise.
NOTE: T1 (Control, No Load) is represented by setting *HighCognitiveLoad*, *BundlesDisplayed*, *BundlesDiscounted*, and *HighCognitiveLoad*BundlesDiscounted* equal to zero.

TABLE 3. Demographics of Subjects, by Treatment (N=287)

Category	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Female (%)	65.12	64.71	64.44	65.52	63.83	62.09
Children under 18 in household (%)	14.65	17.64	8.89	17.24	8.51	9.30
Age (in years)	29.07	33.41	27.89	31.07	31.47	24.63
Income (in tens of thousands of dollars)	6.53	6.15	6.69	5.74	5.88	5.23
Lacking self-control (%)	16.28	17.84	15.56	17.24	17.02	17.91
Already planned to purchase (%)	88.37	90.39	90.56	72.51	87.23	86.05
Following a special diet (%)	25.58	27.45	24.44	22.41	25.53	26.28
Education (%):						
< High school graduate	0	0	0	0	0	0
High school graduate	11.63	11.76	6.67	5.17	12.77	11.63
Some college, no degree	41.86	37.25	55.56	41.38	38.30	55.81
Associate degree	0	3.92	0	1.72	6.38	2.33
Bachelor degree	32.56	29.41	24.44	32.76	25.53	25.58
Graduate /Professional degree	13.95	17.65	13.33	18.97	17.02	4.65
Race, Ethnicity (%):						
White	69.77	86.27	66.67	77.59	68.09	72.09
Black/African American	6.98	5.89	6.67	5.17	0	4.65
Asian	16.28	5.89	15.56	12.07	19.15	18.60
Other race	11.63	3.92	13.33	12.07	12.77	11.63
Hispanic/Latino ethnicity	0	0	6.67	6.89	4.26	4.65

TABLE 4. Percentage of Subjects Selecting Bundles, by Treatment

Treatment	**% Selecting**		**Aggregate (std dev)**
	1 Bundle	**2 Bundles**	
T2 (Bundles-No Discount, No Load)	39.22	7.84	47.06 (50.41)
T3 (Bundles-Discounted, No Load)	26.67	48.89	75.56 (43.43)
T5 (Bundles-No Discount, High Load)	44.68	23.40	68.09 (46.47)
T6 (Bundles-Discounted, High Load)	18.60	34.89	53.49 (50.25)

TABLE 5. Comparison Statistics for Food Item Percentages, by Grocery Selection Treatment

Baseline Treatment	**Comparison Treatment**	**Fruit & Vegetable Items**		**Junk/Snack Food Items**		**Protein/Dairy/ Grain Items**	
		Avg. % Difference over Baseline (std dev)	**Rank-sum p-value[1]**	**Avg. % Difference over Baseline (std dev)**	**Rank-sum p-value[1]**	**Avg. % Difference over Baseline (std dev)**	**Rank-sum p-value[1]**
T1 (Control, No Load)	T2 (Bundles-No Discount, No Load)	5.91 (4.18)	0.2668	0.22 (0.16)	0.2434	-6.13 (4.33)	**0.0817**
	T3 (Bundles-Discounted, No Load)	14.80 (10.46)	**0.0012**	-1.07 (0.76)	0.2325	-13.72 (9.70)	**0.0001**
	T4 (Control, High Load)	0.88 (0.62)	0.8458	3.78 (2.67)	0.5416	-4.66 (3.30)	0.2102
T4 (Control, High Load)	T5 (Bundles-No Discount, High Load)	6.69 (4.73)	**0.0629**	2.67 (0.78)	0.4639	-5.58 (3.95)	0.1452
	T6 (Bundles-Discounted, High Load)	-1.59 (1.12)	0.8794	4.04 (2.86)	0.9972	-2.44 (1.73)	0.5367
T2 (Bundles-No Discount, No Load)	T3 (Bundles-Discounted, No Load)	8.89 (6.29)	**0.0965**	-1.29 (0.91)	0.9714	-7.59 (5.37)	**0.0972**
	T5 (Bundles-No Discount, High Load)	1.66 (1.17)	0.6416	2.45 (1.73)	0.3385	-4.11 (2.91)	0.3572

T6 (Bundles-Discounted, High Load)	T3 (Bundles-Discounted, No Load)	15.51 (10.97)	**0.0028**	-8.89 (6.29)	**0.0760**	-6.62 (4.68)	0.2097
	T5 (Bundles-No Discount, High Load)	8.28 (5.85)	**0.0466**	-5.15 (3.64)	0.4537	-3.14 (2.22)	0.4919

[1] p-values in bold are significant at the 10% level or better
NOTE: p-values obtained from non-parametric Wilcoxon rank-sum (Mann-Whitney) 2-sample tests

TABLE 6. Comparison Statistics for Percentage of Subjects Selecting 1 or More Bundle, by Treatment

Baseline Treatment	**Comparison Treatment**	**Avg. % Difference over Baseline (std dev)**	**Rank-sum p-value**
T2 (Bundles-No Discount, No Load)	T3 (Bundles-Discounted, No Load)	28.50 (20.15)	**0.0046*** **
	T5 (Bundles-No Discount, High Load)	21.03 (14.87)	**0.0273** **
T3 (Bundles-Discounted, No Load)	T6 (Bundles-Discounted, High Load)	-22.07 (15.61)	**0.0428** **
T5 (Bundles-No Discount, High Load)	T6 (Bundles-Discounted, High Load)	-14.60 (10.32)	0.1602

NOTE: values in bold significant at the *10%, **5% and ***1% level respectively

TABLE 7. Fractional Multinomial Logit Estimates for Determinants of Grocery Selection, by Item Category

Variable	Fruit & Vegetable Items				Junk Food/Snack Items			
	Estimated Coefficient	**Robust Standard Error**	**z-statistic**	**Pr > |z|[1]**	**Estimated Coefficient**	**Robust Standard Error**	**z-statistic**	**Pr > |z|[1]**
HighCognitiveLoad	0.1452	0.1534	0.95	0.344	0.0951	0.2542	0.37	0.708
BundlesDisplayed	0.3282	0.1506	2.18	**0.029****	0.4505	0.2534	1.78	**0.075***
BundlesDiscounted	0.4497	0.1839	2.45	**0.014****	-0.0222	0.3456	-0.06	0.949
*HighCognitiveLoad*BundlesDiscounted*	-0.7185	0.2531	-2.84	**0.005*****	-0.1209	0.4399	-0.27	0.783
LackingSelfControl	-0.2347	0.1417	-1.66	**0.098***	0.0624	0.2542	0.25	0.806
AlreadyPlannedToPurchase	-0.0914	0.1974	-0.46	0.643	-0.7534	0.2960	-2.55	**0.011****
FollowingSpecialDiet	0.0743	0.1424	0.52	0.602	-0.7786	0.2807	-2.77	**0.006*****
Female	0.0190	0.1285	0.15	0.882	-0.0173	0.2197	-0.08	0.937
ChildrenUnder18	-0.0859	0.1836	-0.47	0.640	-0.2931	0.3244	-0.90	0.366
NonCaucasian	-0.1339	0.1451	-0.92	0.356	-0.1180	0.2258	-0.52	0.601
Age	0.0018	0.0049	0.36	0.716	-0.0535	0.0121	-4.44	**<0.001*****
HouseholdIncome10K	-0.0024	0.0119	-0.20	0.839	-0.0463	0.0218	-2.13	**0.034****
Intercept	0.5900	0.2369	2.49	**0.013****	-0.1440	0.3582	-0.40	0.688
Observations	287				287			
Wald chi2(24)	93.98							
Prob > chi2	0.0000							

[1] p-values in bold are significant at the *10%, **5% and ***1% level respectively

NOTE: The share of Protein/Dairy/Grain Items is the excluded category

TABLE 8. Marginal Effects for Determinants of Grocery Selection, by Item Category

Variable	Fruit & Vegetable Items		Junk Food/Snack Items	
	Estimated Marginal Effect	**Delta-Method Standard Error**	**Estimated Marginal Effect**	**Delta-Method Standard Error**
HighCognitiveLoad	0.0264	0.0356	0.0001	0.0328
BundlesDisplayed	**0.0387****	0.0366	**0.0330***	0.0338
BundlesDiscounted	**0.1104****	0.0439	-0.0434	0.0448
*HighCognitiveLoad*BundlesDiscounted*	**-0.1623*****	0.0582	0.0477	0.0563
LackingSelfControl	**-0.0621***	0.0342	0.0297	0.0331
AlreadyPlannedToPurchase	0.0455	0.0460	**-0.0962****	0.0386
FollowingSpecialDiet	0.0877	0.0340	**-0.1145*****	0.0358
Female	0.0061	0.0299	-0.0041	0.0283
ChildrenUnder18	0.0056	0.0449	-0.0329	0.0429
NonCaucasian	-0.0217	0.0306	-0.0043	0.0273
Age	0.0052	0.0013	**-0.0076*****	0.0016
HouseholdIncome10K	0.0036	0.0030	**-0.0062****	0.0029

NOTE: values in bold significant at the *10%, **5% and ***1% level respectively

TABLE 9. Food Tasks: Recall Accuracy for High Cognitive Load Manipulation, by Treatment

Treatment	**Memorization Accuracy[1] % (std dev)**	**7-Digit Number**
T4 (Control, High Load)	84.48 (36.52)	5186348
T5 (Bundles-No Discount, High Load)	89.36 (31.17)	6217457
T6 (Bundles-Discounted, High Load)	76.75 (42.75)	7491248

[1]no significant differences observed between treatments using non-parametric Wilcoxon rank-sum (Mann-Whitney) 2-sample tests

TABLE 10. Manipulation Check for High Cognitive Load: Arithmetic Performance

Treatment	% Accurate (std dev)			
	No Load	High Load[1]	Difference[2]	Signed-rank p-value[3]
T1 (Control, No Load)	91.86 (24.83)	81.40 (26.78)	10.46 (21.29)	**0.0003*** **
T2 (Bundles-No Discount, No Load)	86.76 (26.15)	78.43 (27.85)	8.33 (17.08)	**0.0002*** **
T3 (Bundles-Discounted, No Load)	90.00 (23.48)	82.22 (25.91)	7.78 (19.82)	**0.0153** **
T4 (Control, High Load)	95.26 (15.14)	83.62 (19.62)	11.64 (14.97)	**<0.001*** **
T5 (Bundles-No Discount, High Load)	87.77 (24.38)	84.04 (20.47)	3.72 (20.84)	**0.0559***
T6 (Bundles-Discounted, High Load)	92.44 (15.94)	83.72 (20.33)	8.72 (19.58)	**0.0013*** **
Aggregate	90.77 (21.97)	82.23 (23.51)	8.54 (18.85)	**<0.001*** **

[1]No significant differences in high load accuracy observed between high load treatments, and between high versus no load treatments, using non-parametric Wilcoxon rank-sum (Mann-Whitney) 2-sample tests

[2]No significant differences in accuracy difference observed between high load treatments, and between high versus no load treatments, using non-parametric Wilcoxon rank-sum (Mann-Whitney) 2-sample tests

[3] p-values obtained from non-parametric Wilcoxon signed-rank tests for matched pairs

NOTE: values in bold significant at the *10%, **5% and ***1% level respectively

NOTE: in the high load arithmetic condition, the 7-digit numbers employed were 4319162; 8568379; 5862413; 2856979

Figure 1. Individual Food Items Featured in the Food Choice Experiment

Figure 2. Preassembled Product Bundles Featured in the Food Choice Experiment