On Nudging and Psychological Reactance

David R. Just

and

Gnel Gabrielyan

ABSTRACT

Nudging has been suggested as an effective means of encouraging more nutritious food choices without inducing pushback or reactance. Several have pushed back on nudging in this context, often citing only marginal or noisy effects. We test the notion that nudges avoid psychological reactance using a laboratory experiment. We replicate the results of a well-known nudge that is intended to reduce the consumption of snack food. In one condition, we explain the purpose of the nudge to participants and find evidence that understanding the nudge leads to classical reactance.

Introduction

According to a report from the Global Burden of Disease, more 75%, or 170 million, of U.S. adults are obese or overweight (Ng et al. 2024). Obesity and overweight are a major issues not only for the U.S. and the developed world in general (Vuik et al. 2019; Just and Gabrielyan 2016b), but also for the developing world (Fatoye et al. 2024). Many leading causes of preventable death are obesity-related health conditions, including heart disease, stroke, type 2 diabetes, and certain types of cancer (Hurt et al. 2010; Ahima and Lazar 2013). According to Nagi et al. (2024), the annual medical costs from obesity-related health conditions in the U.S. were $126 billion between 2016 and 2022. In fact, the annual medical costs for obese individuals proved $1,429 higher than individuals of normal weight (Finkelstein et al., 2014). Since the introduction of Thaler and Sunstein's concept of nudging (2008), overeating, overweight and obesity have been held out as potential examples establishing policy relevance (see Li et al. 2021).

Proposed nudges have included setting strategic default options in restaurants (van Kleef et al. 2018), reducing the size of serving dishes (Holden et al. 2016, Venema et al. 2020), and prompting diners with potentially healthier choices (Schwartz et al. 2012), among many others. Food choice is perhaps an obvious target for the use of nudges because:

1. First, individuals make an abundance of food choices and must do so under everyday stress and cognitive load (Jabs and Devine 2006). This must limit the amount of cognitive effort one could devote to individual food choices, leading to behavior that is heavily influenced by the environment (Larson and Story 2009). This challenge has led many to suggest that environmental cues may be primarily responsible for increases in obesity (Popkin et al. 2005).

2. Nudges work by changing the environment in subtle ways to alter the cues that so effectively control eating. This has the potential to influence choice in a way that is both low cost and less likely to be regressive (as would a tax) (Caputo and Just 2022).
3. Because nudges operate without changing the choice set and are often subtle enough not to be noticed, they are perceived to be less of an imposition and less likely to lead to psychological reactance (Thaler and Sunstein 2008).

In this paper we focus keenly on the third of these, exploring the potential for nudges to create psychological reactance. Reactance is characterized as a rebellion against threats to freedom. Traditional approaches to restricting food choice through policy often face opposition due to reactance (Debnam 2017) that can undermine the intent of the policy. Even if the restrictions are self-imposed, such responses can lead to binging behavior in response to the restriction (Chesler 2009). Nudging offers a potential solution to this thorny problem, by changing what people eat without their being cognizant of the effect.

Previous research suggests that larger servings of food contribute to excess caloric (energy) intake (Birch, 1999; Rolls et al., 2003; Ledikwe, Ellon-Martin and Ross, 2005). Reducing caloric intake serves as a key preventative measure, helping to reduce the risk of obesity (Chan and Woo 2010). Discovering and implementing effective solutions to curb caloric overconsumption are important steps toward building an environment that supports healthy living behaviors (Just and Gabrielyan 2016a). Individuals are often led to irrational decisions by heuristic cues in their environment, rather than by calculated and goal-oriented choices (Just and Payne, 2009). Within food-related behavior, individuals typically repeat mistakes in decision-making. Environmental cues may determine the variety and quantity of foods an individual purchases (Just and Payne, 2009). Additionally, research shows these cues may dictate how much food an individual consumes (Raghoebar et al. 2019).

Specifically, we focus on the nudge developed by Geier et al. (2012), where consumers were given Pringles potato chips that had been altered so that each nth chip was colored. This was designed to help diners focus on the number of chips they were eating and lead to a reduction in consumption. The researchers conducted the study with undergraduate students, monitoring the students' consumption of potato chips during a film. The control group received a can of plain potato chips, while the Treatment 1 cohort received a can of chips with every 5^{th} or 7^{th} chip colored red. The Second Treatment group had cans with a red chip present every 10^{th} or 14^{th} chip. Under both treatments, the researchers found chip consumption declined over 50% with the red coloration.

In the current study, we use Geier et al.'s (2012) research as a starting point. We implement this nudge as intended to reduce caloric consumption. In addition, we examine how individuals' eating behaviors change given knowledge about the motivation behind the nudge. This study simulates a potential environment for nudged food products to discover if the sale of such foods could benefit both company and consumer. If a food product company was ever to implement a nudge to reduce consumption, they could only increase profits if they could market the benefits of the nudge and perhaps increase prices based on the consumer value. Otherwise, they would simply be reducing consumption (and thus sales). The study aims to answer whether there would be demand for a product designed to reduce consumption in a single sitting and whether the nudge's desired effect would hold once its purpose was revealed to consumers through advertising. It is important to note that it is currently unlawful for marketers to claim that a product has been packaged in a manner that leads to a reduction in consumption. Our study aims to determine the effects to both company and consumer if policies allowed marketers to sell products nudged in this way.

Our nudge involves coloring every fifth chip red within a can of Pringles. This allows the participant to better account for the number of chips eaten, as it draws attention to consumption volume. Participants ate chips while watching television. Previous research shows individuals consume more when they watch television (Anderson, 2006). Bowman (2006) even linked snacking while TV watching to the obesity epidemic in America. Therefore, by placing consumers in an environment that naturally encourages food consumption, we determine what factors lead to an increased consumption and, if consumers might seek out a nudged product in pursuit of their own self-interests.

Literature Review

Consumers are often less aware of "suggestive" environmental cues designed by marketers to alter their food decisions, leading to consumption decisions that fail to maximize consumers' well-being (Just and Payne, 2009). Leveraging environmental cues in a way that "nudges" consumers toward more healthful food decisions may serve as an effective way to curb overconsumption. The term "nudge" was first introduced by Thaler and Sunstein (2008) and is 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." Nudges are psychological manipulations, solely designed to influence behavior without the use of rational persuasion (Cohen, 2013).

Unhealthy nudging is prevalent in food marketing, used to increase consumer purchases and overall consumption (Marteau et al., 2011). In fact, several suggest that food marketing nudges are a leading cause of obesity (Seider and Pettty 2004; Harris et al. 2009; Charlebois 2007). However, others argue that healthy nudging can be used to increase the overall health of the population (Schwartz, 2007; Mancino and Guthrie, 2009; Ledderer et al. 2020). Marteau et

al. (2011) state that healthy nudging is not enough and that price intervention, regulation of food labelling, and the prevention of unhealthy nudging in food marketing are the best ways to move forward for short term health gains.

Meanwhile, Kraak et al. (2017) suggest healthy nudges may prove beneficial amongst brand manufacturers, retailers, and consumers. In fact, Just and Gabrielyan (2018) allude to potential, healthy nudging opportunities that would ensure profit to manufacturers and retailers, while securing healthier eating experiences for consumers. For example, this can be done by promoting fruit and vegetables with convenient bundles prominently placed in store endcaps (Payne and Niculescu 2018), or by placing subtle signage that leads shoppers to the produce aisle (Payne et al. 2015).

Portion size is often cited as one of the factors causing the rise in obesity. Rolls et al. (2003) find that subjects consumed 30% more energy when offered larger portions of food than when offered smaller portions. Furthermore, the response to variations of portion size was not influenced by subject characteristics such as gender or BMI (Rolls et al., 2003). Thus, portion size is a modifiable determinant of caloric intake that could be used in the prevention and treatment of obesity. A nudge toward healthy portion sizes can be a valuable resource for those individuals attempting to control his or her caloric intake.

However, the current literature does not clearly address the potential market for "nudged" or heuristically controlled food packaging. Nor does it address the potential effect of a policy that would allow marketers to claim that a certain type of packaging could discourage overeating. Presently, marketers are unable to profit from the sale of food packaged in such a way as to reduce consumption.

Regulation policy only focuses on the text, instead of the images, designs, and color of a product (Purnhagen et al. 2016). Texts such as "easily digestible," "as important as a daily glass

of milk," "may reduce the risk of heart disease," "helps strengthen the body's natural defenses," and "feel full for longer" have been controversial as health claims.

Current literature also provides insights into consumer's willingness to actively seek nudges in order to improve their food-related behavior. Previous research shows that some consumers are willing to limit their choices and even risk financial loss in an effort to change their consumption. In one particular study, Schwartz et al. (2014) gave grocery shoppers the opportunity to increase their healthy food purchases in order to gain an additional discount on their purchases. If shoppers did not meet the agreed upon increase (5%), they would forfeit their 25% discount for that month. 36% of households that were offered the binding commitment agreed. The average increase in healthy food purchases among those households was 3.5% per month for the six-month duration of the study.

Other research also suggests consumers may willingly select and purchase products, in response to healthy nudges. Thorndike et al. (2014) implemented choice architecture and traffic-light techniques in a hospital cafeteria. Specifically, the researchers assigned various colors to respective foods, labeling products with a given color. Green labels indicated healthy foods, while yellow colors connoted less healthy foods. Red colors denoted unhealthy foods. Over the course of two years, consumers gravitated toward the green-labeled, lower-calorie products, whereas yellow and red products experienced a decline in sales. Although Thorndike's experiment differs substantially in context and intervention from our study, it may indicate a consumer demand for healthy nudges in the food marketplace. Additionally, Hawley et al. (2013) asserts that while traffic-light systems may assist consumers in identifying healthy products, further research is needed regarding potential alternative. Furthermore, other literature expounds factors that may lead individuals to suboptimal food-related behavior.

Brehm (1966) proposed the theory of psychological reactance, which implies that if a behavior is reduced or threatened with reduction, the actor will be "directed toward the re-establishment of whatever freedom has been lost or threatened". That is, the simple existence of a (real or implied) behavioral restriction can lead individuals to act in *opposition* to incentivized behavior. Brehm classifies each of the following behaviors as constituting reactance when following a limitation or threat to some freedoms: increased desire for threatened or reduced freedoms, engaging in threatened or reduced behaviors, engaging in behaviors which imply that the agent is also free to engage in the threatened or reduced behavior, and/or encouraging peers to engage in eliminated or threatened behaviors. The suggestion that an individual will increase their desire for the threatened freedom has significant implications for economic regulation.

Brehm postulates that the magnitude of the reactance behaviors will be a function of the relative and absolute importance of the restricted freedom to the agent and, in the case of a threat, the magnitude of the threat. Reactance behaviors will also increase with the agent's perception that, as a result of the current limitation or threat, other freedoms will also be limited. While Brehm postulates a number of ways that reactance may be observed, we focus on the particular manifestation most relevant for discussions of empirical economics – an increased tendency for individuals to engage in a restricted or prohibited behavior. Importantly, if true, reactance theory predicts that individuals operating in the presence of newly introduced paternalistic policies may respond to them by engaging in the very behavior that the policy has been introduced to correct. This underscores one of the key arguments for nudges: *they avoid any direct or overt threat to freedom, and thus avoid reactance.*

A large literature in psychology provides evidence of *reactance*, in particular that restricted freedoms can lead to an increased likelihood to engage in a restricted activity. For example, after a ban of phosphate-containing detergents in Florida, Mazis, Settle & Leslie (1973) survey

middle-income households in regions both affected and unaffected by the phosphate ban. Consumers for whom phosphate containing detergents were banned expressed more positive attitudes toward these detergents. Further, consumers for whom detergents had been banned expressed more negative attitudes toward government involvement in mitigating pollution. Pennebaker and Sanders (1976) provide the seminal evidence of reactance in their experiment demonstrating that signs prohibiting graffiti on men's bathroom walls resulted in a more graffiti-laden wall. The amount of graffiti found varied positively with the severity of the threat written on the sign and with the authoritativeness of the message source.

Reich & Robertson (1979) conduct a series of field experiments surrounding anti-littering messages, and conclude that direct, threatening messages prohibiting littering resulted in greater littering behavior than those appealing to social norms. Relevant to our work, Cacioppo and Petty 1979; Calder and Sternthal 1980; Petty and Cacioppo 1986 present evidence of increased consumption of foods associated with the placement of a negative warning label. More recent examples include Vrugt (1992) who observes increased negative attitudes toward female faculty members following the implementation of a policy giving women preferential treatment; Plant and Devine (2001) who present similar evidence following the implementation of affirmative action policies favoring blacks; and Allen et al. (1994) who find evidence of increased teen drinking in response to a non-binding increase in the legal drinking age. Kirchler (1999) surveys employers for attitudes toward taxation, tax avoidance and tax evasion and finds evidence that employers who had been in business for a relatively short period of time expressed a greater loss of freedom due to taxation and displayed greater reactance than more experienced employers. Recent literature has focused on differentiating particular features of choice environments in which reactance behaviors are more likely to be observed (cf. Schade & Baum 2007; Laurin et al. 2012; Laurin et al. 2013).

Evidence from the psychology literature overwhelmingly supports the notion that authoritarian restrictions on behavior can induce reactance and result in greater tendencies toward the behavior that is threatened. Within the context of economics and public policy, two primary questions are of substantial interest. First, is the effect large enough that policy-makers should take note?; and second, how does the existence of reactance (a change in preferences that is potentially endogenous to policy changes) affect welfare analysis and evaluation of efficient policy?

Connected to this issue of reactance is a question of how nudges work when individuals are aware of the nudges. Many nudges may cease to be effective if decision-makers know the purpose of the nudge (Hansen et al. 2016). Sunstein (2015) has explored the ethical issues around nudging, finding that people do not regard all nudges as benign. This is an ethical concern if non-neutral nudges are manipulating choice and doing so in ways that consumers are unaware of. In the course of his arguments, Sunstein (2015) claims that many nudges maintain their effectiveness when consumers are aware of them, and further asserts that nudges are by nature transparent. Thus the effectiveness of nudges when they are transparent is a key question. We seek to determine if a nudge maintains effectiveness when subjects are aware of the nudge, and whether knowing the purpose of the nudge can induce reactance.

Data and Methodology

Method

The study was approved by the Cornell's Institutional Review Board. Each session was randomly assigned to one of four different treatment groups in a dimly lit setting. Across all four treatments, participants were asked to have a seat near the front of the room facing a projector screen. After filling out consent forms, a brief introduction was given to each treatment group. Participants were then asked to go to the back of the room to select a can of Pringles and a bottle

of water. Across all treatments, participants selected a can (2.38 Oz) of Pringles chips (with each can containing 35 chips) and sat viewing a TV show (an episode of The Big Bang Theory) with a duration of approximately 20 minutes. Participants were allowed to start eating at the beginning of the show and were informed to stop eating at the end of the show. They were allowed to select another can of chips if they finished their first can during the TV viewing[1].

Those randomly assigned to Treatment 1, the control treatment, were read a brief introduction and were asked to select a can of Pringles chips and a bottle of water prior to viewing the TV show. Treatment 2 was identical to the control group (Treatment 1), except the Pringles cans contained an assortment of chips in which every fifth chip was colored red. In what follows, the term 'nudged can' will refer to the can of chips in which every fifth chip was colored red. In Treatment 2, participants were told that every fifth chip was colored red (without revealing the purpose behind the coloring). Using treatments 1 and 2, we can replicate the prior study by Geier et al. This is a point of particular interest given the general controversy of studies involving Brian Wansink.

Treatment 3 was identical to Treatment 2, except, in this case, participants were informed of the reasoning for the colored chips prior to selecting a can of Pringles chips. They were told that every fifth chip was colored red and this had been shown to lead people to eat less. During Treatment 4, participants were given the option to decide whether they wanted a nudged can (with the reasoning for the colored chips being revealed) or a can without any colored chips (a standard can of Pringles). Participants who chose to select a can without any colored chips did so from a group of cans. Half of these cans were nudged cans while the other half contained no colored chips. This was unknown to participants prior to the selection. This was done to control

[1] - More detailed information about the study design and flow is given in the Appendix.

for selection effects and to identify if there was any reactance by participants who did not receive what they wanted.

At the end of each session, participants were given a survey asking questions about their eating habits, preferences toward nudging and overall perception of healthy eating. For each session, after all participants submitted a completed survey, the number of chips remaining in each participant's chip can was counted and recorded.

The study was conducted in two sets to allow enough observations for the analysis. After each session was completed, six participants were selected as winners for the following prizes: one first place prize of a $300 value, two second place prizes of a $200 value, and three third place prizes at a $100 value. Therefore, 12 people received gift cards with various values.

Data and Summary Statistics

Four treatments were conducted over periods of two months. Participants were recruited to sessions that could seat up to 160, with treatments randomized by session. This led to somewhat uneven treatment sample sizes. Overall 224 observations were collected. However, 12 observations were removed from the analysis since they were in sessions that had less than five people in the session.[2] Descriptive statistics of socio-demographic variables are reported in Table 1. 34% of participants were male and 66% were female[3]. Of all the participants, 37% reported some level of college education, 36% reported they had a bachelor's degree, and 14% indicated they had a post-graduate degree. The majority of participants (60%) were between the ages of 18 and 28, followed by those 51 years or older, 40-50 years old and 29-39 years old with respective shares of 18%, 12%, and 11%. While 52% of participants were white/Caucasian, Asian and Hispanic participants were a respective 19% and 11% share of participants. 10% of participants

[2] Such small sessions led to noticeably different consumption behavior due to the level of social observability.
[3] Early versions of the survey did not ask for gender. These numbers are based on 181 responses or 85% of the total number of observations.

had less than $29,999 household income. Other income groups were almost equally distributed among participants with an average of 22% each.

Treatment 1 had 39 participants consuming an average of 9.3 chips (reported in Table 2). Treatment 2 had 65 participants with an average of 8.1 chips consumed. Treatment 3 had 37 participants with a mean consumption of 15.6. There were 71 participants in Treatment 4 and an average consumption in this group was 13.6. Table 2 also includes data from sub-groups of Treatment 4 as well. Participants who chose to have a standard can of chips, and received a standard can, on average ate 12.3 chips. Those who chose to have a standard can of chips, but received a nudged can, on average ate 15.1 chips. In addition, those who chose to have a nudged can consumed 13.6 chips.

Participants were asked about their purchasing behavior, attitudes towards being nudged or buying a product or a service that nudges them to eat less. The descriptive statistics are provided in Table 3[4]. The variables were measured using a 9-point Likert scale, 1 being strong no to 9 being strong yes. When asked if participants consider themselves informed about nutrition, the average response was 6.9. Interestingly, participants who were in the control group and those who were in 4th group (choice) and selected (and picked) normal chips had the highest response with 7.2 value. We also asked if participants consider themselves a foodie. The average response was 6.0. In this case the same people who had a standard can gave the lowest values: 5.6 and 5.3 for T1 and T4-1 groups respectively. In this case, the highest values are associated with those who received red chips. Those who chose red chips in group 4 had the highest value – 6.4.

[4] - Table 3-7 include both average numbers for all participants, as well as the average numbers for each treatment and sub groups in treatment 4.

We also asked if participants feel guilty when they overeat. The average response was 6.1. The highest values were recorded for the T4-2 group (who chose a standard can but ended up with nudged can) with an average value of 7.0. Another similar question asked how participants feel about their weight. The average response was 5.4 out of 9.0 with 1 being totally unhappy and 9 being totally happy.

When asked if they would be willing to seek a product that claimed to be packaged in a manner that would decrease consumption (closely resembling the choice participants were presented with in Treatment 4), 80% of participants reported a 5 or higher with 15% of participants answering at a level of 9. This resulted in an average value of 4.9. Surprisingly, the participants in the sub-group of Treatment 4 who wanted a standard can of chips but picked a nudged one, gave the highest response of 6.1. But when asked if they would seek out a product that nudges to eat less, the response was slightly higher with an average value of 5.6.

Participants were slightly in favor of products that seek to influence their eating habits with an average response of 5.0 out of 9.0. When we asked participants if they believe they can improve their diet by consuming less calories, the average response was 6.7. Interestingly, the participants who were in Treatment group 3 (received a nudged can with information) had a lower response value of 5.5 compared to the others.

When we specifically presented participants with a question concerning buying a nudged or non-nudged container of potato chips (given that both are of equal price), 66% of participants indicated they would purchase the nudged container of potato chips and 18% indicated no preference. Furthermore, approximately 79% of Treatment 4, sub-group 2 (Standard - Nudged) participants selected a nudged container over a standard container of Pringles chips. We also asked a similar question that asked about willingness to eat at a Chili's restaurant that uses nudges to encourage consumers to eat fewer calories. In this case, 67% of participants were

willing to choose the restaurant that nudges towards healthier consumption. Similarly, people in Treatment 4 sub-group 2 had the highest willingness to choose those restaurants with 79% selecting this option. While the participants were willing to choose a restaurant that nudged consumers to eat less, participants, however, were not willing to pay higher prices for this service. Only 15% of participants were willing to pay a higher margin for the nudging restaurant.

The survey also included questions that asked participants' purchasing and consumption habits for low-nutrition foods, like salty snacks, potato chips, and desserts. The results are reported in Tables 4-7. When we asked participants, using the Likert scale, how much low-nutrition food they consume daily (1-9, with 1 being very little and 9 being a lot), the average response was 3.8 (Table 4). The highest frequency of consumption was again reported by panelists who received red chips with information in the second and the fourth treatment groups. Panelists, on average, consume low-nutrition foods mostly in the evening (40%) or late evening (45%).

The questionnaire also asked if participants get offended when they are told what to eat using the Likert scale (1 being strong no to 9 being strong yes). The average value of 3.6 showed that participants did not seem to get too offended. Participants in Treatment 4 that selected a standard can of chips but received a nudged can, on average, reported that they would be more offended in this case (the average value was 4.7). Participants were also asked about their mood when they consume low-nutrition food (1 – very bad mood to 9 – very good mood) and whether shopping alone influenced them to buy more low nutritional food (1 – strong yes to 9 – strong no). On average, participants reported average mood when purchasing low-nutrition foods. The majority of participants did not agree that shopping alone influenced their consumption volumes (3.8 average value). Participants also indicated that they would be slightly confused if a low

nutritional food brand would try to help them to eat healthier. The average value was 4.9 out of 9 Likert scale (1 being a strong no to 9 being a strong yes).

Results and Discussions

Table 8 shows group mean t-test results of chips consumption between treatments. The table shows results from both 2-sided and 1-sided hypothesis tests. However, we discuss 1-sided tests since we are comparing how much higher or lower the consumption is between the groups. When told that every fifth chip is colored red without telling participants the intention behind the nudge, panelists, on average, consumed 34% less. However, the change was not significant at $p < 0.10$. This is a somewhat interesting result in that it is consistent with the prior result in the literature, though it suggests a somewhat noisier treatment effect than was found previously. The consumption in Treatment 3 (when they are told of the purpose of the nudge) is significantly higher than participants in the control group ($p = 0.016$). Furthermore, the consumption in Treatment 3 is significantly higher ($p =0.001$) than the consumption in the Treatment group 2. This suggests that revealing the intent of our nudge to participants caused their consumption to increase, as we might expect with psychological reactance. In fact, Treatment 3 participants consumed approximately 93% more than participants in Treatment 2 did.

Giving participants a choice in treatment 4 did not have the intended effect on the consumption. Consumption was not significantly different between subgroups in Treatment 4 (Table 8.1.). The average consumption in Treatment 4 was 46% ($p = 0.044$) and 68% ($p = 0.004$) higher than the respective consumptions in Treatment groups 1 and 2. There was no significant difference between Treatments 3 and 4.

Figure 1 further divides chips consumption by gender. Male participants, on average consumed 79% (15.6 vs. 8.7) more chips compared to female participants. While there is almost no change between Treatment 1 and 2 for female panelists, male participants consume 34% less when told that each fifth chip is colored red (again not significant). However, as soon as we

revealed that each fifth chip is colored red and the reason behind the nudge, male participants consumed 133% more ($p = 0.013$) more than in Treatment 2 and 54% (not significant at 10%) more than in control group. In comparison, female participants consumed only 78% more ($p = 0.065$) compared to Treatment 2 and 81% more ($p = 0.070$) compared to the Control group.

Since the majority of participants (60%) were between the ages 18-28 we divided the age variable into two groups 18-28 and 29 and above. Figure 2 represents respective chips consumptions by both treatment and by age groups. Younger participants, on average, consumed 79% (14 vs. 7.8) more compared to older participants. Younger participants decreased their consumption between Treatments 1 and 2 by 40% ($p = 0.055$). When told the reason behind the nudge their consumption increases by 153% ($p = 0.0001$). The difference in consumption between treatment groups 1 and 3 was 50% ($p = 0.050$). When given a choice the consumption dropped by 16% from Treatment 3 (not significant). The only noticeable change (121% $p = 0.073$) in consumption by older participants was between the Control group and the second Treatment group, consistent with information undermining the ability of the nudge to function.

We also ran an analysis of chip consumption based on different education levels (Figure 3). We divided participants into two major groups: those with higher education (bachelor's degree or higher) and those without higher education (high school diploma, GED, or some college). Panelists with higher education, on average, consumed 32% ($p = 0.005$) fewer chips compared to others with lower levels of education. Panelists who do not have high education ate less when they were told that every fifth chip was colored red (Treatment 2) (not significant). However, those in treatment 3 ate 132% ($p = 0.002$) more compared to participants in Treatment 2. When given a choice they ate 25% less ($p = 0.078$). Panelists with higher education only ate 55% more in Treatment 3 compared to those in Treatment 2 ($p = 0.093$). There was no

significant difference in chip consumption between groups with different income levels or different races.

Ordinary least squares (OLS) analysis can be used to control for any possible systematic differences in population between treatments. The robust coefficient estimates of the OLS model are reported in Table 9. Consumption of chips, the dependent variable, was regressed on treatment types controlling for socioeconomic characteristics along with variables identifying participant consumption and preference habits. The results show that panelists ate 5.8 chips more if they were in the Treatment group 3, where we identified the reason behind the coloring of each 5^{th} chip in the can. The coefficient is significant at 5% significance level. Gender also has a positive and significant impact on consumption. Being male increases consumption by 5.4 chips ($p<0.05$). Older consumers (29 years or older), on average consume 3.6 fewer ($p<0.10$) compared to younger consumers.

OLS may be inappropriate due to the censored nature of the data. Out of 212 observations, 32% of observations are zero. As a result, OLS estimates are biased and inconsistent (Hill et al., 2008). Therefore, we used a Tobit model which takes into account the zero values and provides more efficient coefficient estimates. The results of Tobit model are presented in Table 9. The results show that Treatment 3 – revealing the reason behind the nudge – has a positive and significant impact on chip consumption. Participants in Treatment 3 ate 10.1 more chips ($p < 0.05$) compared to those in the Control group. Interestingly, those in sub group of Treatment 4, who chose a standard can but received a nudged can, also ate 10.8 units more ($p < 0.05$) compared to the average consumption in the Control group. Consistent with group mean comparisons, being a male increased the consumption of chips by 7.3 units ($p < 0.01$).

Discussions

Our results suggest that if policy makers or companies decide to offer a product nudged to reduce caloric consumption, they should be careful in communicating the message to consumers. While consumers are eager to choose a product or a service that tries to lower the amount of consumption, the results indicate that it is not going to happen if the same consumers feel manipulated. Consumers ate 93% more chips when told about the nudge and the reasons behind the nudge compared to those who are only told about the nudge or to those who were presented with the standard option. This further suggests that revealing the intent of our nudge and restricting choice leads to an increased consumption.

Interestingly, the participants, who had a choice to select between a standard can and a nudged can, selected a standard can but ended up with a nudged can, consumed almost the same amount as participants in a Treatment 3 did. Even though we did not mix their choices in Treatment 3, but giving them a manipulative option proved to be as *bad* as altering their choice in the subgroup of Treatment 4. This shows that giving participants a choice to make after telling them about the nudge and its intentions and altering some of their choices did not have significant impact on the consumption. A plausible explanation is that after telling participants about the nudge induces a reactance, which overrides the benefits of giving them a choice.

We also notice bigger consumption variation between groups for male participants. It implies that male consumers are more inclined to a nudge in general and show higher levels of reactance than female consumers. While male consumers show higher levels of reactance compared to females, we notice that their respective consumption is almost identical in Treatment 4 (when given a choice). This shows that giving a choice while revealing the purpose behind the nudge did not have any positive impact on male or female participants.

While younger participants decreased their consumption by 40%, older participants increased their respective consumption by 121% when told about the nudge without revealing

the purpose. Younger consumers are more inclined to a nudge compared to older consumers. They are also more likely to have higher levels of induced reactance revealed by the 153% increase in chips consumption in Treatment 2 compared to Treatment 3.

The consumption of chips among panelists who do not have higher education decreased by 28% when told about the colored chips compared to control group. In comparison, the respective consumption increased by 15% among those panelists who had higher education. This implies that panelists who do not have a higher education are more sensitive to a nudge compared to those with higher education. At the same time, we observed that consumers with higher education levels are less inclined toward reactance compared to their counterparts with lower education levels.

Conclusions

We find evidence that a transparent nudge can induce behavior that looks substantively like psychological reactance. This was especially the case for males in the sample, and those who are younger. Older individuals did not display the same reactance. Moreover, we find little evidence that consumers would be willing to pay any premium for foods that would nudge healthier eating.

Our study suggests that if a company offers a product designed to reduce caloric consumption during a single sitting, the product may actually increase the consumption. The reactance induced by perceived manipulation may increase consumption, undermining the intent of the nudge. It is not clear, however, if consumers will act differently if the nudge is implemented by food packagers or from the government. Moreover, while the behavior we observe is consistent with psychological reactance, it may also result from individuals overcompensating for the nudge and simply seeking to maintain their normal consumption pattern. This would be indistinguishable from reactance.

Of secondary importance in this study is the replication exercise. Given the cloud of suspicion hanging over the body of work involving Brian Wansink, a replication is of special interest. The result, however, is wholly unsatisfying. While the direction of the change in consumption between the control and Treatment 1 (the no-information udge) is consistent with prior work, the result is noisy and insignificant. In accord with Tversky and Kahneman (1974) this should add credibility to the original result. However, given the circumstances, it is difficult to draw any strong conclusion.

Finally, it is important to recognize the broader question of reactance undermining nudges. To the extent that nudges can induce reactant behavior, nudges will be severely limited in their policy and marketing effectiveness. While this study is only suggestive, it underscores a pressing need to understand how motivated individuals may respond to perceptions of being manipulated.

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Table 1. Descriptive statistics of socioeconomic variables

Variable	Description	Freq. (%)
Gender	0 if male	36.79
	1 if female	63.21
Age	1 if 18 – 28 years	59.82
	2 if 29-39 years	11.16
	3 if 40-50 years	12.05
	4 if 51 or above years	18.38
Education	1 if high school graduate	4.91
	2 if GED	0.45
	3 if some college or associate degree	37.05
	4 if Associate's degree	7.59
	5 if Bachelor's degree	35.71
	6 if post-graduate degree	14.29
Income	1 if income between 0-$29,999	10.55
	2 if income between $30,000-$59,999	22.94
	3 if income between $60,000-$74,999	18.35
	4 if income between $75,000-$119,999	25.23
	5 if income between $120,000 or above	22.94
Race	1 if African American	6.82
	2 if American Indian	0.45
	3 if Asian	19.09
	4 if Caucasian	51.82
	5 if Hispanic	11.36
	6 if Other	10.45

Table 2. Definition of each treatment and the number of observations in each group

Treatment	Description	Reference Name	N	Chips eaten (St. Dev.)
1	Standard can of Pringles	"Control"	39	9.3 (12.5)
2	Nudged can with the nudge's intent not provided to subjects	"No Info"	65	8.1 (11.2)
3	Nudged can with the nudge's intent provided to subjects	"Info"	37	15.6 (12.7)
4	Nudged can (with intent provided) + Option for standard can	"Choice"	71	13.6 (12.6)
4.11	Chose a standard can and picked a standard can	Normal-Normal	16	12.3 (13.1)
4.12	Chose a standard can and picked a nudged can	Normal-Red	14	15.1 (13.3)
4.2	Chose a nudged can at the beginning	Red	41	13.6 (12.0)

Table 3. Consumer preferences, willingness to choose and willingness to pay for products and services that nudge to eat healthier

Variable	Description	T1 Normal	T2 Red – No info	T3 Red - Info	T4 Choice	T4-1 Normal-Normal	T4-2 Normal-Red	T4-3 Red-Red	Average
		Mean value (St. Dev.)							
Feel about your weight	1 being an totally unhappy – 9 being totally happy	5.69 (2.31)	5.98 (2.23)	4.81 (2.32)	5.14 (2.44)	5.19 (2.64)	4.79 (2.72)	5.24 (2.32)	5.44 (2.36)
Consider informed about nutrition	1 being a strong no – 9 being a strong yes	7.18 (1.30)	6.82 (1.92)	6.78 (1.47)	6.86 (1.62)	7.19 (1.47)	6.79 (2.01)	6.76 (1.56)	6.89 (1.64)
Consider yourself a foodie		5.56 (2.66)	5.97 (2.63)	6.05 (2.10)	6.12 (2.33)	5.25 (2.84)	5.97 (2.63)	6.44 (2.06)	5.96 (2.46)
Feel guilty when overeat		6.41 (2.68)	6.25 (2.67)	6.30 (2.65)	5.83 (2.90)	5.00 (3.33)	7.00 (2.60)	5.76 (2.76)	6.14 (2.74)
Purchase a brand that asks to watch your health		4.00 (2.37)	5.18 (2.35)	4.68 (2.51)	5.23 (2.23)	5.13 (2.19)	6.14 (2.18)	4.95 (2.24)	4.89 (2.37)
It is desirable to have a company that tries to influence your eating habits		4.26 (2.17)	5.37 (2.34)	4.73 (2.21)	5.03 (2.52)	4.31 (2.63)	4.43 (2.17)	5.51 (2.53)	4.94 (2.37)
Do you believe that you can improve your diet by consuming less calories		6.90 (2.55)	6.45 (2.55)	5.54 (2.78)	6.94 (2.29)	7.19 (1.97)	5.93 (1.87)	7.20 (2.15)	6.71 (2.50)
Seek out a product that nudges to it less		5.51 (2.55)	6.38 (2.42)	2.30 (2.60)	6.15 (2.44)	6.13 (2.63)	5.93 (2.23)	6.24 (2.49)	5.56 (2.50)
Willingness to choose (WTC) a normal chips	1 if yes, 0 otherwise	0.18 (0.39)	0.15 (0.36)	0.22 (0.42)	0.11 (0.32)	0.31 (0.48)	0.07 (0.27)	0.05 (0.22)	0.16 (0.36)
WTC a chips that's packaged to nudge to eat less		0.54 (0.51)	0.71 (0.46)	0.62 (0.49)	0.69 (0.47)	0.50 (0.52)	0.79 (0.43)	0.73 (0.45)	0.66 (0.48)
WTC a normal Chili's restaurant		0.15 (0.37)	0.17 (0.38)	0.16 (0.38)	0.10 (0.30)	0.06 (0.25)	0.00 (0.00)	0.15 (0.36)	0.14 (0.35)
WTC a Chili's restaurant that nudges to reduce calories consumed		0.59 (0.50)	0.66 (0.48)	0.59 (0.50)	0.75 (0.44)	0.56 (0.51)	0.86 (0.36)	0.78 (0.42)	0.67 (0.47)
Willingness to pay for nudging restaurant		0.10 (0.31)	0.18 (0.39)	0.11 (0.31)	0.17 (0.38)	0.06 (0.25)	0.21 (0.43)	0.20 (0.40)	0.15 (0.36)

Table 4. Consumer preferences and consumption habits for low nutritional foods (LNF)

Variable	Description	T1 Normal	T2 Red – No info	T3 Red - Info	T4 Choice	T4-1 Normal-Normal	T4-2 Normal-Red	T4-3 Red-Red	Average
		Mean value (St. Dev.)							
How much LNF do you consumer daily	1 being too little – 9 being too much	3.41 (1.73)	3.60 (1.83)	4.30 (1.89)	3.89 (1.97)	3.69 (1.54)	4.43 (1.99)	3.78 (2.12)	3.78 (1.97)
Get offended when told to eat healthier	1 being a strong no – 9 being a strong yes	3.62 (5.53)	3.09 (2.08)	4.43 (2.35)	3.65 (2.50)	3.38 (2.80)	4.71 (2.61)	3.39 (2.30)	3.61 (2.39)
Shopping alone influences the purchase of LNF		4.38 (2.73)	3.69 (2.58)	3.95 (2.39)	3.65 (2.61)	2.81 (2.14)	3.79 (2.91)	3.93 (2.66)	3.85 (2.58)
Would you be confused if LNF brand is trying to help you		5.49 (2.29)	4.95 (2.62)	5.05 (2.49)	4.69 (2.53)	4.88 (2.53)	4.64 (2.27)	4.63 (2.66)	4.98 (2.51)
The mood when eating LNF	1 being a very bad mood, 9 being a very good mood	5.49 (2.29)	4.95 (2.62)	5.05 (2.49)	4.69 (2.53)	4.88 (2.53)	4.64 (2.27)	4.63 (2.66)	4.98 (2.51)
Time of day consuming LNF									
Morning	1 if yes, 0 otherwise	0.00 (0.00)	0.02 (0.12)	0.11 (0.31)	0.06 (0.23)	0.13 (0.34)	0.07 (0.27)	0.24 (0.16)	0.04 (0.20)
Afternoon		0.33 (0.48)	0.18 (0.39)	0.08 (0.28)	0.17 (0.38)	0.13 (0.34)	0.14 (0.36)	0.20 (0.40)	0.19 (0.39)
Evening		0.49 (0.51)	0.38 (0.49)	0.38 (0.49)	0.38 (0.49)	0.31 (0.48)	0.50 (0.52)	0.37 (0.49)	0.40 (0.49)
Late evening		0.28 (0.46)	0.42 (0.50)	0.46 (0.51)	0.45 (0.50)	0.44 (0.51)	0.29 (0.47)	0.51 (0.51)	0.45 (0.50)
Activities before eating LNF									
TV	1 if yes, 0 otherwise	0.26 (0.44)	0.51 (0.50)	0.43 (0.50)	0.48 (0.50)	0.50 (0.52)	0.43 (0.51)	0.49 (0.51)	0.44 (0.50)
Exercise		0.13 (0.34)	0.17 (0.38)	0.24 (0.43)	0.15 (0.36)	0.13 (0.34)	0.14 (0.36)	0.17 (0.38)	0.17 (0.38)
Work		0.69 (0.47)	0.45 (0.50)	0.59 (0.50)	0.51 (0.50)	0.50 (0.52)	0.64 (0.50)	0.46 (0.50)	0.54 (0.50)

Socialize		0.31 (0.47)	0.26 (0.44)	0.41 (0.50)	0.28 (0.45)	0.19 (0.40)	0.29 (0.47)	0.32 (0.47)	0.30 (0.46)
Videogames		0.10 (0.31)	0.12 (0.33)	0.14 (0.35)	0.07 (0.26)	0.06 (0.25)	0.07 (0.27)	0.07 (0.26)	0.10 (0.31)
Other		0.13 (0.34)	0.08 (0.27)	0.16 (0.37)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.02 (0.16)	0.08 (0.27)
Activities while eating LNF									
TV		0.64 (0.49)	0.68 (0.47)	0.78 (0.42)	0.66 (0.48)	0.63 (0.50)	0.64 (0.50)	0.68 (0.47)	0.68 (0.47)
Exercise		0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.02 (0.16)	0.00 (0.07)
Work		0.51 (0.50)	0.22 (0.41)	0.41 (0.50)	0.34 (0.48)	0.44 (0.51)	0.36 (0.50)	0.29 (0.46)	0.34 (0.48)
Socialize	1 if yes, 0 otherwise	0.26 (0.44)	0.43 (0.50)	0.51 (0.51)	0.41 (0.49)	0.31 (0.48)	0.43 (0.51)	0.44 (0.50)	0.41 (0.49)
Videogames		0.10 (0.31)	0.12 (0.33)	0.11 (0.31)	0.06 (0.23)	0.06 (0.25)	0.07 (0.27)	0.05 (0.22)	0.09 (0.29)
Other		0.10 (0.31)	0.08 (0.27)	0.03 (0.16)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.02 (0.16)	0.05 (0.22)
Activities after eating LNF									
TV		0.36 (0.49)	0.40 (0.49)	0.49 (0.51)	0.45 (0.50)	0.44 (0.51)	0.57 (0.51)	0.41 (0.50)	0.42 (0.50)
Exercise		0.15 (0.37)	0.06 (0.24)	0.05 (0.23)	0.08 (0.28)	0.06 (0.25)	0.00 (0.00)	0.12 (0.33)	0.08 (0.28)
Work		0.46 (0.51)	0.28 (0.45)	0.41 (.050)	0.37 (0.49)	0.56 (0.51)	0.29 (0.47)	0.32 (0.47)	0.36 (0.48)
Socialize	1 if yes, 0 otherwise	0.26 (0.44)	0.18 (0.39)	0.35 (0.48)	0.31 (0.47)	0.31 (0.48)	0.433 (0.51)	0.44 (0.50)	0.27 (0.44)
Videogames		0.08 (0.27)	0.05 (0.21)	0.03 (0.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.18)
Other		0.28 (0.46)	0.17 (0.38)	0.46 (0.51)	0.13 (0.34)	0.06 (0.25)	0.14 (0.36)	0.15 (0.36)	0.23 (0.42)

Table 5. Consumer preferences and consumption habits for salty snacks (SS)

Variable	Description	T1 Normal	T2 Red – No info	T3 Red - Info	T4 Choice	T4-1 Normal-Normal	T4-2 Normal-Red	T4-3 Red-Red	Average
		Mean value (St. Dev.)							
How much SS do you consumer daily	1 being too little – 9 being too much	3.38 (1.53)	3.65 (2.14)	3.70 (2.31)	3.93 (2.19)	4.00 (1.86)	4.43 (2.28)	3.73 (2.29)	3.70 (2.08)
Shopping alone influences the purchase of SS	1 being a strong no – 9 being a strong yes	4.08 (2.65)	3.46 (2.60)	3.84 (2.30)	3.69 (2.47)	3.00 (2.16)	3.50 (2.56)	4.022 (2.55)	3.72 (2.51)
Would you be confused if SS brand is trying to help you		5.33 (2.26)	4.77 (2.43)	4.78 (2.44)	4.54 (2.46)	4.13 (2.28)	4.79 (2.46)	4.61 (2.57)	4.80 (2.41)
The mood when eating SS	1 being a very bad mood, 9 being a very good mood	4.74 (1.25)	5.37 (1.50)	5.27 (1.79)	4.94 (1.47)	5.19 (1.33)	5.00 (1.88)	4.83 (1.39)	5.09 (1.51)
Time of day consuming SS									
Morning	1 if yes, 0 otherwise	0.00 (0.00)	0.09 (0.74)	0.03 (0.16)	0.04 (0.20)	0.06 (0.25)	0.00 (0.00)	0.05 (0.22)	0.05 (0.43)
Afternoon		0.56 (0.50)	0.38 (0.52)	0.30 (0.46)	0.34 (0.48)	0.44 (0.51)	0.21 (0.43)	0.34 (0.48)	0.39 (0.50)
Evening		0.31 (0.47)	0.37 (0.49)	0.38 (0.49)	0.44 (0.50)	0.38 (0.50)	0.64 (0.50)	0.39 (0.49)	0.38 (0.49)
Late evening		0.28 (0.46)	0.29 (0.46)	0.41 (0.50)	0.28 (0.45)	0.13 (0.34)	0.14 (0.36)	0.39 (0.49)	0.31 (0.46)
Activities before eating SS									
TV	1 if yes, 0 otherwise	0.26 (0.44)	0.38 (0.49)	0.41 (0.50)	0.35 (0.48)	0.25 (0.45)	0.29 (0.47)	0.41 (0.50)	0.35 (0.48)
Exercise		0.15 (0.37)	0.20 (0.40)	0.30 (0.46)	0.20 (0.40)	0.19 (0.40)	0.21 (0.43)	0.20 (0.40)	0.21 (0.41)

Work		0.72 (0.54)	0.54 (0.50)	0.65 (0.48)	0.65 (0.48)	0.69 (0.48)	0.71 (0.47)	0.61 (0.49)	0.43 (0.48)
Socialize		0.31 (.047)	0.25 (0.43)	0.41 (0.50)	0.28 (0.45)	0.19 (0.40)	0.57 (0.51)	0.22 (0.42)	0.30 (0.46)
Videogames		0.10 (0.31)	0.11 (0.31)	0.05 (0.23)	0.07 (0.26)	0.06 (0.25)	0.00 (0.00)	0.10 (0.30)	0.08 (0.28)
Other		0.05 (0.22)	0.05 (0.21)	0.03 (0.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.17)
Activities while eating SS									
TV	1 if yes, 0 otherwise	0.62 (0.49)	0.60 (0.49)	0.78 (0.42)	0.58 (0.50)	0.50 (0.52)	0.50 (0.52)	0.63 (0.49)	0.63 (0.48)
Exercise		0.03 (0.16)	0.03 (0.17)	0.00 (0.00)	0.01 (0.12)	0.00 (0.00)	0.00 (0.00)	0.02 (0.16)	0.02 (0.14)
Work		0.51 (0.56)	0.37 (0.49)	0.59 (0.50)	0.46 (0.50)	0.56 (0.51)	0.36 (0.50)	0.46 (0.50)	0.47 (0.51)
Socialize		0.46 (0.32)	0.55 (0.47)	0.51 (0.51)	0.34 (0.48)	0.25 (0.45)	0.57 (0.51)	0.29 (0.46)	0.39 (0.48)
Videogames		0.10 (0.31)	0.14 (0.35)	0.14 (0.35)	0.06 (0.23)	0.06 (0.25)	0.00 (0.00)	0.07 (0.26)	0.10 (0.31)
Other		0.05 (0.22)	0.06 (0.24)	0.03 (0.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.18)
Activities after eating SS									
TV	1 if yes, 0 otherwise	0.33 (0.48)	0.42 (0.50)	0.51 (0.51)	0.45 (0.50)	0.31 (0.48)	0.50 (0.52)	0.49 (0.51)	0.43 (0.50)
Exercise		0.10 (0.31)	0.08 (0.27)	0.11 (0.31)	0.14 (0.35)	0.13 (0.34)	0.14 (0.36)	0.15 (0.36)	0.11 (0.31)
Work		0.62 (0.49)	0.32 (0.47)	0.59 (0.50)	0.59 (0.50)	0.63 (0.50)	0.57 (0.51)	0.59 (0.50)	0.51 (0.50)
Socialize		0.38 (0.49)	0.34 (0.48)	0.43 (0.50)	0.24 (0.43)	0.25 (0.45)	0.57 (0.51)	0.29 (0.46)	0.33 (0.47)
Videogames		0.10 (0.31)	0.05 (0.21)	0.08 (0.28)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.05 (0.21)
Other		0.15	0.14	0.22	0.06	0.06	0.07	0.05	0.13

		(0.37)	(0.35)	(0.42)	(0.23)	(0.25)	(0.27)	(0.22)	(0.33)

Table 6. Consumer preferences and consumption habits for potato chips (PC)

Variable	Description	T1 Normal	T2 Red – No info	T3 Red - Info	T4 Choice	T4-1 Normal-Normal	T4-2 Normal-Red	T4-3 Red-Red	Average
		Mean value (St. Dev.)							
How much PC do you consumer daily	1 being too little – 9 being too much	1.69 (1.40)	1.94 (1.63)	2.08 (1.52)	2.08 (1.75)	1.88 (1.57)	2.50 (2.07)	2.02 (1.72)	1.97 (1.61)
Shopping alone influences the purchase of PC	1 being a strong no – 9 being a strong yes	3.82 (2.56)	3.40 (2.71)	3.41 (2.42)	3.65 (2.71)	3.00 (2.71)	3.71 (2.05)	3.88 (2.61)	3.56 (2.62)
Would you be confused if PC brand is trying to help you		5.59 (2.27)	5.02 (2.71)	5.32 (2.60)	4.53 (2.77)	3.88 (2.87)	4.36 (2.27)	4.85 (2.88)	5.01 (2.65)
The mood when eating PC	1 being a very bad mood, 9 being a very good mood	5.08 (1.48)	5.35 (1.95)	5.03 (0.76)	5.21 (1.67)	5.5 (1.46)	4.79 (2.01)	5.24 (1.64)	5.20 (1.74)
Time of day consuming PC									
Morning	1 if yes, 0 otherwise	0.00 (0.00)	0.25 (0.13)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.08 (0.63)
Afternoon		0.49 (0.51)	0.38 (0.52)	0.16 (0.37)	0.37 (0.49)	0.44 (0.51)	0.36 (0.50)	0.34 (0.48)	0.36 (0.49)
Evening		0.33 (0.48)	0.37 (0.49)	0.51 (0.51)	0.42 (0.50)	0.44 (0.51)	0.36 (0.50)	0.44 (0.50)	0.41 (0.50)
Late evening		0.26 (0.44)	0.32 (0.47)	0.38 (0.49)	0.23 (0.42)	0.13 (0.34)	0.21 (0.43)	0.27 (0.49)	0.29 (0.45)
Activities before eating PC									
TV	1 if yes, 0 otherwise	0.33 (0.48)	0.34 (0.48)	0.35 (0.48)	0.42 (0.50)	0.38 (0.50)	0.29 (0.47)	0.49 (0.51)	0.37 (0.48)
Exercise		0.13	0.12	0.22	0.14	0.06	0.07	0.20	0.15

		(0.34)	(0.33)	(0.42)	(0.35)	(0.25)	(0.27)	(0.10)	(0.35)
Work		0.59	0.48	0.62	0.52	0.69	0.43	0.49	0.54
		(0.50)	(0.50)	(0.49)	(0.50)	(0.48)	(0.51)	(0.51)	(0.50)
Socialize		0.41	0.23	0.51	0.30	0.31	0.50	0.22	0.33
		(0.50)	(0.42)	(0.51)	(0.46)	(0.48)	(0.52)	(0.42)	(0.47)
Videogames		0.08	0.08	0.05	0.08	0.13	0.07	0.07	0.08
		(0.27)	(0.27)	(0.23)	(0.28)	(0.34)	(0.27)	(0.26)	(0.26)
Other		0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.02
		(0.16)	(0.17)	(0.16)	(0.00)	(0.00)	(0.00)	(0.00)	(0.14)
Activities while eating PC									
TV		0.67	0.52	0.78	0.51	0.44	0.43	0.56	0.59
		(0.48)	(0.50)	(0.42)	(0.49)	(0.51)	(0.51)	(0.50)	(0.49)
Exercise		0.00	0.05	0.00	0.04	0.00	0.00	0.07	0.03
		(0.00)	(0.21)	(0.00)	(0.20)	(0.00)	(0.00)	(0.26)	(0.17)
Work		0.31	0.37	0.32	0.35	0.31	0.29	0.39	0.34
		(0.47)	(0.49)	(0.47)	(0.48)	(0.48)	(0.47)	(0.49)	(0.48)
Socialize	1 if yes, 0 otherwise	0.44	0.43	0.51	0.37	0.44	0.50	0.29	0.42
		(0.50)	(0.50)	(0.51)	(0.49)	(0.51)	(0.52)	(0.46)	(0.50)
Videogames		0.10	0.14	0.16	0.03	0.06	0.00	0.02	0.10
		(0.31)	(0.35)	(0.37)	(0.17)	(0.25)	(0.00)	(0.16)	(0.30)
Other		0.05	0.03	0.03	0.03	0.06	0.00	0.02	0.03
		(0.22)	(0.17)	(0.16)	(0.17)	(0.25)	(0.00)	(0.16)	(0.18)
Activities after eating PC									
TV		0.54	0.37	0.54	0.52	0.44	0.57	0.54	0.48
		(0.51)	(0.49)	(0.51)	(0.50)	(0.51)	(0.51)	(0.50)	(0.50)
Exercise		0.15	0.09	0.08	0.07	0.06	0.07	0.07	0.09
		(0.37)	(0.29)	(0.28)	(0.26)	(0.25)	(0.27)	(0.26)	(0.29)
Work		0.44	0.40	0.51	0.46	0.44	0.43	0.49	0.45
	1 if yes, 0 otherwise	(0.50)	(0.49)	(0.51)	(0.50)	(0.51)	(0.51)	(0.51)	(0.50)
Socialize		0.44	0.29	0.46	0.37	0.44	0.50	0.29	0.37
		(0.50)	(0.46)	(0.51)	(0.49)	(0.51)	(0.52)	(0.46)	(0.48)
Videogames		0.05	0.06	0.11	0.00	0.00	0.00	0.00	0.05
		(0.22)	(0.24)	(0.31)	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)

Other		0.08 (0.27)	0.11 (0.31)	0.19 (0.40)	0.03 (0.17)	0.06 (0.25)	0.00 (0.00)	0.02 (0.16)	0.09 (0.29)

Table 7. Consumer preferences and consumption habits for dessert foods (DF)

Variable	Description	T1 Normal	T2 Red – No info	T3 Red - Info	T4 Choice	T4-1 Normal-Normal	T4-2 Normal-Red	T4-3 Red-Red	Average
		Mean value (St. Dev.)							
How much DF do you consumer daily	1 being too little – 9 being too much	3.56 (2.23)	3.61 (2.12)	3.70 (1.96)	3.37 (2.09)	2.81 (1.97)	3.93 (2.20)	3.39 (2.08)	3.54 (2.09)
Shopping alone influences the purchase of DF	1 being a strong no – 9 being a strong yes	3.95 (2.74)	4.08 (2.69)	3.70 (2.38)	4.03 (2.69)	3.00 (2.28)	4.50 (3.16)	4.27 (2.63)	3.97 (2.63)
Would you be confused if DF brand is trying to help you		5.31 (2.47)	5.29 (2.74)	4.89 (2.61)	4.62 (2.69)	4.50 (2.68)	5.00 (2.48)	4.54 (2.81)	5.10 (2.66)
The mood when eating DF	1 being a very bad mood, 9 being a very good mood	5.85 (1.51)	6.38 (1.66)	6.16 (1.62)	5.89 (1.66)	6.06 (1.77)	5.64 (2.17)	5.90 (1.45)	6.08 (1.63)
Time of day consuming DF									
Morning	1 if yes, 0 otherwise	0.00 (0.00)	0.03 (0.17)	0.03 (0.16)	0.06 (0.23)	0.06 (0.25)	0.00 (0.00)	0.07 (0.26)	0.03 (0.18)
Afternoon		0.13 (0.34)	0.09 (0.29)	0.19 (0.40)	0.23 (0.42)	0.25 (0.45)	0.21 (0.43)	0.22 (0.42)	0.16 (0.37)
Evening		0.62 (0.49)	0.51 (0.50)	0.57 (0.50)	0.51 (0.50)	0.44 (0.51)	0.64 (0.50)	0.49 (0.51)	0.54 (0.50)
Late evening		0.41 (0.50)	0.43 (0.50)	0.35 (0.48)	0.34 (0.48)	0.38 (0.50)	0.29 (0.47)	0.34 (0.48)	0.38 (0.49)
Activities before eating DF									
TV	1 if yes, 0 otherwise	0.28	0.40	0.35	0.34	0.38	0.29	0.34	0.35

		(0.46)	(0.49)	(0.48)	(0.48)	(0.50)	(0.47)	(0.48)	(0.48)
Exercise		0.15	0.17	0.19	0.13	0.00	0.14	0.17	0.16
		(0.37)	(0.38)	(0.40)	(0.36)	(0.00)	(0.36)	(0.38)	(0.36)
Work		0.51	0.48	0.51	0.51	0.38	0.71	0.49	0.50
		(0.51)	(0.50)	(0.51)	(0.50)	(0.50)	(0.47)	(0.51)	(0.50)
Socialize		0.46	0.40	0.49	0.41	0.31	0.57	0.39	0.43
		(0.51)	(0.49)	(0.51)	(0.50)	(0.48)	(0.51)	(0.49)	(0.50)
Videogames		0.05	0.08	0.00	0.01	0.00	0.00	0.02	0.04
		(0.23)	(0.27)	(0.00)	(0.19)	(0.00)	(0.00)	(0.16)	(0.19)
Other		0.05	0.09	0.27	0.04	0.13	0.00	0.02	0.10
		(0.23)	(0.29)	(0.45)	(0.20)	(0.34)	(0.00)	(0.16)	(0.30)
Activities while eating DF									
TV		0.59	0.55	0.54	0.45	0.44	0.57	0.41	0.52
		(0.50)	(0.50)	(0.50)	(0.50)	(0.51)	(0.51)	(0.50)	(0.50)
Exercise		0.00	0.02	0.00	0.01	0.00	0.00	0.02	0.01
		(0.00)	(0.12)	(0.00)	(0.12)	(0.00)	(0.00)	(0.16)	(0.10)
Work		0.33	0.20	0.27	0.28	0.19	0.43	0.27	0.26
		(0.48)	(0.40)	(0.45)	(0.45)	(0.40)	(0.51)	(0.45)	(0.44)
Socialize	1 if yes, 0 otherwise	0.64	0.60	0.54	0.59	0.50	0.64	0.61	0.58
		(0.49)	(0.50)	(0.51)	(0.50)	(0.52)	(0.50)	(0.49)	(0.49)
Videogames		0.03	0.08	0.05	0.00	0.00	0.00	0.00	0.04
		(0.16)	(0.27)	(0.23)	(0.00)	(0.00)	(0.00)	(0.00)	(0.23)
Other		0.05	0.05	0.14	0.01	0.06	0.00	0.00	0.05
		(0.22)	(0.21)	(0.35)	(0.12)	(0.25)	(0.00)	(0.00)	(0.22)
Activities after eating DF									
TV		0.59	0.42	0.57	0.45	0.50	0.50	0.41	0.49
		(0.50)	(0.50)	(0.50)	(0.50)	(0.52)	(0.52)	(0.50)	(0.50)
Exercise		0.10	0.08	0.03	0.13	0.06	0.14	0.15	0.09
		(0.31)	(0.27)	(0.16)	(0.34)	(0.25)	(0.36)	(0.36)	(0.29)
Work		0.28	0.25	0.41	0.31	0.19	0.36	0.34	0.30
		(0.46)	(0.43)	(0.50)	(0.47)	(0.40)	(0.50)	(0.48)	(0.46)
Socialize	1 if yes, 0 otherwise	0.44	0.32	0.51	0.44	0.50	0.64	0.61	0.42
		(0.50)	(0.47)	(0.51)	(0.50)	(0.52)	(0.50)	(0.49)	(0.49)
Videogames		0.03	0.09	0.00	0.00	0.00	0.00	0.00	0.03
		(0.16)	(0.29)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.18)
Other		0.13	0.17	0.30	0.07	0.00	0.07	0.10	0.15

	(0.34)	(0.38)	(0.46)	(0.26)	(0.00)	(0.27)	(0.30)	(0.36)

Table 8: Consumption Differences between Main Treatment Groups: Results of t-test Statistics

Treatment groups		Control	Nudged – No info	Nudged – Info	Choice	*Consumption (in units)*
		p-values of two-tailed tests*				*Mean (Std. Err.)*
Control	**p-values of one-tailed tests****		0.618	**0.031**	0.088	9.3 (12.5)
Nudged – No info		0.309		**0.003**	**0.008**	8.1 (11.2)
Nudged – Info		**0.016**	**0.001**		0.412	15.6 (12.7)
Choice		**0.044**	**0.004**	0.206		13.6 (12.6)
					F-test (p-value)	**4.25 (0.006)**

* - Alternative hypothesis – Group means are not equal to each other
** - Alternative hypothesis – One group means is greater than the other

Table 8.1: Consumption Differences between Sub-groups in the 4th Treatment Group (*Choice*): Results of t-test Statistics

Treatment groups		Standard - Standard	Standard - Nudged	Nudged - Nudged	*Consumption (in units)*
		p-values of two-tailed tests*			*Mean (Std. Err.)*
Control	**p-values of one-tailed tests****		0.573	0.737	12.3 (13.1)
Standard - Nudged		0.286		0.689	15.1 (13.3)
Nudged - Nudged		0.368	0.656		13.6 (12.0)
				F-test (p-value)	0.18 (0.834)

Table 9: Coefficient estimates of ordinary Least Squares and Tobit models

Variables	OLS			Tobit	
	Robust Coefficient	Std. Err	P-value	Coefficient	Std. E
Treatment 2 – No info	- 2.55	2.56	0.321	-3.38	3.5
Treatment 3 –Info	5.78**	2.92	0.050	10.12**	4.2
Treatment 4.1. – Standard-Standard	2.73	3.56	0.445	6.29	5.1
Treatment 4.2. – Standard-Red	5.95*	3.60	0.101	10.77**	4.9
Treatment 4.1. – Red-Red	3.17	3.09	0.306	4.48	3.8
Gender	5.44**	2.15	0.012	7.30***	2.7
Age 29 and above	- 3.62*	2.13	0.091	-4.26	2.8
Middle income ($30,000-$74,999)	0.18	3.30	0.956	1.20	4.0
High income ($30,000-$74,999)	- 2.25	3.20	0.483	-2.50	4.0
Bachelor's Degree or higher	- 2.15	2.04	0.295	-2.64	2.6
Race – none white	2.06	1.95	0.293	2.96	2.5
I feel good about my weight	- 0.16	0.45	0.732	0.04	0.6
I feel guilty when I overeat	- 0.89**	0.41	0.030	-1.39***	0.5
I consider myself foodie	0.31	0.41	0.442	0.64	0.5
I am informed about nutrition	- 0.41	0.55	0.459	-0.87	0.8
Daily chips consumption	0.44	0.58	0.450	0.40	0.7
My mood when eating chips	0.49	0.49	0.312	0.93	0.7
Shopping alone influences my chips' consumption	0.48	0.41	0.239	0.72	0.5
I would be confused if chips producing company tries to influence my health	- 0.13	0.37	0.717	-0.15	0.4
It's desirable to have a company that tries to influence my eating habits	- 0.24	0.38	0.537	-0.38	0.5
I purchase a brand that asks to watch my health	0.32	0.43	0.466	0.53	0.6
I can improve my health consuming less calories	- 0.02	0.49	0.960	0.15	0.6

I am willing to choose chips that's packaged to nudge to eat less	1.57	2.12	0.461	3.80	3.0
Constant	11.77	7.78	0.132	3.21	10.7

Table 9.1: Coefficient estimates of ordinary Least Squares and Tobit models

Variables	OLS			Tobit	
	Robust Coefficient	Std. Err	P-value	Coefficient	Std. E
Treatment 2 – No info	- 1.86	2.44	0.447	-2.44	3.3
Treatment 3 –Info	5.46**	2.67	0.043	9.01**	3.6
Treatment 4.1. – Standard-Standard	1.37	3.46	0.692	3.90	4.7
Treatment 4.2. – Standard-Red	5.10	3.48	0.144	9.53*	4.9
Treatment 4.1. – Red-Red	2.54	3.02	0.403	4.02	3.6
Age 29 and above	- 5.33***	1.96	0.007	- 6.66**	2.6
Middle income ($30,000-$74,999)	1.49	2.85	0.601	1.50	3.5
High income ($30,000-$74,999)	0.61	2.77	0.827	-0.03	3.5
Bachelor's Degree or higher	- 1.38	1.87	0.459	-1.85	2.4
Race – none white	2.08	1.77	0.244	3.24	2.3
I feel good about my weight	- 0.41	0.43	0.341	-0.28	0.6
I feel guilty when I overeat	- 1.10***	0.37	0.004	-1.57***	0.4
I consider myself foodie	0.18	0.37	0.623	0.42	0.4
I am informed about nutrition	- 0.31	0.53	0.564	-0.71	0.7
Daily chips consumption	0.78	0.54	0.152	0.76	0.7
My mood when eating chips	0.81*	0.42	0.056	1.28*	0.6
Shopping alone influence chips consumption	0.48	0.34	0.155	0.73*	0.4
I would be confused if chips producing company tries to influence my health	- 0.12	0.33	0.725	-0.20	0.4
It's desirable to have a company that tries to influence my eating habits	- 0.18	0.35	0.622	-0.17	0.4
I purchase a brand that asks to watch my health	0.28	0.39	0.481	0.43	0.5

I can improve my health consuming less calories	- 0.17	0.46	0.715	-0.07	0.5
I am willing to choose chips that's packaged to nudge to eat less	1.74	1.78	0.331	3.18	2.6
Constant	13.41*	7.09	0.060	7.36	9.4

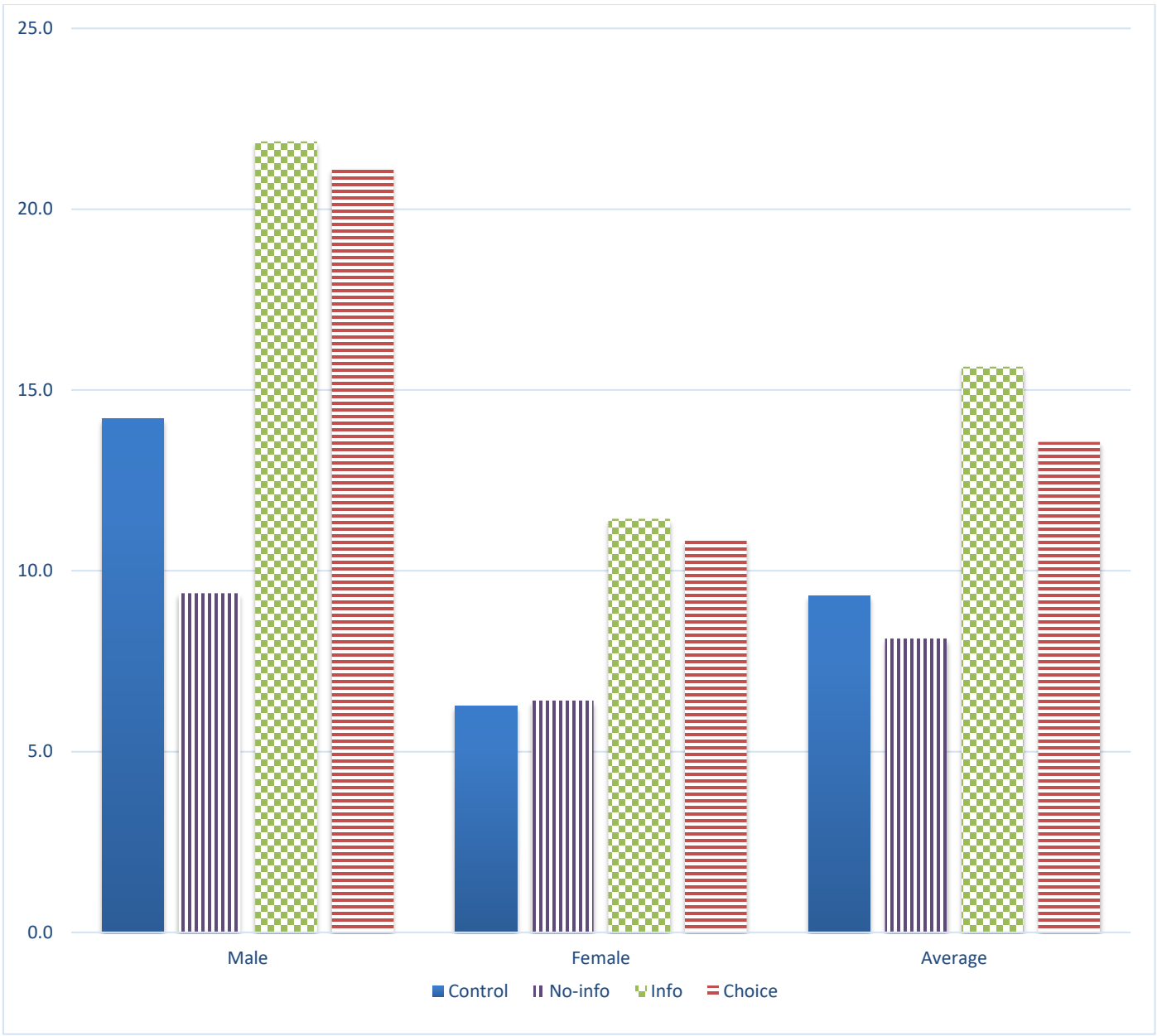

Figure 1: The variation of chips consumption by treatment group and by gender

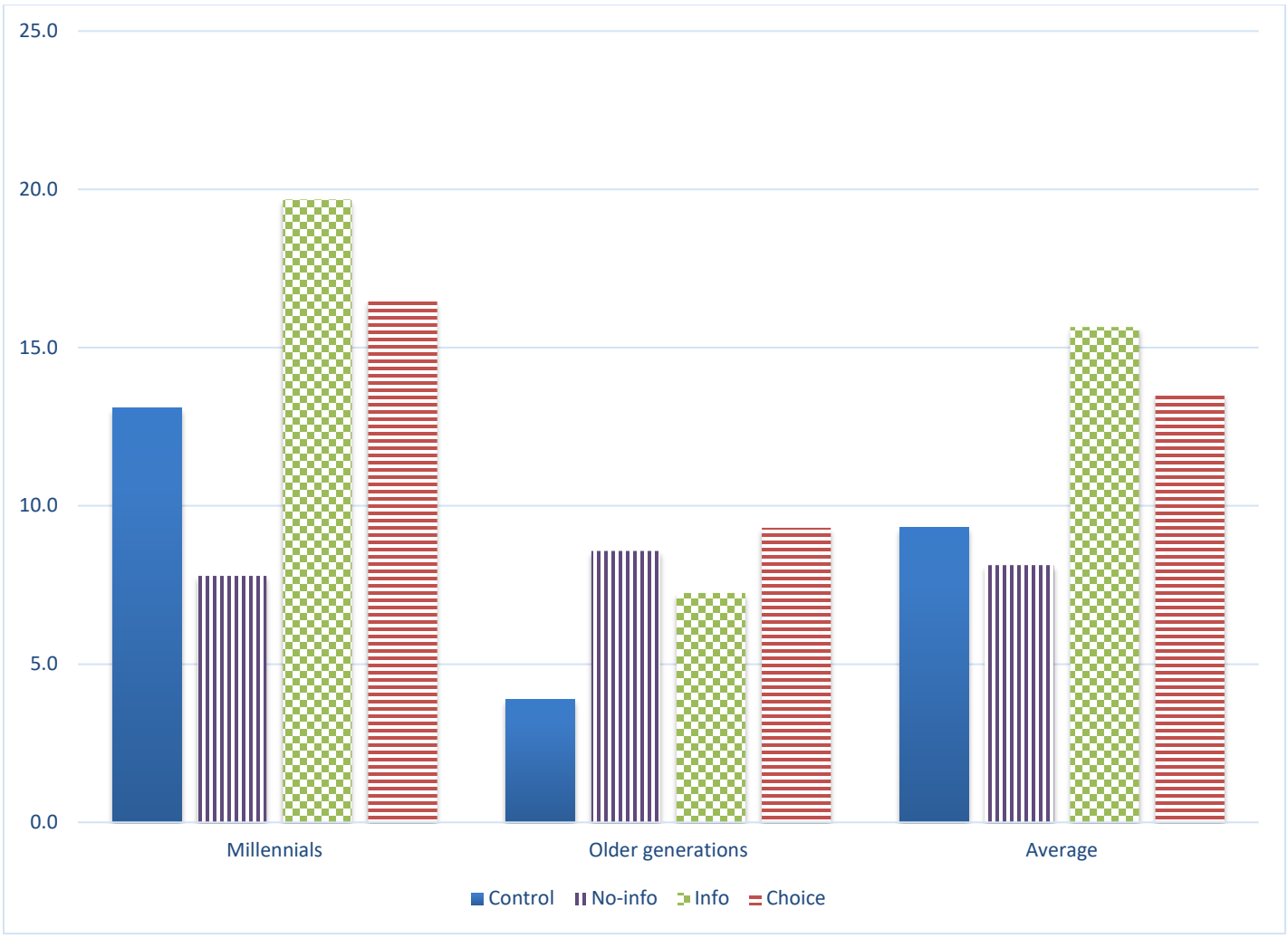

Figure 2: The variation of chips consumption by treatment and age groups

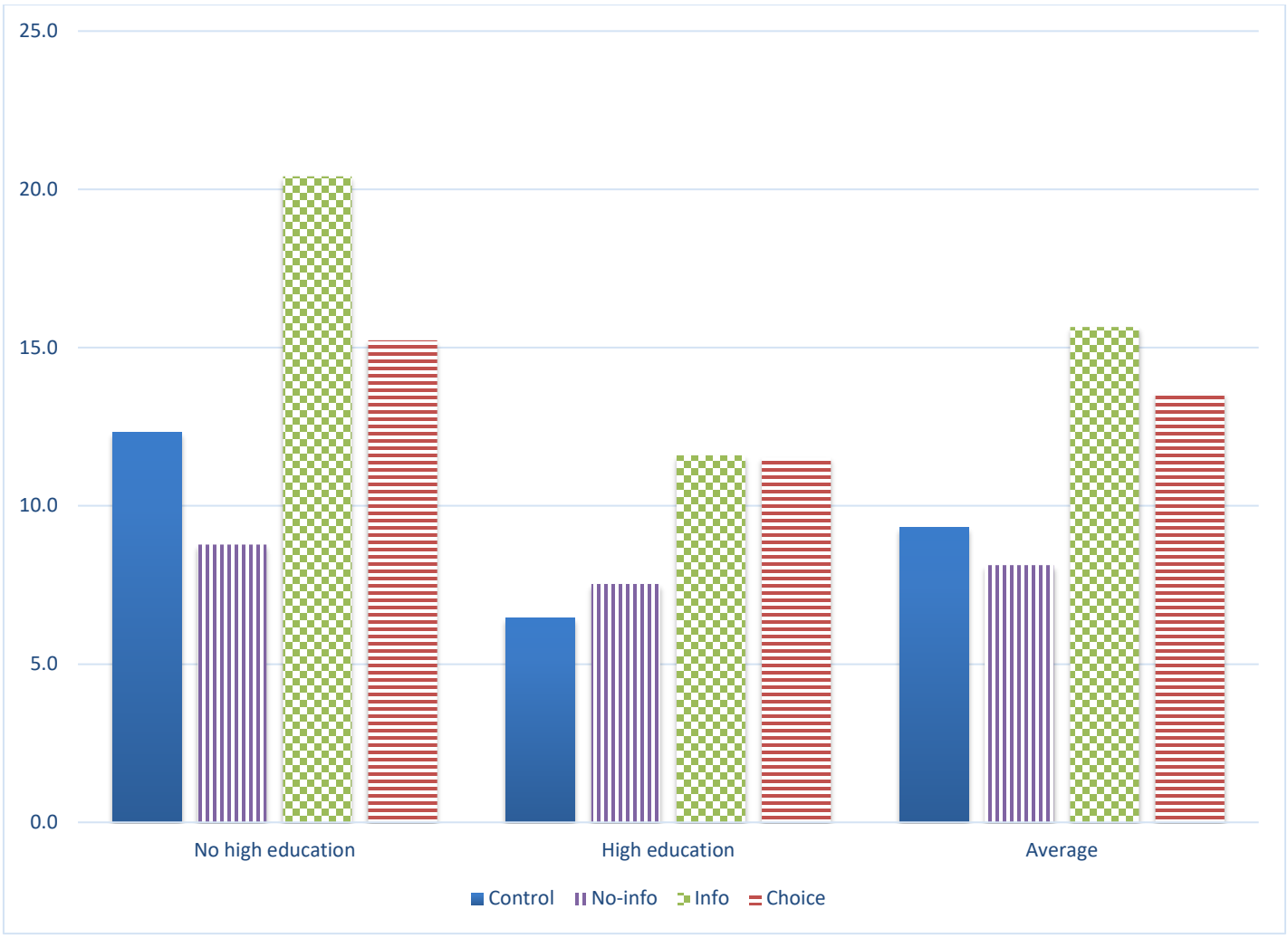

Figure 3: The variation of chips consumption by treatment and education groups

Appendix

Treatment 1: Control. Participants are asked to select a can of standard Pringles chips.

"Welcome. Thank you for coming. In a moment we will be watching an episode of The Big Bang Theory. Snacks are in the back, please help yourself. Everyone is required to take one water and one can of chips. Turn in your consent forms to a research associate as you head to the back of the room. If you would like more chips or water during the show, feel free to get up and help yourself."

(END OF SHOW)

"Stop eating. We're going to come around and hand each of you a survey, when you are handed a survey we will take your chip can. When you complete your survey you are free to leave. Please do not tell any of your friends about the study in case they are in the next study. Thank you."

Treatment 2: Participants are asked to select a can of Pringles chips containing an assortment of chips in which every fifth chip is colored red, no other information is given.

"Welcome. Thank you for coming. In a moment we will be watching an episode of the The Big Bang Theory.. Snacks are in the back, please help yourself. *Every 5th chip is colored red. I do not know why.* Everyone is required to take one water and one can of chips. Turn in your consent forms to a research associate as you head to the back of the room. If you would like more chips or water during the show, feel free to get up and help yourself."

(END OF SHOW)

"Stop eating. We're going to come around and hand each of you a survey, when you are handed a survey we will take your chip can. When you complete your survey you are free to leave. Please do not tell any of your friends about the study in case they are in the next study. Thank you."

Treatment 3: Participants are asked to select a can of Pringles chips containing an assortment of chips in which every fifth chip is colored red, participants are given the reasoning behind the colored chips.

"Welcome. Thank you for coming. In a moment we will be watching an episode of the The Big Bang Theory. Snacks are in the back, please help yourself. *Every 5th chip is colored red. This has been shown to lead people to eat less.* Everyone is required to take one water and one can of chips. Turn in your consent forms to a research associate as you head to the back of the room. If you would like more chips or water during the show, feel free to get up and help yourself."

(END OF SHOW)

"Stop eating. We're going to come around and hand each of you a survey, when you are handed a survey we will take your chip can. When you complete your survey you are free to leave. Please do not tell any of your friends about the study in case they are in the next study. Thank you."

Treatment 4: Participants are asked to make a choice. Participants are asked to decide whether they want a Pringles chip can with every fifth chip colored red (with the reasoning for the colored chips being revealed) or without any colored chips (a standard can of Pringles).

"Welcome. Thank you for coming. In a moment we will be watching an episode of the The Big Bang Theory. Snacks are in the back, please help yourself. *We ask you to choose between enjoying a regular can of chips or a can with every 5th chip colored red. Previous studies have shown that coloring the chips red leads people to eat less. The cans containing the colored chips will in on your left, the cans containing no colored chips will be on your right.* Everyone is required to take one water and one can of chips. Turn in your consent forms to a research associate as you head to the back of the room. If you would like more chips or water during the show, feel free to get up and help yourself."

(END OF SHOW)

“Stop eating. We’re going to come around and hand each of you a survey, when you are handed a survey we will take your chip can. When you complete your survey you are free to leave. Please do not tell any of your friends about the study in case they are in the next study. Thank you.”