

Nudging Behavior Change: Using In-Group and Out-Group Social Comparisons to Encourage Healthier Choices

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ABSTRACT

This paper revisits concepts of nudge in the context of helping consumers to make healthier food choices. We introduce a novel form of social influence nudge not yet investigated by HCI scholars, the out-group social comparison, and test whether this form of nudging works at the point of checkout rather than the more conventional point of product consideration. Across two online experiments, we measure the effectiveness of using nutritional information nudges with added in-group (people like you) and out-group (people not like you) social comparisons. Our preliminary findings suggest that out-group social comparison nudges can be effective in encouraging both normal weight and overweight adults to reduce calories, even when these adults indicate that they do not typically change their diet behaviors. This research has implications for digital information design, interactive marketing, and public health.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

Consumer behavior, choice, decision making, nudging, persuasive communication, information design, social influence, health, nutrition, food, diet, online, digital shopping, intervention

ACM Reference Format:

Blake M. DiCosola III and Gina Neff. 2022. Nudging Behavior Change: Using In-Group and Out-Group Social Comparisons to Encourage Healthier Choices. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*, April 29–May 05, 2022, New Orleans, LA, USA. ACM, New York, NY, USA, 14 pages. <https://doi.org/10.1145/3491102.3502088>

1 INTRODUCTION

A recent systematic analysis of nudging research conducted within the Human Computer Interaction (HCI) community documented 23 distinct nudging mechanisms that have been developed and refined by HCI scholars over the past 10 years [14]. These mechanisms were

clustered into six contextual categories— (1) facilitate, (2) confront, (3) deceive, (4) social influence, (5) fear, and (6) reinforce. Such work has established a framework for *how* and *why* we might employ nudging mechanisms in online interactions, but previous research fails to address the critical question of *when* these mechanisms might be most effective to end users. While the HCI community has tried to expand nudge research, there is still much we do not know about *how to best* nudge within these six contexts, including when it comes to *social influence* [22]. This paper seeks to address these two gaps in the HCI literature. First, we investigate a novel form of social influence nudge not yet studied in a HCI nudge research—the out-group social comparison. Second, we investigate whether placing social influence nudges at the point of checkout, rather than at the more conventional point of product consideration, meaningfully works for end users in a grocery shopping context. Our research aims to connect nudging research with the CHI community [2, 61] and responds to recent call to actions from the wider public health community for nudges to promote healthier and more sustainable diets [25, 29].

Why nudge? Thaler and Sunstein [71] argue that by understanding how people make decisions and altering their choice environments and choice architectures accordingly, we can nudge individuals, making it easier for them to choose what is best for them, their families and society. A nudge is a modification of “any aspect of the choice architecture that alters people’s behavior in a predictable way (1) without forbidding any options, or (2) significantly changing their economic incentives.” Nudging may help people make optimal decisions that benefit themselves while benefitting society more broadly.

Whether organizations should be using nudges to change consumer behavior is subject to ethical and normative debate. Recent work by governments during COVID-19 and in other public health contexts may inspire confidence in how to approach nudging in a positive and ethical manner. For example, the UK government’s Behavioural Insights Team found that their nudges encouraged Britons to make healthier drink choices, drive more safely on public roads and achieve higher exam scores, which points to some of the positive benefits of nudging when harnessed for good [56, 59]. For nudging to be applied ethically and virtuously, nudges must meet three conditions: (1) they should be transparent, (2) they must be easy to opt out of, and (3) they should improve the person’s welfare [69]. Dark patterns in online behavior have rightly dimmed the reputation of nudge research. In the domain of food choice there is still work to be done on how to design systems to support user’s goals [25]. The nudges detailed in this research adhere to these

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CHI '22, April 29–May 05, 2022, New Orleans, LA, USA

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ACM ISBN 978-1-4503-9157-3/22/04...\$15.00
<https://doi.org/10.1145/3491102.3502088>

three guidelines, while responding to calls by scholars in public health to help design effective, ethical, and virtuous nudges.

2 RELATED WORK

Given the promise of nudging, scholars in consumer behavior, behavioral economics, public health, and human computer interaction (HCI) have worked to develop nudges for social good. A recent meta-analysis of field experiments on healthy eating interventions [12] found that nudges in traditional brick-and-mortar eateries, cafeterias, and grocery stores have produced mixed results. Interventions that focus on manipulating behavior, rather than influencing what consumers know or how they feel, were most effective. For example, nudges that placed healthier food options in convenient purchase locations resulted in greater uptake of healthy foods than nudges that called out the nutritional benefits of such healthier food options. HCI researchers have been exploring how to best design and employ digital nudges to encourage positive behavior change across a variety of domains, not just food choice [14]. The HCI community has been able to design noteworthy nudging interventions that get consumers (or users) to slow down and tap into conscious, effortful, reflexive thinking, thus allowing people to overcome their cognitive biases and mishaps in automatic information processing [28]. Our goal is to address some of the limitations of traditional food nudges that have been identified by applying some of these more so-called virtuous techniques of nudging.

2.1 Facilitating Behavior Change in Private Food Choice Settings

BJ Fogg’s model of persuasive design presumes people have three things: sufficient motivation, the ability to perform the desired behavior, and adequate triggers to perform it [32]. People, however, often lack an inherent motivation to eat healthily [39, 53]. Fogg’s model suggests that interventions for healthier eating can encourage behavior change among people who lack motivation by focusing on making the behavior change as simple as possible and making the triggering mechanism transparent, meaningful, and contextually relevant to individuals. The challenge for the CHI community is that a one-size-fits-all approach to nudging for health might further encourage a social-technological gap, failing to prioritize the complex and nuanced interventions that we know are needed to support people [1]. As such, it is important we seek to understand when nudges work best, who they work for, what the next best alternatives might be to ensure we meet the needs and demands of broad and diverse populations.

Our approach to nudging involves delivering personalized communications in a private setting to prompt users to consider a change in behavior that is completely optional. This makes our approach fit with the criterion for virtuous nudging. Our approach is distinct from the many existing health and fitness interventions that seek to initiate behavior change through connected communities or peer support [21, 62]. Social support and community sensemaking can help individuals achieve success [54], and people often make more deliberate, thoughtful choices when they are socially-exposed to behavior-changing nudges in public [3, 60]. While literature exists that suggests people make virtuous choices in public settings where choices are exposed to others [73, 76, 79], there is not yet

evidence to suggest the same holds true in private settings where impression management is of little concern. As such, our approach to nudging seeks to invoke a heuristic goal to align to others [31], rather than activating impression management goals [44, 45, 64].

2.2 Designing Novel Social Comparison Nudges

Social influence can be harnessed to nudge consumers towards making optimal choices through mechanisms like invoking reciprocity, leveraging public commitment, making user actions more visible, and enabling social comparisons [14]. Social information is important and meaningful to end users because people look to others to inform their own behavior when the best course of action is unclear [31], even when deciding how much to eat [24, 78]. People seek out such social information in a purposeful way. People care about what most people do [16, 17, 79] or what most people might approve of [41], demonstrating a tendency to adhere to social norms based on demonstrated social proof points [31]. HCI scholars have found employing social norm comparisons very effective in nudging consumers to exhibit positive behaviors in contexts like fitness self-tracking [37] and gaming [20], provided people felt that such comparisons were easy to understand and the desired behavior was within reach. Scholars in public health have found that social norm statements can impact food choice positively [52, 63]. Statements [16, 17] regarding “what most others do” work better than injunctive norm statements [41] on “what most others approve of” in prompting healthy food choices. [72]. Generic social comparisons, though, may not work in all conditions [63] and can be difficult to leverage at scale in the real-world, indicating a need for alternative forms of social nudging that work under a broader set of conditions.

The influence that in-groups can have on our thoughts, feelings, emotions and decisions is well studied within social psychology [7, 8] and marketing [26, 27, 42, 66] and research on minimal group paradigm was pivotal in demonstrating we have an innate desire to align with the in-group, even when preconceptions about an out-group fail to exist [4, 70]. In the context of food choice, the “in-group effect” will prompt us to select foods we don’t prefer when dining in social settings to maintain our status within our in-group [3]. These well-documented in-group effects have caused digital designers to focus almost exclusively on in-group or “people like you” social comparisons, especially when the broader trend on “what most people are doing” might not be available or easy to tap into [36].

Consider how we might compare food choice to Netflix recommendations. Netflix’s personalized recommendation engines generate over \$1 billion a year in value from customer retention because 80% of views come from the engine’s recommendations [36]. Netflix’s “What’s Trending Now” recommendation is essentially a social norm visualization applied at the country-level (see Fig. 1).

While such broad recommendations might work for Netflix [36] or in e-Commerce [5], it is potentially risky when applied in a grocery store setting with beer, high-fat sausages and bacon, soda, and chocolate candy bars accounting for the most popular grocery products today in the UK [46, 48, 72]. The UK, for example, will soon introduce legislation that will restrict the promotion of these kinds of unhealthy foods [58]. Netflix’s “Because You Watched”



Figure 1: Netflix “What’s Trending in USA” Social Norm Recommendation Visualization

recommendations tie together genre expectations and patterns in what like-users have subsequently watched and enjoyed, thus creating an “in-group” recommendation based what other ‘people like you’ have watched and liked [36]. This approach could also be problematic when applied in a food choice context. The popular selection of soda would pair more frequently with salty snacks, based on typical like user behavior, than healthier fruits or vegetables. This example highlights why nudging out-group comparisons might be desirable, even necessary, in some situations. However, the effectiveness of out-group comparisons for nudging has yet to be studied.

2.3 Designing Effective, Ethical, and Desirable Healthy Food Nudges

Our research aims to test transparent nudging mechanisms that highlight or bring attention to possible choices and healthier alternatives [28]. Many food choice nudges employed in the field today focus on manipulating or influencing behavior by making changes to choice environments that the consumer cannot detect [12]. These undetectable behavioral nudges tend to work well [12], although consumers largely reject this form of nudging [11]. In addition, nudges that work on the automatic mind fail the first condition of ethical nudging: (1) they should be transparent [69]. Recent studies in marketing suggest that organizations that want to nudge healthier food choices face a dilemma: they must make a trade-off between using nudges that work best (i.e., those that tap into the automatic mind) and nudges that people approve of (i.e., those that are transparent and force a reflexive mindset) [11]. Our research seeks to test healthy food nudges that are both effective and acceptable to end users by prompting a reflexive choice.

Focusing on nudges that prompt a reflexive choice is worthwhile as this form of nudging is transparent and causes a user to reflect on his or her choices (see Fig. 2), which is what consumers indicate they prefer [30] and fits with the drive for ethical and virtuous nudging. Designing nudges that prompt a reflexive choice and still produce strong healthy choice outcomes is a challenge, though; existing field studies show that these types of nudges typically have smaller effect sizes and limited consumer impact [12].

Effective nudging mechanisms already identified by the HCI community include suggesting alternatives and reminding consumers of choice consequences [14, 28]. Research in food choice is calling for new thinking and novel approaches that can bring about more significant impact than these mechanisms do. For example, an experimental grocery shopping site nudged consumers to swap out higher calorie foods for healthier, lower calorie options in the

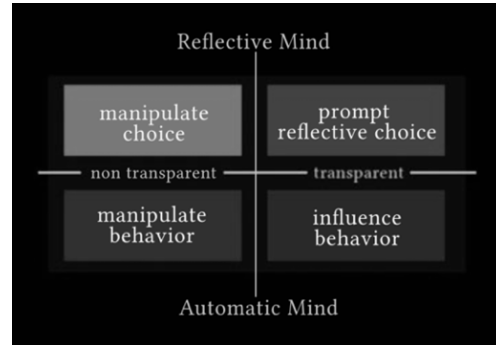


Figure 2: Nudging Mechanism Options [14]

same food category, but had mixed results and did not lead a significant reduction in overall calories [34]. Traditional nudge research conducted in a real-world setting within a university eatery setting found small but significant increases in purchase of low-calorie, low-fat foods after using food labels that prompted students to consider their choices [18].

We test if adding social dimensions to existing nudging interventions can improve nudge uptake, using willingness to reduce calories as our key measure. Calorie reduction is commonly studied in public health on food choice because of the policy and health concerns about rising obesity [18, 34] in the UK [80], USA, [9], and around the globe [6, 49]. Our research has the potential to shape more broadly how policymakers view nudging mechanisms that are transparent, effective, ethical, and more widely accepted than those used in current behavioral policy interventions [68].

2.4 Nudging for Greater Impact

The HCI community has explored *what* type of nudges work and *why* but has done less research on *when* nudging can have the greatest impact. A key difference in the nudging approach we take is that it is applied at the point of checkout and at a global (i.e., grocery basket) level. Current standard practice for online shopping nudges provides personalized item-level product recommendations as people shop or browse [34, 43, 52, 63]. There are two good reasons for considering global, basket-level recommendations at checkout. First, healthy food nudges at the point of checkout in traditional brick-and-mortar stores have been successful [35]. Second, this approach may be more meaningful to consumers because they see the overall impact of their collective food choices and not simply of single items. The timing of nudges may also matter. Constantly

nudging healthy food products during the browse-and-shop process could create a lot of undue friction. Nudging at the end of shopping could help users better assess their choices in context. Our holistic, basket-level approach to nudging fits with recent findings by marketers showing the impact of real-time aggregation of total calorie count on encouraging healthier meal choices [74]. That said, there are tradeoffs by introducing a nudge later in the process, namely that it could be seen to require more effort at a time when users are simply ready to checkout. We believe this can be addressed through effective design and by helping to automate and highlight recommended food swaps in-situ at the time of nudge, building on existing food swap designs tested in public health [34], rather than asking users to go back and shop again. We believe both forms of nudging (e.g., in process, at checkout) can be effective and should be part of a designer's overall toolkit to design experiences that benefit end users.

3 RESEARCH OVERVIEW

Our research tests two types of social comparisons—in-group comparisons and out-group comparisons—displayed prior to final checkout when cart calories are high. We hope to demonstrate that novel out-group comparisons serve as worthwhile alternative to in-group comparisons within the context of social nudging. When testing nudges that could prevent obesity, we target normal weight individuals to understand if there is any differential impact of comparing their basket calories to other typical normal, healthy weight adult baskets (in-group comparison) versus comparing their basket calories to typical overweight adult baskets (out-group comparison). The results of our pilot study have been previously reported in less detail [23]. When testing nudges that could be used to reduce obesity, we target overweight adults to understand their response to a variety of nudges, including those that add in-group or out-group social comparisons. Below, we discuss the findings across these two studies and highlight future directions for follow-up research.

3.1 Study One: Pilot Experiment on Social Comparisons

3.1.1 Study Design. We designed a simple online experiment on Qualtrics with a single factor (social comparison) and two levels (in-group comparison, out-group comparison) to test the hypothesis that out-group comparisons may be equally or more effective than in-group comparisons in encouraging healthier choices. Our pilot study was designed to test a conceptual intervention that could be applied to broad populations to help prevent obesity before it starts by detecting trends in shopping basket choices that could result in the consumption of too many calories.

We recruited 100 normal or healthy-weight adults living in the United Kingdom (UK) from Prolific.co, an online panel designed for academic research. Prolific allowed us pre-screen participants based on their Body Mass Index (BMI). Participants with a BMI of less than 25 were contacted via e-mail through Prolific and notified they could participate in a four-minute online study on health and nutrition in the UK. Participants were offered a payment of £0.50 for their participation in this short study. The overall study design is shown in Table 1.

Table 1: Study 1 Design

Study Sample	100 Normal Weight UK Adults (BMI < 25)
Study Design	Single Factor (Social Comparison), Two-Level, Between Subjects
Study Conditions	In-Group Social Comparison Out-Group Social Comparison

After giving their consent, participants completed a 10-question survey on health, fitness, and nutrition. Participants rated their interest in trying new diets on a sliding scale (0 = no interest, 100 = high interest). Then, participants were asked to imagine that they were buying groceries from an online grocery store where they had previously setup a profile to allow the grocery store to know their specific health and nutrition goals. They were then asked to imagine they were buying one week's worth of groceries and were about to complete the online checkout process. At this point, participants were randomly assigned to one of the two experimental conditions: an in-group comparison condition or an out-group comparison condition (see Fig. 3).

Participants were shown a nutritional cart analysis with added social comparison and then asked if they would like to keep their shopping basket as-is and checkout or to reduce the calories in their basket and checkout using a free digital nutrition assistant. This choice is the key dependent measure. Individuals who elected to reduce calories were asked a follow-up question related to the number of total calories they wished to reduce their basket by—they indicated this by using a sliding scale from 0 calories to 5,000 calories. After completing this step, all participants were shown a closing page that debriefed them and revealed more details about the study. The last page of the experiment also included a manipulation check that asked participants to recall what type of individual they were compared to. Twenty-six participants failed the manipulation check and were removed from the study results, leaving 74 possible valid observations in the experimental data set. Nine individuals self-identified as overweight or underweight and were omitted from the study analysis, leaving 65 final responses.

3.1.2 Study Predictions. The overarching goal of this simple pilot experiment was to provide some initial evidence that out-group comparisons could serve as a worthwhile alternative to the more common in-group social comparison employed by recommendation engines in e-Commerce today. Going beyond “people like you” comparisons would give digital designers and grocery retailers more varied (and possibly more practically meaningful) options to socially nudge consumers towards healthier choices, in this instance calorie reduction when basket calories are high.

We know from existing research on social facilitation that people will inherently look to others when deciding how much to eat [79]. Building on foundational anchor and adjustment models on purchase decisions from the field of marketing and consumer behavior [75], we posit that both in-group comparisons and out-group comparisons will provide a desirable social anchor point that users can latch onto to inform their decision around whether to keep basket calories as-is or to reduce them. We expect that in-group comparisons will trigger users to assimilate or move close to the reference

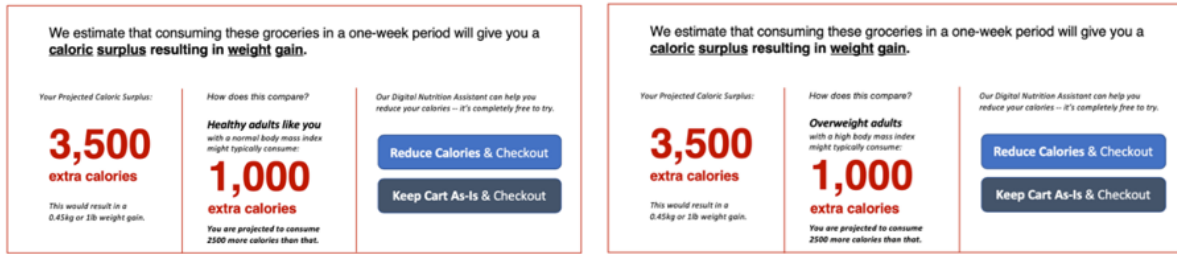


Figure 3: Experimental Condition Stimuli

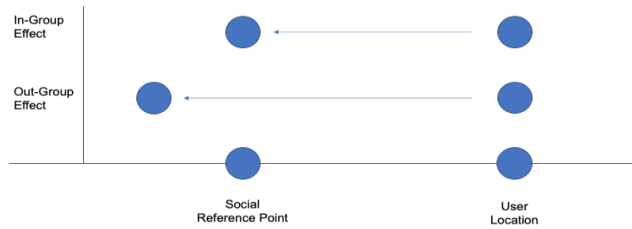


Figure 4: Visualization of Anticipated In-Group vs. Out-Group Effect

point to align to their in-group while an out-group comparison will produce a contrast effect as group members seek to stand out or differentiate from other groups [65]. To put this in concrete terms, if consumers are told that in-group members typically consume 2,500 calories, we would expect them to try match this and align their basket to be around 2,500 calories so their behavior is in accordance with group norms. Conversely, if consumers are told that out-group members typically consume 2,500 calories, we expect they may try to distance themselves from this amount and seek to improve upon it, potentially reducing even more calories so that their basket may be closer to say 2,000 calories instead of 2,500 calories, in effort to be better than the out-group. This matching effect for the in-group and distancing or contrast effect for the out-group is shown in Fig. 4.

We believe that when consumers are presented with an out-group comparison, it may trigger dual motivation—individual-level motivation and group-level motivation—such that the individual and group impacts of one’s decision becomes more salient. In other words, when prompted with an out-group comparison, we believe individuals will be incentivized to help themselves while also helping their group perform better than the out-group. This dual motivation triggered by an out-group comparison could help produce a contrast or distancing effect, as depicted in Fig. 4.

3.1.3 Study Results. Although we recruited 100 participants, there were 65 valid responses that could be analyzed after data cleansing was complete. VanVoorhis & Morgan [77] indicate that when conducting statistical analyses to measure group differences a reasonable cell size is 30, assuming a power level threshold of 80%. As such, the final cleansed data set with 65 observations was used for all analyses, although we recognize the total number of observations after cleansing was less than optimal.

Table 2: Study 1 Statistical Model Summary

Chi-Square Value	$X^2 (3, n = 65) = 15.62$
p-Value	$p = .0014$
R^2 Value	$R^2 = .1770 (17.70\%)$

Table 3: Study 1 Effects

Variable	Degrees of Freedom	Chi-Square Value	p-Value
Interest in Trying New Diets (IV1)	1	4.68	$p = .03$
Social Comparison Condition (IV2)	1	2.67	$p = .10$
Interaction (IV1 x IV2)	1	7.50	$p = .006$

A statistical model that included the key discrete dependent measure (choice: unhealthy/keep basket as-is and checkout vs. healthy/reduce calories and checkout) along with two independent variables—level of interest in trying new diets and social comparison type (in-group vs. out-group) as well as the interaction between these two variables—was established. A nominal logistic regression analysis was conducted on the model. The overall model was found to be highly significant, $X^2 (3, n = 65) = 15.62, p = .0014$. The coefficient of determination (R^2) value of the model was .1770 (17.70%), indicating that we have identified a medium to large experimental effect within this statistical model [24]. Our overall model results are summarized in Table 2.

There was a significant main effect of level of interest in trying new diets on unhealthy/healthy choice, $X^2 (1, n = 65) = 4.68, p = .03$, such that those who were more interested in trying new diets were more likely to select the healthier option, which is intuitive and not surprising. That said, there was a more significant interaction effect between level of interest in trying new diets and the type of social comparison used, $X^2 (1, n = 65) = 7.50, p = .006$, such that those who were less interested in trying new diets (and thus more at-risk for over-consuming) but assigned to the out-group condition were more likely to reduce calories (see Fig. 5).

The main effect of social comparison type did not prove to be statistically significant, $X^2 (1, n = 65) = 2.67, p = .10$. However, the pattern of results indicated that healthy choice outcomes were

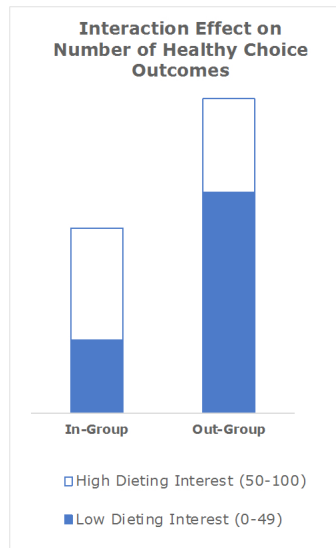


Figure 5: Interaction Effect

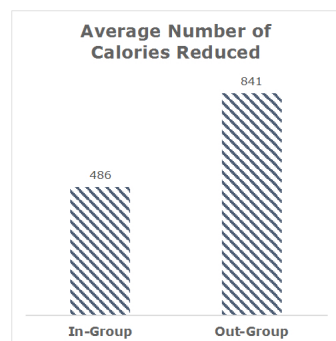


Figure 6: Interaction Effect

more abundant in the out-group condition. An analysis of variance (ANOVA) using the continuous measure of calorie reduction revealed the mean number of calories reduced in the in-group condition was 486 compared to 841 in the out-group condition (see Fig. 6), which provides some baseline support for our hypothesis that out-group comparisons may be as effective if not more effective than the more frequently used in-group comparisons. However, the difference between social comparison types was not found to be statistically significant in the ANOVA model either. The key effect tests are summarized in Table 3.

3.1.4 Study Discussion. Our pilot study revealed two statistically significant findings. There was an overall main effect of level of interest in trying new diets on healthy choice outcomes such that participants who were interested in trying new diets were also likely to consider reducing calories, regardless of the type of social nudge they were exposed to. In addition, there was a stronger interaction effect between people’s interest in dieting and the type of social comparison that was used, indicating that the out-group comparison was effective in nudging individuals who had a low

Table 4: Effect Size Comparison [24]

Measure	Small Effect	Medium Effect	Large Effect
Cohen’s d	0.2 - 0.3	≈ 0.5	0.8
R^2	1%	9%	25%

interest in dieting to make the healthy choice. These findings are important as they contradict findings from field studies that show individuals are more likely to be influenced by thin rather than obese individuals when making food choices [50]; our findings show that normal weight adults can be influenced by overweight adults in very positive ways.

The results indicate that the nutritional basket summary with an added social comparison was an effective intervention among people who are open to trying new diets, regardless of whether they were shown comparisons to people like or unlike them. That said, the lack of a no comparison control condition in this simple pilot study limits our ability to decipher whether this effect is due to the social comparison element of our experimental stimuli. We will address this limitation in future studies.

The interaction effect that we observed seems to indicate that we have identified a novel way to reach people who are not interested in trying new diets or changing their eating behaviors. Our findings show that a shopping basket nutritional analysis paired with an out-group comparison—rather than the standard “people like you” comparison—resulted in an increase in the healthier choice amongst more resistant individuals.

It is worth noting the medium-to-large effect size we observed with our overall model returning an R^2 value of .1770 or 17.70% (see Table 2, 4). In Cadario and Chandon’s meta-analysis of field studies exploring healthy eating nudges taking place in traditional brick-and-mortar settings [13], the researchers found that the effect sizes for healthy eating nudges were small, on average, across all seven studies they looked at. The medium-to-large effect size we observed in our online experiment points to the potential promise of digital nudging to influence healthier food choices.

Another key difference in our approach was nudging at the point of checkout rather than point of product consideration and asking participants to reduce the overall basket-level calories. Participants exposed to an in-group comparison indicated they were willing to reduce their basket calories by 486 calories, on average, while those who were exposed to an out-group comparison were willing to reduce their basket calories by 841 calories. Cadario and Chandon found that existing healthy eating nudges, primarily taking place at the product or item level, produce (not surprisingly) smaller effects when it comes to calorie reduction [13]. Nudges that focused on improving awareness, or what people know or understood about their food choices, resulted in a mean calorie reduction of only 64 calories, while those that aimed to influencing emotions, or how people felt about their food choices, resulted in a mean calorie reduction of 129 calories. The most effective nudges were those that focused on manipulation behavior change (typically outside of consumer awareness); these behaviorally oriented nudges resulted in a mean calorie reduction of 209 calories, which is much lower than the amount of intended calorie reduction observed in our

experiment. While there may be a significant gap between the number of calories consumers say they are willing to reduce their calories and the amount they would reduce their calories by in a real-world context, these results point to the potential positive impact that shifting towards basket-level recommendations might have on healthy choice outcomes.

While our pilot study revealed some promising results, there are numerous limitations that must be addressed. It is important to note that we recruited adults with a body mass index of under 25 in order to be able to assign participants to an in-group (i.e., normal weight adults) or out-group (i.e., overweight adults), and as such we cannot over-generalize our findings and assume these results would be observed among overweight adults, given that we know from previous research in public health that normal weight adults and overweight adults often exhibit different responses to nutrition interventions [4, 10]. Different goals may require different designs, especially in health-related tracking [67], and this context is no different. To address this shortcoming, our next experiment will be run on participants with a body mass index over 25 who view themselves as being overweight and will provide an in-group comparison to overweight adults and an out-group comparison to normal weight adults. We will also add a no comparison control condition and increase the sample size moving forward, as those are two other key limitations we note in our current pilot. Finally, we want to reiterate that these explorations are still academic and conceptual in nature and designed to test novel forms of social comparisons as nudging mechanisms in controlled lab settings. Should our future studies be successful, we will need to design and test other forms of in-group and out-group comparisons that do not involve body image or body weight, as such comparisons would not be appropriate in real-world settings. All in all, we believe our pilot study demonstrates that social comparisons, particularly out-group comparisons, may serve as effective nudging mechanisms in online grocery shopping contexts and gives sufficient motivation for further exploration.

3.2 Study Two: Core Experiment on Social Comparisons

3.2.1 Study Design. 350 overweight adults in the United Kingdom with a body mass index over 25 were recruited to participate in this study on Prolific.co for a 1 GBP incentive. This core experiment on social comparisons builds upon preliminary pilot research on the topic but employs a four-cell experimental design that aims to help us understand whether calorie information alone, calorie information paired with possible weight gain implications, or calorie information paired with possible implications and an additional social comparison is most effective in nudging overweight consumers to consider reducing basket calories when in a caloric surplus situation. While our pilot experiment focused on normal weight adults to help prevent obesity, this core experiment is focused on recruiting overweight adults to help design and test social nudging mechanisms that might be used to help reduce obesity through behavior change. Our overall study design is summarized in Table 5.

Participants were contacted via email by the Prolific subject pool and given a URL to access the study from a device and location of their choosing. This survey flow and design was similar to the one

Table 5: Study 2 Design

Study Sample	350 Overweight UK Adults (BMI > 25)
Study Design	Four-Level Between Subjects
Study Conditions	1. Baseline: Caloric Surplus Amount 2. Control: Baseline + Weight Gain Implication 3. Control + In-Group Social Comparison 4. Control + Out-Group Social Comparison
Additional Measures	Dietary Control Behaviors (DCB) Scale
Dependent Variable	Discrete Choice: Keep Calories As-Is & Checkout (Unhealthy Choice) Reduce Calories & Checkout (Healthy Choice)

employed in the Pilot Study but included multiple statements from the dietary control behavior (DCB) scale [47], a proven scale used by the marketing and consumer behavior community to measure the extent to which individuals are willing to change their eating behaviors in an effort to control their weight [10], rather than the self-constructed question on Interest in Trying New Diets used in the Pilot. Participants responded the dietary control statements like “I eat low-calorie foods in an effort to avoid weight gain” using a 7-point Likert scale from “Strongly Disagree” to “Strongly Agree” and an average score was computed based on their mean response to all statements. This important measure allows us to understand how consumers with varying levels of dietary control may differentially respond to alternative forms of nudging. Critically, we want to show that social nudges are effective in encouraging harder to reach individuals to make healthier choices.

After completing the short survey, participants were told to imagine they were buying groceries from their preferred online grocery store. They were told to imagine that they had previously set up a profile with this grocery store which allowed the grocery store to know who they were and what their specific health and nutrition goals might be. Participants were told to imagine they are about to complete the online checkout process after selecting one week’s worth of groceries for themselves alone. Up to this point, all participants followed the same steps and had seen the same study materials. After this point, participants were randomly assigned to one of the four experimental conditions with different stimuli (see Fig. 7).

All participants, regardless of condition, were asked to make a discrete choice: they could either elect to keep their shopping basket as-is and complete checkout or reduce the calories in their basket and checkout. This discrete, binary choice represents the dependent variable that will be measured and compared across all four conditions. Individuals who elected to reduce calories were asked a follow-up question related to the number of total calories they wished to reduce their basket by; they were shown a sliding scale from 0 to 5,000 calories and could select any value between 0 and 5,000. They also completed a manipulation check to ensure they processed the social comparisons accurately. After completing this final step, all participants were shown a closing page that debriefed them and revealed more details about the study; participants were

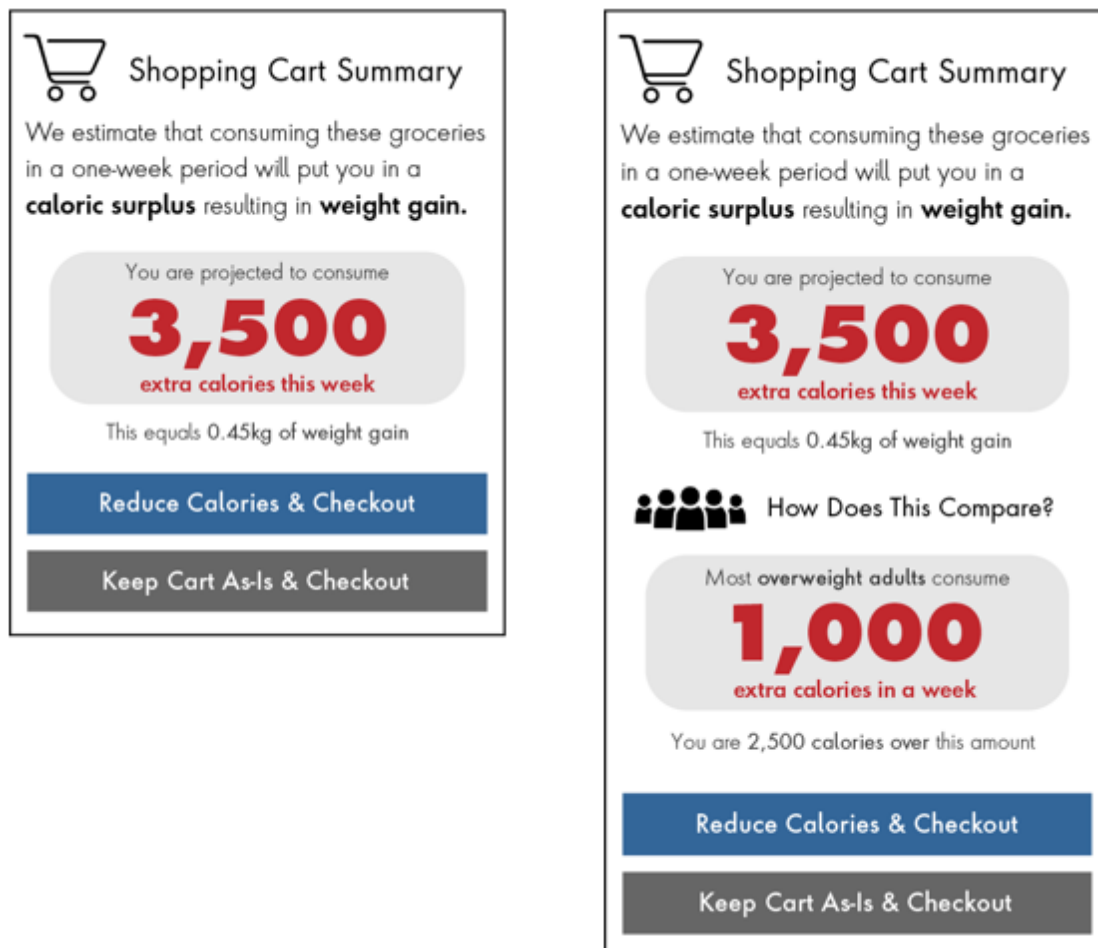


Figure 7: Representative Experimental Condition Stimuli (Control vs. Social Comparison)

given code to give to Prolific to confirm study completion and initiate payment for participating.

3.2.2 Research Questions and Associated Hypotheses. We had three questions we wanted to answer in this follow up study:

- Does adding a weight gain implication statement (i.e., this equals 0.45kg of weight gain) to the baseline caloric surplus amount increasingly nudge consumers towards the healthy choice?
- Does adding a social comparison to the caloric surplus amount and implication statement increasingly nudge consumers towards the healthy choice?
- Are social comparison nudges effective amongst harder to reach populations or individuals who do not typically modify their eating behaviors to control weight gain?

We expect that making the calorie surplus more “real” and translating into what it means in terms of potential weight gain will make it more meaningful to the end user and, as a result, increase uptake of the nudge to reduce calories. That said, we think providing additional social context to this nudge will be even more

effective and that the two social comparison conditions that provide this added social reference point will perform better than the control condition. Finally, we think that social comparisons will add an external source of motivation that will encourage individuals who may lack sufficient intrinsic motivation to make the healthy choice, in essence nudging consumers who would otherwise be unlikely to make the healthy choice. Our hypotheses are outlined in Table 6.

3.2.3 Study Results. 349 of the 350 recruited participants successfully completed the entire study, one participant dropped out. 63 participants failed the manipulation check, leaving 286 valid results. Finally, a check was done on self-report of body weight to ensure only overweight adults were included to ensure proper analysis of in-group (overweight) vs. out-group (normal weight) comparison. 38 remaining adults who viewed themselves as being “about right” in weight but were assigned to either an in-group (overweight) or out-group (normal weight) were omitted due to mismatch between their view and the comparison category stimuli. 248 participants were included in the final data set, which exceeded the number of

Table 6: Study 2 Hypotheses

Hypothesis 1	There will be an overall main effect of experimental condition on choice outcomes such that increased healthy choice will occur in the control condition (caloric surplus + weight gain implication) as compared to the baseline (caloric surplus only) condition.
Hypothesis 2	There will be an overall main effect of experimental condition on choice outcomes such that increased healthy choice will occur in the social comparison conditions as compared to the control condition.
Hypothesis 3	There will be an interaction effect between the experimental condition and DCB rating on choice such that those who rate low to moderate on DCB will be more likely to pursue the healthy choice when presented with a social comparison nudge as compared to the control condition.

Table 7: Study 2 Statistical Model Summary

Chi-Square Value	$X^2 (4, n = 248) = 20.08837$
p-Value	$p = .0005$
R^2 Value	$R^2 = .0596 (5.96\%)$

Table 8: Study 2 Effects

Variable	Degrees of Freedom	Chi-Square Value	p-Value
Average DCB Rating	1	11.2221711	$p = 0.0008$
Experimental Condition	3	8.64311251	$p = 0.0344$

participants recommended in an a priori G*Power analysis by 16 participants.

A statistical model that included two independent variables (experimental condition, average DCB rating) and our key dependent measure (discrete choice: keep calories/reduce calories) was constructed. A nominal logistic analysis was conducted on the model. The overall model was found to be highly significant, $X^2 (4, n = 248) = 20.08$, $p = .0005$. The coefficient of determination (R^2) value of the model was .0596 (5.96%) indicating a small to medium effect of the model [19, 57] in line with studies on healthy eating nudges [12]. Our overall model results are summarized in Table 7.

Both predictors in our model proved to be significant (see Table 8). There was a highly significant main effect of average dietary control behavior (DCB) rating on healthy choice outcomes, $X^2 (1, n = 248) = 11.22$, $p = .0008$, such that those with higher average dietary control score ratings were more likely to make the healthy choice, regardless of the type of nudge they were exposed to. Critically there was a significant main effect on the experimental condition on healthy choice outcomes, $X^2 (3, n = 248) = 8.64$, $p = .0344$, such that all conditions (baseline condition and both social comparison conditions) produced more healthy choice outcomes than the control condition. The interaction between DCB rating and experimental condition was not significant and thus not included in the model, though general trends between these two variables will be discussed in due course.

3.2.4 Study Discussion. The first question we sought to answer was: does adding a weight gain implication statement to the baseline caloric surplus amount increasingly nudge consumers towards the healthy choice? We expected that it would, but our results proved otherwise. Healthy choice outcomes were more prevalent in the baseline (caloric surplus only condition) than in the control condition (caloric surplus + weight gain implication statement). In our experiment, participants were told they were projected to consume 3,500 extra calories across all study conditions. This amount was apparently alarming enough to cause participants to consider reducing calories without any further information. When participants were told this surplus equated to 0.45kg of weight gain, they were more likely to keep their basket as-is than to reduce calories, which indicates that 3,500 extra calories are perceived to be more worrisome than 0.45kg of weight gain by the UK consumers in our experiment. That said, it's hard to know if this trend would hold with different figures; there is good reason to believe once weight gain starts to equate to a full unit of weight gain or more (i.e., 1kg or 1lb) that this pattern of results would dissipate. This will be tested in our next set of experiments. In any case, we reject our hypothesis that adding a weight gain implication statement would increase healthy choice based on these unexpected results (see Table 9).

The next question we sought to answer was the following: does adding a social comparison to the caloric surplus amount and implication statement nudge the consumer towards the healthy choice? We expected that it would, and our results confirmed this (see Fig. 8). Both the in-group and out-group comparison conditions perform better than the control condition, though it appears comparing overweight adults to other overweight adults (in-group comparison) was more effective than comparing them to normal weight adults (out-group comparison) in inspiring uptake of the nudge. We cannot be certain this is because in-group comparisons are more meaningful to participants in general; it is possible that seeing "overweight" in the stimuli in the in-group condition might have caused a fear or stigma response that is driving the added effect. This will be addressed in our next study.

If we collapse the in-group and out-group conditions and analyze them as a collective set of social comparisons, we see that participants are much more likely to make the healthy choice when exposed to a social comparison nudge as compared to the calorie information nudge used in the control condition. To be more specific, less than half of participants (46.5%) decide to reduce calories when exposed to the control condition stimuli but more than half of participants (66.7%) participants decide to reduce calories when the social comparison is added (see Fig. 9). A Pearson's pair test

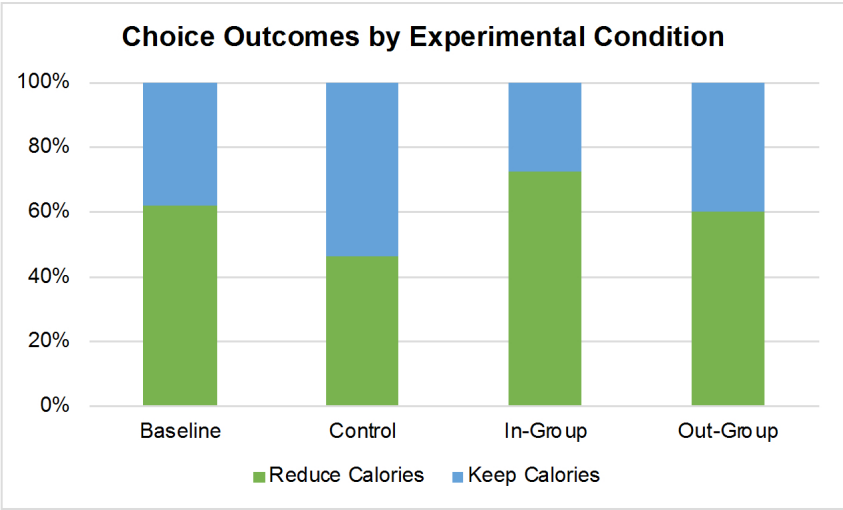


Figure 8: Choice Outcomes by Experimental Condition

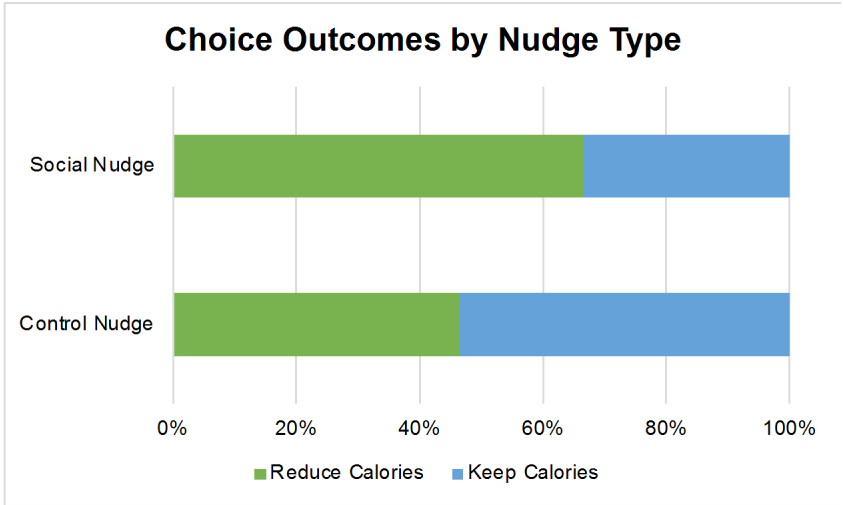


Figure 9: Choice Outcomes by Experimental Condition

reveals these differences are significant with a Pearson Chi-square p-value of .0102. We confirm our hypothesis (see Table 9).

We also found that amongst those who decide to take up the nudge and reduce basket calories, mean calorie reduction was 1944 calories in the control condition, 2366 in the in-group condition, and 1900 in the out-group condition. While the differences in intended calorie reduction were not statistically different across conditions, the level of intended calorie reduction observed across our experiments was quite high, pointing to the promise of nudging basket-level change at the point of checkout.

The final question was whether social comparison nudges are effective amongst harder to reach populations or individuals who do not typically modify their behaviors to control weight gain. In other words, do social nudges help get people who would otherwise not reduce calories to consider doing so? Our data showed that those

who had a low average rating on the Dietary Control Behaviors (DCB) scale were much less likely to reduce calories on average than those who had a high average DCB rating (see Fig. 10).

Amongst those who rate low in DCB (1 or 2) to moderate (3 or 4), we notice that healthy choice outcomes are much more likely if these participants were exposed to a social comparison nudge than the health information nudge in the control condition. Only 39% of participants low to moderate in DCB decide to reduce calories in the control condition, while 67% of participants low to moderate in DCB reduce calories if exposed to the same nudge with an added social comparison (see Fig. 11). A Pearson’s comparison test was run to assess if there was a meaningful difference between the control condition and the social comparison conditions on healthy choice outcomes amongst those who rate low to moderate in dietary control behaviors and the results were highly significant with a

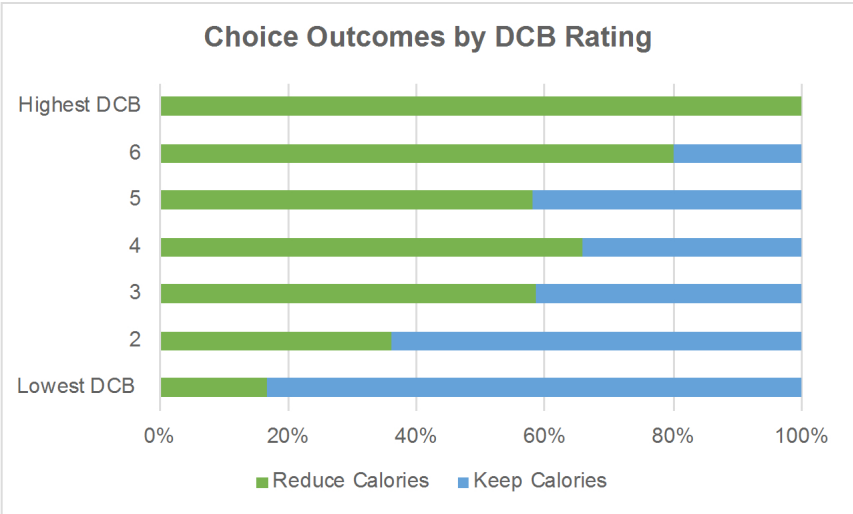


Figure 10: Choice Outcomes by DCB Rating

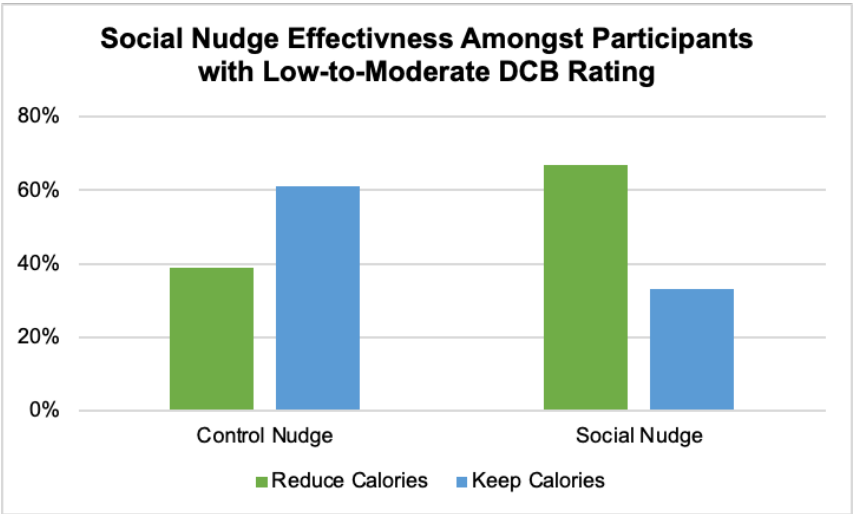


Figure 11: Nudge Performance Amongst Low to Moderate DCB Participants

Pearson Chi-square p-value of .0028. We indicate that there is a promising trend that supports our third and final hypothesis (see Table 9) but we cannot confirm our hypothesis given the interaction was not found to be significant in our overall model.

All in all, our core experiment on social comparisons as nudging mechanisms gives us good reason to believe that social comparisons can effectively be used to nudge overweight adults to consider reducing calories in appropriate contexts, even among people who rate low in dietary control behaviors and may thus be more resistant to dieting.

There are several limitations should be addressed. First, we cannot overgeneralize the potential reach of the nudge effects given this study focused on overweight adults living in the United Kingdom. Second, the stimuli used in these experiments were appropriate for a controlled academic study but would not be recommended

for use in the real-world given the sensitivity around comparing individuals by body weight or body image. In this experiment we found that comparing overweight adults to other overweight adults (an in-group comparison) produced greatest nudge uptake, though our pilot experiment with normal weight adults found that an out-group comparison (to overweight adults) produced better choice health outcomes, indicating that a fear or stigma associated with being overweight might be contributing to the observed in-group and out-group comparison effect. Our next experiment will address this shortcoming by taking a nod from minimal group paradigm and allowing participants to join teams based on colors, a technique that is well documented in social psychology literature [7, 15, 70]. In this approach, a participant might elect to join Team Blue and would see comparisons to other Team Blue members (an in-group comparison) or comparisons to Team Red members (an out-group comparison).

Table 9: H1/H2/H3 Results

Hypothesis 1 Statement	H1 Result
There will be an overall main effect of experimental condition on choice outcomes such that increased healthy choice will occur in the control condition (caloric surplus + weight gain implication) as compared to the baseline (caloric surplus only) condition.	Rejected
Hypothesis 2 Statement	H2 Result
There will be an overall main effect of experimental condition on choice outcomes such that increased healthy choice will occur in the social comparison conditions as compared to the control condition.	Confirmed
Hypothesis 3 Statement	H3 Result
There will be an interaction effect between the experimental condition and DCB rating on choice such that those who rate low to moderate on DCB will be more likely to pursue the healthy choice when presented with a social comparison nudge as compared to the control condition.	Promising Trend

Should we be able to replicate results, we can be more confident that it is the social group comparison driving the results, not any fear or stigma response. Third, our experiment revealed that consumers responded quite differently to stimuli that displayed a caloric surplus amount (i.e., you are projected to consume 3,500 extra calories) and stimuli that displayed the same exact caloric surplus amount but indicated this could result in weight gain (i.e., this could result in 0.45kg of weight gain), indicating that using nudges with specific numbers could produce varying and unexpected results. Our next experiment will move away from using raw numbers and we will seek to design and test cleaner, visual nudges that should be easier to employ and adopt at scale in real-world settings. These visual stimuli will provide a relative social comparison using a visualization and corresponding text assessment (i.e., your cart calories are very high), rather than call out specific caloric figures. Finally, although this experiment shows us that social comparison nudges seem to work across the board, we do not yet fully understand what underlying mechanisms might be driving the observed effects or who these nudges are most well-suited to.

4 DISCUSSION AND NEXT STEPS

The goal of this research was to design and test novel nudging mechanisms to encourage healthier choices and facilitate behavior change. We leveraged what we already know about nudging based on 10 years of learning on the topic [14]. We sought to challenge conventional nudge practices employed in the field by asking HCI scholars to consider a novel form of social influence nudging (the out-group social comparison) that has not been tested in the behavioral sciences, prior these experiments. We tested our nudges at the point of checkout, rather than point of product consideration, as we believe doing so could produce healthy choice outcomes and less is known about nudging at checkout than nudging during the shop or browse experience. We also aimed to resolve an ethical dilemma that has been documented in the literature on healthy food choice nudging: namely, the nudges that have proven to be most effective tend to manipulate consumer behavior outside of their awareness, a practice that consumers neither appreciate nor approve of.

Across two experiments, we focused on testing out-group social comparisons to understand if they could perform on par with the

more conventional in-group social comparison. Our results show that both kinds of transparent social comparison nudges work. These social nudges worked particularly well among people who indicated they do not typically change their diet behaviors to control weight gain, as measured by the dietary control behavior scale [47]. Our point-of-checkout, basket-level social comparison nudges also encouraged users to make greater calorie reductions compared to healthy eating nudges employed in the field today (which find reduction averages between 64 calories to 209 calories).

We believe these results have potentially strong implications for experience design. Social nudges should be harnessed in new ways to help people better achieve their goals in a variety of areas, not just food choice. Our initial findings seem to indicate that out-group comparisons may be just as effective as in-group comparisons in encouraging socially responsible decisions and should be further explored, in academia and the field alike. When trying to help individuals change behaviors for social good (e.g., eating healthier, saving more for retirement, using less energy), out-group social comparisons become critical as in-group social comparisons are likely to promote the status quo, which is not helpful given alarming trends in obesity, retirement readiness, and climate change in various parts of the world. Some may argue that individuals may feel bad about themselves after being exposed to upward social comparisons that pit them against others who perform better than they do in areas such as healthy eating or saving for retirement. However, existing literature suggests that is not necessarily true. After reviewing a series of studies looking at the impacts of upward social comparisons, Collins [33] asserts that “upward comparison is not in conflict with the desire for positive self-regard and indeed serves it indirectly (through self-improvement) and sometimes directly (by enhancing the self).” Further nudge studies that prompt upward social comparison should seek to validate this. We hope our work inspires scholars and designers to think of social comparisons more broadly and employ comparisons that go beyond “people like you” in contexts where it makes sense, particularly when broad sweeping social norm statements on what most people are doing would not be appropriate.

These preliminary findings could not come at a better time. The rise and adoption of online grocery shopping brings about opportunities in digital food choice nudging that were not possible just a few years ago [40, 51, 55]. We know that online recommendation agents can influence consumer choice in meaningful ways [5, 36, 38, 43, 78], giving us reason to challenge conventional approaches and consider new ways to optimize recommendation algorithms. Our research suggests that embracing novel forms of social comparisons and nudging consumers later in their shopping experiences and at a higher order could promote nudge uptake in meaningful ways. Future research should go beyond calorie reduction and nudge other healthy diet choices and test how out-group comparisons might have other positive benefits for public health or policy outcomes. Our results suggest that there may be more tools available to designers to create effective, ethical, transparent nudges that help people achieve goals for themselves in a way that suits them, while also benefitting society more broadly.

ACKNOWLEDGMENTS

This primary author of this research has been awarded an industry studentship from Tesco, a leading online grocery retailer, to support his DPhil research. The authors of this research would like to thank the team at Tesco and Tesco Labs for their on-going support and interest in this research. While Tesco was consulted and informed throughout the research and publication process, Tesco did not participate in study design, data collection or data analysis for the studies contained within this paper. BMD led on the conception and design of study, conducting the experiments, data analysis, and drafting the end-to-end manuscript. GN supported on interpretation of data, reviewing literature, and revising the manuscript critically for important intellectual content, as well as supervising the project, advising on key questions at critical junctures.

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