Informed indulgence: The effects of nutrition information provision and dietary restraint on consecutive food consumption decisions

Abstract

Objective: Nutrition and menu labelling have been increasingly implemented worldwide. This research examines the effect of nutrition information provision on the immediate and subsequent consumption decisions of restrained and unrestrained eaters.

Design: We conducted three scenario-based experiments. In study 1 (*N* = 478) and study 2 (*N* = 199), we manipulated the availability of nutrition information and measured dietary restraint. Study 3 (*N* = 275) extended study 2 by adding a condition where we provided reference information about recommended daily calories.

Main outcome measures: We measured choices between relatively low-calorie and high-calorie alternatives (studies 1-3), and measured a subsequent decision to consume indulgent food (studies 2 and 3).

Results: Nutrition information did not generally affect choices between low-calorie and high-calorie options, irrespective of dietary restraint. However, restrained eaters who chose a high-calorie option in the presence of nutrition information indicated they would reduce subsequent intake.

Conclusion: Nutrition information does not necessarily reduce the choice of relatively high-calorie food, but it can help restrained eaters reduce subsequent intake after a high-calorie choice. These results suggest that despite not having an immediate effect on choices, nutrition and menu labelling may benefit restrained eaters at a later time.

Keywords: nutrition labelling; menu labelling; food choice; dietary restraint; self-regulation; public policy

Word count: 8,056

Introduction

Nutrition and menu labelling regulations have become increasingly popular worldwide (European Food Information Council, 2018; FDA & HHS, 2014). The prevalent intuition of public health officials and lawmakers implementing such regulations is that the provision of such information should encourage people to restrict their intake of high-calorie foods. However, the existing research shows that people tend not to pay attention to such information (Grunert et al., 2010). Consequently, labelling appears to have a minimal effect on calorie intake, if any (Long et al., 2015). Indeed, in a recent meta-analysis of studies of menu labelling, the overall effect of nutrition labelling was estimated as a reduction of a mere 27 calories (Zlatevska et al., 2018).

One possible reason for this weak effect at the population level is that people vary in their interest in eating and nutrition (Grunert et al., 2010), and hence there are likely to be individual differences in responsiveness to nutrition and menu labelling (Burton & Kees, 2012). Restrained eaters, who are motivated to restrict food intake to control their weight (Herman & Polivy, 1980), may be more likely to take into account the available calorie information when making consumption decisions. However, counter to this assumption, previous research has suggested that providing calorie information does not reduce the total calories consumed by either restrained eaters or unrestrained eaters (Platkin et al., 2014; Droms Hatch, 2016).

In this research, we depart from the prevalent thinking and propose that one important consequence of nutrition labelling which has been neglected in the literature is its effects on subsequent consumption decisions. Specifically, we predict that these downstream effects emerge among restrained eaters in particular. Restrained eaters may consciously choose a relatively high-calorie option when calorie counts are salient as they can balance out their calorie intake by eating less at the next meal. Indeed, people eat in a balanced manner across meals within a day, such that higher calorie intake at lunch is related to lower calorie intake at dinner, and vice versa (Khare & Inman, 2009). Similarly, perceiving high-calorie intake in the previous meal leads to a reduction in calorie intake in the following meal (Brown et al., 2020). This suggests that the provision of nutrition information on food packaging and restaurant menus may help restrained eaters adjust their calorie intake later. Thus, we propose that the provision of nutrition information may not necessarily have an immediate impact on restrained eaters, but rather a delayed impact by inducing them to reduce their subsequent calorie intake.

Prior research has shown that restrained eaters often lose their inhibition in various situations such as after consuming high-calorie food (Herman & Mack, 1975) and after being exposed to cues of palatable food (Fedoroff et al., 1997). Although restrained eaters tend to show disinhibition, studies have shown that they are more likely to regulate themselves when they are reminded of their restraint goals (Papies & Hamstra, 2010; Van Koningsbruggen et al., 2011). Thus, extending the literature on dietary restraint, the present research demonstrates that the provision of nutrition information can help restrained eaters switch back to being restrained after having chosen a high-calorie option.

To test this proposed carryover effect of labelling among restrained eaters, in study 1, we first show that providing nutrition information does not have a significant effect on immediate food choices unless the options differ greatly in calorie content. In studies 2 and 3, we presented participants with scenarios that involved two consecutive food decisions at time 1 (T1) and time 2 (T2), with nutrition information provision manipulated for the T1 choices. This framework builds on the existing literature on nutrition and menu labelling which predominantly examines the impact of labelling on one-off consumption decisions (Zlatevska et al., 2018). By proposing the moderating role of dietary restraint, the present studies test whether the provision of nutrition information can be an effective means of curbing restrained eaters' tendency to disinhibit after indulging.

Two sides of restrained eaters: motivated to restrain but susceptible to temptations

Restrained eaters are motivated to control their weight by regulating their food intake (Herman & Polivy, 1980). They set and rely on dietary rules such as restricting certain types of food and keeping count of the calories they consume while discounting physiological needs such as hunger cues (Bublitz et al., 2010; Herman & Polivy, 1980; Knight & Boland, 1989). Despite their intent, restrained eaters often forgo their dietary regulation. For example, in the presence of a cue of palatable food, they increase consumption of that palatable food (Fedoroff et al., 1997). Also, once they fail in keeping to their dietary rules, they become more inclined to consume (Herman & Mack, 1975; Knight & Boland, 1989). This ironic disinhibition of restrained eaters occurs because they have the desire to enjoy indulgent food, which conflicts with their restraint goal (Stroebe et al., 2008). The palatable food cues stimulate their affective responses, resulting in disinhibition (Papies et al., 2008; Stroebe et al., 2008). Similarly, eating forbidden indulgent food triggers a repressed desire for indulgent food (De Witt Huberts et al., 2014), making them highly responsive to such foods (Demos et al., 2011). Together, these findings suggest that restrained eaters may be thwarted in pursuing their dietary goals due to being strongly tempted by pleasurable foods (Stroebe et al., 2008).

Although restrained eaters often succumb to their temptation for pleasurable foods, studies have shown that strategies such as priming a restraint goal may enhance their self-regulation. For example, when restrained eaters were made to form implementation intentions (e.g., "if confronting tempting food, remember my dieting goal"), their dieting goal was activated upon exposure to tempting food cues, leading to reduced intake (Van Koningsbruggen et al., 2011). Similarly, the presence of a cue to diet made restrained eaters eat fewer unhealthy snacks (Papies & Hamstra, 2010). While these studies have focused on automatic processes such as goal priming (Stroebe et al., 2008), we examine a strategy relying on a more conscious process—that is, considering nutrition information—to increase self-regulation among restrained eaters.

Effect of nutrition information provision on a food choice at time 1 (T1)

Restrained eaters' dietary concerns make them more likely to pay attention to nutrition information. However, given the discussion above, it is not clear how nutrition information might influence their choices, since calorie content by itself might reduce the intention to consume, but the associated cognitions might tempt indulgence, leading to conflicting desires. It is possible that these conflicting desires, if similar in magnitude, might cancel each other, thereby leading to the observed minimal effects in the literature of nutrition information provision. Indeed, prior work suggests that neither restrained nor unrestrained eaters respond to calorie information by consuming lower calories (Platkin et al., 2014; Droms Hatch, 2016). This suggests that even in the presence of nutrition information, restrained eaters may not necessarily prefer relatively low-calorie foods to high-calorie foods.

To explore this idea further, consider someone choosing between two options, one of which is higher in calorie content than the other. If the calorie difference between the two options is not substantial, this person—if s/he is a restrained eater—will be likely to either ignore it or not factor it into his/her decision making whereas a restrained eater may either succumb to the temptation non-consciously or justify the relatively higher-calorie choice following his/her desire to enjoy the more pleasurable food (Stroebe et al., 2008). In contrast, if the calorie difference is large, it becomes a salient factor in the decision making for everyone —restrained as well as unrestrained eaters. In other words, providing calorie information about a pasta and a salad should only reduce choice of the pasta if it is perceived as containing substantially more calories than the salad (Irmak et al., 2011). Accordingly, we hypothesize that providing nutrition information will not have a major impact on one-off decisions unless it reveals a large enough difference in calories between the options.

H1: The provision of nutrition information at T1 does not influence consumption decisions at T1, regardless of individuals' dietary restraint, unless it reveals a substantially higher calorie count for one option over another.

Effect of nutrition information provision on subsequent decisions at time 2 (T2)

While providing nutrition information for food options at T1 should not have a major impact on a consumer's choice at T1 unless the calorie difference between options is substantially large, we predict that it will influence a subsequent decision at T2. Before considering this potential carryover effect, it is necessary to understand how restrained eaters make consumption decisions at T2, after a T1 decision when nutrition information was absent. In this case, after having chosen a high-calorie (vs. low-calorie) food at T1, restrained eaters may exhibit disinhibited behaviour such as increased consumption of indulgent food at T2. When they fail to refrain from eating indulgent food, they tend to consume more indulgent food at a subsequent opportunity (Herman & Mack, 1975; Knight & Boland, 1989). Similarly, while some restrained eaters can maintain restraint over time, others fail to stick to their restraint goals (Papies et al., 2008; Van Koningsbruggen et al., 2011). This is because prior success in pursuing their dietary goal helps them guard this goal, but prior failure serves as a justification to ignore it, making indulgence more likely (De Witt Huberts et al., 2014). These findings suggest that, for restrained eaters, a prior goal success at T1 (i.e., making a low-calorie choice) leads to a subsequent success at T2 (i.e., restraint). In contrast, a prior failure (i.e., making a high-calorie choice at T1) leads to a subsequent failure (i.e., indulgence at T2). The latter case is particularly problematic for restrained eaters as repeatedly disinhibiting dampens their restraint goal.

But how might restrained eaters' behaviour at T2 be influenced by the provision of nutrition information at T1? Restrained eaters' continued deviation from prior goal violation could be partly based on the dichotomous classification of food as forbidden versus permitted

(Knight & Boland, 1989). People make such stereotypic judgments of food items—intuiting, for example, that 'unhealthy' foods contain more calories than 'healthy' foods (Carels, Konrad, & Harper, 2007). However, counter to these stereotypes, eating a relatively small quantity of seemingly unhealthy food may not be too detrimental if actual calories are taken into account. For example, four Hershey's Kisses chocolates contain 100 calories, which is only half of people's estimate of 202 calories (Carels et al., 2007). These kinds of stereotype-based judgments may contribute to restrained eaters' disinhibition by making them ignorant of the actual amount of calories consumed. Indeed, regardless of the amount of indulgent food consumed previously (e.g., 7.5 oz. vs. 15 oz. of milkshake), restrained eaters showed the same degree of increase in their ice cream consumption (Herman & Mack, 1975; Knight & Boland, 1989). In the absence of nutrition information, restrained eaters might perceive their restraint goal to be completely violated by their previous consumption of the 'forbidden' food, without discerning their actual calorie intake. This may lead to subsequent unfettered transgressions as regards their dietary goals.

The disclosure of nutrition information at T1 may alter this behaviour. When the actual calorie counts of their T1 choices were made salient, restrained eaters may be less likely to rely on preconceived notions about the calorie contents in specific foods that lead them to perceive their high-calorie choices at T1 as goal failure. Consequently, being better informed of the calorie intake from their T1 choice, restrained eaters may be likely to adjust their subsequent consumption at T2. Indeed, people having flexible control over intake decisions (e.g., "if I eat more during one meal, I make up for it at the next meal.") have been shown to disinhibit less than people who rigidly control intake by completely forbidding themselves any unhealthy food (Westenhoefer et al., 1999). Moreover, people can flexibly manage their calorie intake across consumption episodes within the same day (Khare & Inman, 2009). For example, when people believe that they consumed a lot of calories for breakfast, they consume fewer calories for lunch (Brown et al., 2020). Thus, we propose that the salient provision of nutrition information at T1 can help restrained eaters compensate at T2 by reducing calorie intake, especially if they had chosen a high-calorie option at T1.

The compensatory reduction of calories consumed at T2 after high-calorie intake at T1 is not symmetric. Nutrition information provision should not necessarily lead restrained eaters to increase their subsequent consumption if they had chosen a low-calorie option at T1. Research has shown that restrained eaters' previous success at controlling their consumption influences their future success (Papies et al., 2008; Van Koningsbruggen et al., 2011). Nutrition information that confirms that a healthy item contains fewer calories than an unhealthy item does not convey any incremental information that is actionable. As a result, information provision leading to a low-calorie choice at T1 should not influence restrained eaters' decisions at T2. Formally:

H2: The provision of nutrition information has an interactive influence with prior food choice at T1 on a subsequent consumption decision at T2 among restrained eaters, such that:

H2a: When nutrition information is provided (vs. not provided) at T1, restrained eaters will reduce their consumption at T2 after having consumed a high-calorie food at T1.

H2b: When nutrition information is provided (vs. not provided) at T1, restrained eaters may not change their consumption at T2 after having consumed a low-calorie food at T1.

In contrast to restrained eaters, unrestrained eaters are unlikely to change their subsequent consumption when nutrition information is provided at T1. The relatively small calorie gap between food choices at T1 would not raise a red flag for them because they are relatively unconcerned about their diet (Bublitz et al., 2010) and do not pay much attention to nutrition information (Antonuk & Block, 2006). Thus, we hypothesize that revealing calorie information about the choices at T1 would not change unrestrained eaters' decisions at T2.

H3: The provision of nutrition information at T1 does not influence subsequent consumption at T2 among unrestrained eaters regardless of their T1 choice.

To summarise, the present research investigates how restrained eaters might use nutrition information across consecutive consumption decisions. Specifically, we suggest that providing nutrition information will not necessarily reduce the likelihood of choosing high-calorie foods at T1 unless there is a large calorie difference between healthy and unhealthy options. However, the provision of nutrition information at T1 would help restrained eaters balance calorie intake across consumption decisions by reducing their intake of indulgent food at T2 after a high-calorie food choice at T1.

Overview of studies

We tested our hypotheses in three experiments. All studies were conducted online on Amazon Mechanical Turk, recruiting participants residing in the USA, as menu labelling is now common in the USA (FDA & HHS, 2014). We restricted participation to non-vegetarians as the T1 choices in our stimuli were not vegetarian. As vegetarians may have sub-categories of dietary rules (e.g., vegan, lacto-ovo), inviting non-vegetarian participants only allowed us to exclude those who have and follow such specific rules. Study 1 tested our hypothesis regarding the effect of nutrition information provision on choices at T1, establishing that the effect is only significant when the difference in the calorie contents of the two available options is large (H1). In studies 2 and 3, participants made two consecutive food consumption decisions in scenarios in which the calorie difference between healthy and unhealthy options at T1 was not substantially large, and thus the effect of nutrition information provision on T1 decision was not expected. Study 2 tested our hypotheses regarding compensatory consumption among restrained eaters by investigating the effects of providing nutrition information on their T1 choices (H1) and their subsequent T2 consumption decisions (H2; H3). Study 3 investigated a boundary condition of the carryover effect of providing nutrition information—specifically, when available reference information about recommended daily calories can serve as justification. With a justifiable reason for indulgence, we predicted that the provision of nutrition information would no longer lead restrained eaters to reduce subsequent calories consumed even after they had previously chosen a high-calorie food.

Study 1 The effect of nutrition information provision on T1 food decisions

In study 1, we tested the effect of providing nutrition information on a choice between a high-calorie option and a low-calorie option at T1. We predicted that the provision of nutrition information would not affect a T1 decision unless the high-calorie food option contained substantially more calories than the low-calorie option (H1).

Method

Participants and design

Participants (N = 478; 49.4% female; M_{age} = 33.71) were randomly assigned across conditions in a 3 (nutrition information: absent vs. small gap vs. large gap) between-subjects design with dietary restraint measured. We report how we determined the sample size and the post-hoc power analysis results for all studies in the supplemental materials.

Procedure

Participants were instructed to imagine that they were ordering a main course at a restaurant. They received a single-page menu containing two options: a cheeseburger and a grilled chicken salad (see supplemental materials). Participants in the *nutrition information-absent* condition did not receive any nutrition information. Only participants assigned to the *nutrition information small-gap* and the *nutrition information large-gap* conditions received nutrition information for both options. In the *small-gap* condition, the unhealthy option (650 calories) contained slightly more calories than the healthy one (570 calories) but in the *large-gap* condition, the unhealthy option (850 calories) contained substantially more calories (570 calories). The small calorie gap between the unhealthy and healthy options represented actual calorie counts from the fast-food restaurant menus we took our stimuli from. All participants chose one of the two options and then evaluated the perceived healthfulness and tastiness of each item. In the absent condition, they estimated the calorie content of both food options. In the small-gap and large-gap conditions, they were asked to recall the calorie content (the results for items, for all studies, are reported in the supplemental materials). Lastly, they completed the Herman and Polivy (1980) 10-item dietary restraint scale (α = .78), reported how many hours had passed since their last meal, and provided demographic information.

Note that we selected stereotypically healthy and unhealthy entrées for choices at T1 in all studies so that the unhealthy option contained higher calories than the healthy option (Carels et al., 2007). This is because if disclosed information disconfirms expectations (e.g., a healthy option containing higher calories than expected), it may induce attentional and cognitive processes that have effects distinct from the effects of interest in this research (Howlett et al., 2009).

Results

We conducted a logistic regression with food choice as the dependent variable (0 = high-calorie option; 1 = low-calorie option) and separate dummy variables for the small-gap and large-gap nutrition information conditions (with the information-absent condition serving as the baseline in both cases), dietary restraint (standardized), and interactions between restraint and the nutrition information dummies as the independent variables, controlling for the time since the last meal, b = –.03, SE =.02, $Wald$ = 2.50, p = .11, odds ratio = .97. There was a significant effect of dietary restraint, b = .42, SE =.17, $Wald$ = 6.18, p = .01, odds ratio = 1.53, no significant effect of the small gap, b = –.21; SE =.23, $Wald$ = .83, p = .36, odds ratio = .81, and a significant effect of the large gap, *b* = .53, *SE* =.23, *Wald* = 5.24, *p* = .02, odds ratio = 1.69. Neither two-way interaction was significant (*p*s > .55). Regardless of dietary restraint, participants in the small-gap condition chose the healthy food as much as participants in the nutrition information-absent condition whereas participants in the large-gap condition chose the healthy option significantly more than those in the nutrition information-absent condition, consistent with our predictions (see Figure 1; see Table 1 for estimated choice probability of T1 choices in all studies).

[INSERT FIGURE 1 AND TABLE 1 ABOUT HERE]

Discussion

This study shows that providing nutrition information does not always increase the preference for healthy food. We found the effect only when the calorie difference between unhealthy and healthy options was substantially large. Furthermore, responses to nutrition information did not depend on dietary restraint. Only when the calorie gap between the two items was very large, compared to when it was unknown, were participants more likely to choose the low-calorie option. When the calorie gap was relatively small, the preference for the low-calorie option did not increase. In studies 2 and 3, we adopted this relatively small calorie difference between T1 options to test the delayed effects of T1 nutrition information provision on restrained eaters' decisions at T2.

Study 2 The effect of nutrition information provision and dietary restraint on T1 and T2 food decisions

In study 2, we tested the effect of providing nutrition information at T1, with a relatively small calorie gap, on consecutive decisions: an entrée choice at T1 and a subsequent dessert decision at T2. Consistent with prior literature and study 1, we predicted that the provision of nutrition information would not affect T1 decisions regardless of dietary restraint (H1), but it would have a significant effect on T2 decisions (H2). Specifically, as a result of receiving nutrition information at T1, restrained eaters would try to reduce calorie intake at T2 after having chosen a high-calorie option (H2a) but not after having chosen a low-calorie option at T1 (H2b). In contrast, among unrestrained eaters, we predicted that the nutrition information provided at T1 would not have a carryover effect on the T2 decision (H3).

Method

Participants and design

We recruited one hundred and ninety-nine Americans (47.7% female; M_{age} = 31.95) and manipulated the availability of nutrition information at T1 by randomly assigning participants across conditions while measuring dietary restraint. Hence, for the T1 choice, the design was 2 (nutrition information: absent vs. present) x dietary restraint (measured). For the T2 consumption decision, the design was 2 (nutrition information: absent vs. present) x dietary restraint (measured) x 2 (T1 choice: low-calorie vs. high-calorie, measured).

Procedure and measures

Participants were informed that they would participate in two short studies since we intended to avoid an unintended effect from anticipating future consumption at T2 on the preceding decision at T1. The first study followed a similar procedure to study 1, with different stimuli. All participants were asked to imagine being at a restaurant, choosing between strawberry and avocado salad versus rib-eye steak (see supplemental materials). Participants in the *nutrition information-present* condition saw nutritional facts panels for both items, indicating that the steak contained 650 calories and the salad contained 570 calories, similar to the calorie difference used in the *small-gap* condition in study 1. In contrast, those in the *nutrition information-absent* condition did not receive any nutritional information. Similar to study 1, all participants made a choice at T1, evaluated the healthfulness and tastiness of each item, and recalled or estimated the calorie content of both options.

Next, all participants proceeded to the second study, in which they imagined visiting an ice cream store for dessert after this T1 meal (McFerran et al., 2010). Participants indicated how much ice cream they would like to eat using a sliding scale ranging from ‘not at all’ (0) to ‘a lot’ (100), as an indicator of desired intake at T2 (see supplemental materials). Finally, participants completed the 10-item dietary restraint scale (α = .78), and the rest of the procedure was identical to that of study 1.

Results

Food choice at T1

Similar to study 1, we conducted a logistic regression with T1 food choice as the dependent variable with provision of nutrition information, dietary restraint, and their interaction as the independent variables, controlling for the time since the last meal, *b* = –.05, *SE* = .03, *Wald* = 2.24, *p* = .13, odds ratio = .95. As before, the T1 choice was not significantly affected by the provision of nutrition information, *b* = –.32, *SE* = .30, *Wald* = 1.11, *p* = .29, odds ratio = .73, dietary restraint, *b* = .37, *SE* = .23, *Wald* = 2.61, *p* = .11, odds ratio = 1.44, or their interaction, *b* = –.24, *SE* = .31, *Wald* = .59, *p* = .44, odds ratio = .79. Providing nutrition information did not increase the likelihood of choosing the low-calorie option, either among unrestrained eaters (estimated at 1 *SD* below the mean of the dietary restraint scale), *b* = –.09, *SE* = .44, *Wald* = .04, *p* = .85, odds ratio = .92 (see figure 2), or among restrained eaters (estimated at 1 *SD* above the mean of the dietary restraint scale), *b* = –.56, *SE* = .42, *Wald* = 1.73, *p* = .19, odds ratio = .57, thereby supporting H1.

[INSERT FIGURE 2 ABOUT HERE]

Subsequent ice cream consumption decision at T2

We predicted that the T1 choice should interact with the provision of nutrition information to influence the intake intention at T2, but only among restrained eaters. Because the T1 choice was self-selected, we adopted an endogenous treatment-regression model (Maddala, 1986), using STATA, to address any issues of endogeneity. Reassuringly, the estimation results showed no significant correlation between residuals of T1 and T2 decisions, $\rho = -.02$, $\sigma = 25.67$, $\chi^2(1) = .00$, $p > .97$, suggesting that there was no significant self-selection problem. Since this concern about endogeneity was alleviated, we also conducted a standard OLS regression with nutrition information provision (0 = nutrition information-absent; 1 = nutrition information-present) and T1 choice (0 = high-calorie T1 choice; 1 = low-calorie T1 choice) as dummy-coded variables, dietary restraint standardised, and all interactions. Both sets of regressions supported our predictions, and hence, for brevity, we report here the results of the OLS regression (see supplemental materials for the detailed results).

The OLS regression results revealed a significant main effect of nutrition information provision, $b = -10.17$, $SE = 4.63$, $t(191) = -2.20$, $p = .03$, a significant interaction between nutrition information provision and dietary restraint, $b = -9.90$, $SE = 4.57$, $t(191) = -2.17$, $p = .03$, a significant interaction between T1 choice and dietary restraint, $b = -12.06$, $SE = 6.00$, $t(191) = -2.01$, $p = .046$, and a marginally significant interaction between nutrition information provision and T1 choice, $b = 15.53$, $SE = 7.90$, $t(191) = 1.97$, $p = .051$, all of which were qualified by a significant three-way interaction, $b = 19.60$, $SE = 8.15$, $t(191) = 2.40$, $p = .02$, (overall effect size, $f^2 = .029$, $F(1, 191) = 5.78$, $p = .02$). Other effects were not significant (*p*s > .200).

To probe the three-way interaction, we conducted interaction contrasts and simple slopes analyses at 1 *SD* above and below the mean of the dietary restraint scale (Aiken, West, & Reno, 1991). Among restrained eaters (i.e., at 1 *SD* above the mean), the interaction contrast between T1 choice and the provision of nutrition information was significant, $F(1, 191) = 10.31$, $p = .002$, $\eta^2 = .05$ (see figure 3). As predicted, when nutrition information was available, restrained eaters who had chosen the high-calorie option at T1 significantly reduced their intended ice cream consumption at T2 ($M_{nutrition\_information\_present}$ = 26.07 vs. M_{absent} = 46.15), *b* = –20.08, *SE* = 6.77, *t*(191) = –2.96, *p* = .003, η^2 = .04. In contrast, when nutrition information was available at T1, restrained eaters who had chosen the low-calorie option at T1 did not significantly increase their intended ice cream consumption at ($M_{nutrition\_information\_present}$ = 42.11 vs. M_{absent} = 27.06), *b* = 15.05, *SE* = 8.59, *t*(191) = 1.75, *p* = .08, η^2 = .015 (see Table 2 for the estimated means of the intended intake at T2 in studies 2 and 3). Together, these results support H2a and H2b.

[INSERT FIGURES 3A AND 3B AND TABLE 2 ABOUT HERE]

Among unrestrained eaters (i.e., at 1 *SD* below the mean), the two-way interaction between nutrition information provision and T1 choice was not significant, *F*(1, 191) = .12, *p* = .73, η^2 = .001, as hypothesised (H3). The intended T2 consumption of unrestrained eaters was not influenced by either their choice at T1 or nutrition information provision at T1, *p*s > .65.

Additionally, we tested the differences in intended T2 intake as a function of T1 choices in each of the experimental conditions. In the absence of nutrition information at T1, restrained eaters who chose a high-calorie food at T1 (*M* = 46.15) reported higher intended intake at T2 compared to those who chose a low-calorie food at T1 (*M* = 27.06), *b* = –19.08, *SE* = 7.88, *t*(191) = –2.42, *p* = .02, η^2 = .029, consistent with our assumption of disinhibition. However, in the presence of nutrition information at T1, restrained eaters who chose a high-calorie food at T1 (*M* = 26.07) exhibited lowered intended T2 consumption relative to those who chose a low-calorie food at T1 (*M* = 42.12), *b* = 16.04, *SE* = 7.59, *t*(191) = 2.11, *p* = .04, η^2 = .022), suggesting that nutrition information provision may temper restrained eaters' disinhibition tendency.

Discussion

Consistent with study 1, when the calorie difference between food options was not large, the provision of nutrition information did not influence food choices at T1. However, it affected the subsequent consumption decisions at T2 among restrained eaters. Specifically, when provided with nutrition information for choices at T1, restrained eaters lowered dessert consumption at T2 if they had made a high-calorie choice at T1, but did not increase dessert consumption at T2 if a low-calorie option had been chosen at T1. In contrast, neither T1 choices nor the provision of T1 nutrition information significantly influenced unrestrained eaters' intended dessert consumption at T2. These results indicate that restrained eaters do indeed incorporate nutrition information, albeit in a delayed manner, and compensate for their prior high-calorie intake. Because the provision of nutrition information enabled restrained eaters to take into account actual calorie intake, they could afford a high-calorie choice at T1 while reducing intake of another indulgent food at T2.

Study 3 Boundary condition of carryover effect of nutrition information provision at T1

Study 3 aimed to replicate the findings of study 2 and also test a possible boundary condition for the carryover effect observed in the previous studies. Our theory suggests that when calorie information is available for food choices at T1, restrained eaters would try to compensate for prior calorie intake by reducing subsequent consumption after a high-calorie food choice. However, as justifications tend to liberate people to indulge (De Witt Huberts et al., 2014), if restrained eaters have a justification for continued indulgence, they would be less likely to balance their subsequent consumption after having chosen a high-calorie option at T1. Therefore, in this study, we added a new condition where we provided reference information regarding the average daily calorie intake of the US population (2,000 to 2,500 calories), which is often included in labelling. Since this daily intake reference greatly exceeds calorie counts of the available choices at T1 (an intentional feature of our experimental design), restrained eaters may think they have room for more indulgent food and justify their ongoing indulgence. As a result, we predicted that they would be unlikely to refrain from eating indulgent foods at T2 even after having chosen a high-calorie food at T1.

Method

Participants and design

We recruited two hundred seventy-five Americans (49.5% female; M_{age} = 33.04). This study had three experimental conditions, two of which were the same as in study 2. In the new third condition, the available options were identical and were accompanied by both nutrition information and reference information about recommended daily calorie intake.

Procedure and measures

All participants were given a choice between two T1 items—a cheeseburger and a grilled chicken salad—as in study 1, with the provision of nutrition information manipulated between-subjects. Participants in the *nutrition information-absent* condition did not receive any nutrition information. Participants in both the *nutrition information-present* and the *nutrition information-present with reference* condition received information indicating that the cheeseburger contained 650 calories and the salad contained 570 calories—the same difference used in the small-gap condition in study 1. Those in the *nutrition information-present with reference* condition also received a reference value (i.e., “The average daily calorie intake of the US population is 2,000–2,500 calories”). After participants had indicated their T1 choice, they evaluated each item in the same manner as in studies 1 and 2. The remaining procedure was the same as study 2 for the T2 decision measure, dietary restraint scale (α = .79), the time passed since their last meal and demographic information.

Results

Food choice at T1

We examined the effect of nutrition information and dietary restraint on T1 choice using a logistic regression with two dummy codes for nutrition information (i.e., the no-information condition served as the baseline), standardised dietary restraint, the interaction of nutrition information-present dummy and dietary restraint, and the interaction of the reference dummy and dietary restraint, controlling for time since the last meal, *b* = –.13, *SE* = .03, *Wald* = 14.94, *p* < .001, odds ratio = .88. The results revealed no significant effects of nutrition information-present dummy, *b* = .34, *SE* = .33, *Wald* = 1.09, *p* = .30, odds ratio = 1.41, reference dummy, *b* = .22, *SE* = .30, *Wald* = .50, *p* = .30, odds ratio = 1.24, dietary restraint, *b* = .12, *SE* = .20, *Wald* = .36, *p* = .55, odds ratio = 1.13, or either interaction term (nutrition information-present dummy x dietary restraint, *b* = –.06, *SE* = .30, *Wald* = .05, *p* = .83, odds ratio = .94; reference dummy x dietary restraint, *b* = .41, *SE* = .33, *Wald* = 1.54, *p* = .22, odds ratio = 1.51). In both the *nutrition information-present* condition and the *nutrition information-present with reference* condition, the choice shares of the low-calorie option were not significantly different from that in the *nutrition information-absent* condition among either unrestrained eaters (1 *SD* below the mean, *p*s > .37; see figure 4) or restrained eaters (1 *SD* above the mean, *p*s > .16).

[INSERT FIGURE 4 ABOUT HERE]

Subsequent ice cream consumption decision at T2

As in study 2, we adopted an endogenous treatment-regression model to test for a potential endogeneity problem (see supplemental materials for the details). The analysis again revealed that there was no significant endogeneity problem (ρ = – .42, σ = 24.90, $\chi^2(1)$ = 3.73, *p* = .05). The results of the OLS regression also support our predictions.

As before for ease of interpretation, we report the results from the equivalent OLS regression. The results were almost identical. Specifically, none of the main effects were significant, *p*s > .5, except the main effect of dietary restraint, *b* = 10.22, *SE* = 3.15, *t*(263) = 3.24, *p* = .001, none of the two-way interactions were significant, *p*s >.07, except the interaction between the nutrition information-present dummy and dietary restraint, *b* = –

15.66, *SE* = 4.67, $t(263) = –3.36$, $p = .001$, and neither was the three-way interaction between the reference dummy, T1 choice, and dietary restraint, $b = 9.23$, $SE = 7.21$, $t(263) = 1.28$, $p = .20$. However, as in study 2, the three-way interaction between the nutrition information-present dummy, T1 choice, and dietary restraint was significant, $b = 23.11$, $SE = 8.23$, $t(263) = 2.81$, $p = .005$. Furthermore, adding the three-way interaction term improved the model fit significantly, $F(2, 263) = 3.94$, $p = .021$ (overall effect size, $f^2 = .028$). To probe this three-way interaction, we examined the two-way interaction between T1 choice and nutrition information provision at different levels of dietary restraint. Among restrained eaters (i.e., 1 *SD* above the mean), the interaction contrast of T1 choice and nutrition provision was significant, $F(2, 263) = 4.26$, $p = .02$, $\eta^2 = .030$. Replicating study 2, restrained eaters who had chosen the high-calorie option at T1 subsequently decreased intended T2 consumption due to the provision of nutrition information ($M_{nutrition\_information\_present} = 34.28$ vs. $M_{absent} = 54.16$), $b = –19.88$, $SE = 7.08$, $t(263) = –2.81$, $p = .005$, $\eta^2 = .028$ (see figure 5). Importantly, the effect of nutrition information provision was not observed when reference information about recommended daily calories was provided. When restrained eaters were given this reference along with the nutrition information, they intended to consume as much at T2 after having chosen a high-calorie option at T1 ($M_{reference} = 52.06$) as restrained eaters in the *nutrition information-absent* condition, $b = –2.10$, $SE = 6.37$, $t(263) = –.33$, $p = .74$, $\eta^2 = .000$, but intended to consume significantly more than restrained eaters in the *nutrition information-present* condition, $b = 17.79$, $SE = 6.66$, $t(263) = 2.67$, $p = .008$, $\eta^2 = .025$.

Among restrained eaters who had chosen the low-calorie option at T1, there were no significant variations. Those in the *nutrition information-present* condition did not want to consume more at T2 ($M = 51.96$) than those in the *nutrition information-absent* condition ($M = 41.66$), $b = 10.30$, $SE = 8.20$, $t(263) = 1.26$, $p = .21$, $\eta^2 = .006$. There was also no difference between the *nutrition information-present with reference* ($M = 46.27$) and *nutrition* *information-absent* conditions, $b = 4.61$, $SE = 7.99$, $t(263) = .58$, $p = .56$, $\eta^2 = .001$.

[INSERT FIGURES 5A AND 5B ABOUT HERE]

Importantly, among unrestrained eaters (i.e., 1 *SD* below the mean), the interaction contrast of T1 choice and nutrition information was not significant, $F(2, 263) = 1.09$, $p = .34$, $\eta^2 = .008$. This suggests, as in study 2, that providing nutrition information did not influence T2 consumption among unrestrained eaters, regardless of their choice at T1.

Again, we tested the baseline for the relationship between T1 and T2 decisions among restrained eaters in each of the nutrition information conditions. When nutrition information was absent at T1, among restrained eaters (1 *SD* above the mean), those who chose a high-calorie item at T1 ($M = 54.16$) showed a directional increase in T2 dessert consumption intentions compared to restrained eaters who had chosen a low-calorie option at T1 ($M = 41.66$), $b = –12.50$, $SE = 7.49$, $t(263) = –1.67$, $p = .096$, $\eta^2 = .010$. Although the effect was not significant, the direction of the effect was consistent with our theorising as in study 2. In contrast, when nutrition information was present at T1, among restrained eaters, those who had chosen a high-calorie option ($M = 34.28$) intended to reduce T2 consumption relative to restrained eaters who had chosen a low-calorie option ($M = 51.96$), $b = 17.68$, $SE = 7.83$, $t(263) = 2.26$, $p = .03$, $\eta^2 = .018$, showing again that restrained eaters use nutrition information to balance across decisions. Lastly, when reference information was added to the nutrition information, there was no difference in T2 consumption intentions between those who chose a high-calorie T1 option ($M = 52.06$) and those who chose a low-calorie T1 option ($M = 46.27$), $b = –5.79$, $SE = 6.95$, $t(263) = –.83$, $p = .41$, $\eta^2 = .002$, suggesting that reference information may have served to justify indulgence.

Discussion

Replicating studies 1 and 2, providing nutrition information for the food options at T1 did not influence the decision of restrained eaters at T1, but it did impact their T2 decision.

Restrained eaters who had chosen the high-calorie item at T1 decreased their intended ice cream intake at T2 as a result of the nutrition information provision. However, providing reference information about recommended daily calorie intake in addition to the nutrition information reduced the beneficial carryover effect of nutrition information provision among restrained eaters who had chosen a high-calorie food at T1. This occurs because the reference value for recommended daily calorie intake is quite large compared to the calorie contents of the available options. Thus, restrained eaters justify to themselves so that they can indeed indulge. This result is consistent with prior research that found that providing daily calorie recommendations with the calorie counts of food options does not reduce consumption (Downs, Wisdom, & Loewenstein, 2015).

General discussion

Across three studies, our findings shed new light on the nuances of providing nutrition information on consecutive consumption decisions. Consistent with prior findings that observed T1 choices alone, the provision of nutrition information appeared to have no effect on either restrained eaters' or unrestrained eaters' decisions at T1 unless the high-calorie option contained substantially more calories than the low-calorie option. However, extending our investigation across consumption decisions presents a different picture. Nutrition information provided for preceding meal choices enabled restrained eaters to modulate their intended calorie intake by adjusting their subsequent intake decisions. When nutrition information was provided at T1, restrained eaters successfully compensated for their high-calorie intake at T1 by seeking fewer calories at T2. But when restrained eaters were presented with reference information regarding recommended daily calories together with nutrition information at T1, we found no evidence of changes in subsequent food decisions. This shows that the carryover effect of nutrition information provision no longer emerges when restrained eaters can justify continuing to indulge, with the reference information serving more as a target than as a restricting factor.

We predicted that providing nutrition information may not drive restrained eaters who made a low-calorie choice at T1 to change their intended consumption at T2. However, we observed a directional effect such that they tended to increase their subsequent consumption after choosing a low-calorie option. This may be due to restrained eaters feeling a tension between wanting to both lose weight and enjoy tempting foods (Stroebe et al., 2008). When they have reasons to indulge, such as previously making a healthy food choice, they may later allow themselves to splurge an unhealthy but palatable food (De Witt Huberts et al., 2014; Mukhopadhyay & Johar, 2009). However, it is not clear why this was observed only in the presence of nutrition information. Presumably, restrained eaters may need some justification, such as nutrition information, to license indulgence after choosing healthy food.

Theoretical implications

We believe the present research makes at least three substantive theoretical and practical contributions to our understanding of how providing nutrition information influences consumption decisions. First, our findings show that the provision of nutrition information does not necessarily have an effect on one-off decisions about food choices, but rather it influences consumption decisions more broadly by affecting subsequent consumption decisions. Prior research on nutrition labelling reveals weak evidence regarding the effectiveness of providing nutrition information as a way to promote healthy food consumption (e.g., Long et al., 2015; Zlatevska et al., 2018). Our findings suggest that these observed null or weak effects may, in part, be due to the paradigm that has commonly been used. Almost all research on nutrition labelling has studied how the provision of nutrition information about a given food item affects a decision about that specific item. However, as consumers can flexibly regulate their consumption decisions across time, they may respond to nutrition labelling by balancing out calorie intake in a later food choice rather than the immediate one (Khare & Inman, 2009; Brown et al., 2020). Our framework suggests that the effects of providing nutrition information should be examined more broadly to capture consumers' tendency to manage their calorie intake across consecutive decisions.

Second, we observed this carryover effect of the provision of nutrition information only among restrained eaters. Burton and Kees (2012) argue that researchers should focus on specific groups within the population who are likely to be responsive to nutrition labelling. While there is a lack of research on how individual differences (apart from BMI) affect responses to nutrition labelling (Deb & Vargas, 2016), our research reveals that dietary restraint is a key individual difference contributing to the effectiveness of nutrition labelling. We found that restrained eaters incorporated the nutrition information from earlier food decisions into their subsequent decisions.

Third, our findings provide evidence that nutrition information provision can help restrained eaters regulate their calorie intake across consumption decisions even when they face the temptation to disinhibit after prior goal violation. Previous research has suggested that restrained eaters are inaccurate in their judgements about the consequences of eating indulgent food. For example, research suggests that restrained eaters disinhibit to a similar degree regardless of how many calories they consumed earlier (Herman & Mack, 1975; Knight & Boland, 1989), and they have poor causal reasoning about behavioural causes of weight changes (Husted et al., 2019). However, the present studies reveal that restrained eaters can overcome their tendency to disinhibit if they have made an informed decision regarding their calorie intake. While several approaches are proposed to reduce restrained eaters' disinhibition (Stroebe et al., 2008), previous research has focused on strategies to influence automatic processes such as activating a diet goal on the verge of temptations (Van Koningsbruggen et al., 2011; Papies & Hamstra, 2010). In addition to these strategies, we show that providing nutrition information is an effective way to help restrained eaters flexibly take control over their eating decisions. Taking flexible control over eating is beneficial for the successful pursuit of the restraint goal in the long term (Westenhoefer et al., 1999). Thus, nutrition information provision can and should be adopted as a means to prevent restrained eaters from disinhibition.

Limitations and future research directions

While our results are in line with our theory that providing nutrition information to restrained eaters facilitates the compensatory reduction of calories in later intake, there are some important limiting factors to consider. We conducted two additional studies that had similar designs to that of study 2, to test boundary conditions of the carryover effect of nutrition information provision. In one study in which the information was not made salient before the T2 decision, unlike studies 2 and 3, the carryover effect was not observed. In another study, participants were not allowed to make their own food choice at T1 but imposed with the T1 choice by random assignment. This too eliminated the carryover effect, possibly due to reactance. These findings suggest that the carryover effect can be turned off by reducing information salience or forcing choices at T1.

One important limitation of our findings is that in our studies, there was never any nutrition information available for the T2 consumption option. We deliberately did this to test both the immediate and delayed effects of nutrition information provided at T1, rather than introducing a fourth factor to our experiments. Conceptually, we believe that the provision of nutrition information at T2 should exaggerate the effects that we observed as it would allow participants to integrate the T1 information with the T2 information more effectively. However, this is a complex empirical question we leave for future research.

In all studies, we did not measure restrained eaters' goals about restraint or eating enjoyment. Prior research has shown that successful dietary regulation can be achieved by increasing goal importance (Kroese, Evers, & De Ridder, 2009) and goal accessibility (Van

Koningsbruggen et al., 2011; Papies & Hamstra, 2010). To test the role of goals, one may test whether providing nutrition information for an earlier food choice activates dieting-related goals for a later food decision. Also, we did not measure emotional responses associated with food decisions. Successful self-regulators balance their calorie intake after prior indulgence without negative emotions or a sense of perceived failure (Prinsen et al., 2019; Westenhoefer et al., 1999). If the nutrition information provision at T1 reduces negative emotions associated with restrained eaters' high-calorie choice at that time, it could contribute to their intention to balance at T2. We thank a reviewer for suggesting this emotion-based mechanism which should be tested in future research.

In our studies, we measured the intended consumption of indulgent food at T2, not the actual consumption. Future research should employ actual behavioural measures to ensure generalizability of the present findings.

Conclusions

To conclude, our investigation extends the study of the effects of nutrition information provision by exploring its effects on consecutive consumption decisions. Doing so allows us to identify the beneficial effects of nutrition information provision that have not been explored in previous research. Such benefits can be useful for restrained eaters who tend to disinhibit after prior indulgent food consumption. While providing nutrition information did not always increase the likelihood of choosing a low-calorie option immediately, it helped restrained eaters balance out their prior calorie consumption by eating less indulgent food. Together, our findings contribute to understanding why aggregated investigations that focus on one-off consumption decisions and the general population have revealed weak effects of nutrition labelling, highlighting the delayed benefits of labelling for restrained eaters.

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