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Regular or low-fat? An investigation of the long-run impact of the first low-fat purchase on subsequent purchase volumes and calories

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ABSTRACT

Health organizations stimulate the development of low-fat variants to fight the obesity epidemic. We examine the effectiveness of this policy by studying the short- and long-term consequences of the first low-fat purchase on subsequent purchased volume and calories. Using a structural break analysis, we show that purchases increase in the short run after the first low-fat purchase, thereby confirming the single-occasion overconsumption effect of low-fat as shown in the experimental literature. Importantly, our results also show a significant positive long-term effect, which suggests that overpurchasing persists in the long run. In addition, our findings show that the long-term overpurchasing after the first low-fat purchase is solely due to the overpurchasing of low-fat items and not of regular items. These results provide support for the overgeneralization of claim effects and habit formation resulting in the enduring effect of healthier variants of unhealthy food.

1. Introduction

Several Western governments declared obesity as one of today's most urgent challenges. Since 1980, the number of overweight and obese people has more than doubled, with globally approximately 1.9 billion overweight (BMI ≥ 25) adults in 2014 (Ng et al., 2014; World Health Organization, 2015). Guided by the notion that overweight causes emotional and social problems and has recently also been linked to different diseases (e.g., different types of cancer, cardiac problems, and diabetes), health organizations suggest the stimulation of healthier products to improve the quality and reduce the quantity of food intake. More specifically, the WHO states that one of the remedies for solving obesity is "creating environments through public policies that promote the availability and accessibility of a variety of *low-fat*, high-fiber foods, and that provide opportunities for physical activity" (World Health Organization, 2004). Not surprisingly, companies realized this opportunity, and products that claim to be low-fat have now become big business.

While the proliferation of lower-fat alternatives might be beneficial for individuals who tend to make healthier food choices when given the opportunity to do so, experimental research unequivocally shows that these low-fat claims may actually backfire and increase the quantity and caloric value of single-occasion low-fat as well as regular food intake (Belei, Geyskens, Goukens, Ramanathan, & Lemmink, 2012; Geyskens, Pandelaere, Dewitte, & Warlop, 2007; Wansink & Chandon, 2006). This is mainly

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due to the fact that consumers tend to perceive these low-fat snacks as less dangerous to the long-term health goal (Andrews, Netemeyer, & Burton, 1998; Ebneter, Latner, & Nigg, 2013) and believe that they can indulge without implications on their health (Finkelstein & Fishbach, 2010; Fishbach & Dhar, 2005; Fishbach & Zhang, 2008; Wilcox, Vallen, Block, & Fitzsimons, 2009). Prior experimental research thus seems to point to an immediate "boomerang effect" of low-fat claims to the extent that they may actually increase a consumers' total snack consumption in terms of volume and calories. Most imperative for policy makers, however, is whether or not these single-occasion immediate overconsumption effects translate in a long-term effect in terms of purchase volume and/or calories, which may occur because of habit formation (Aarts & Dijksterhuis, 2000).

Experimental studies have only considered immediate responses of healthy food consumption. This mainly occurs due to the experimental set-up of these studies and the lack of longitudinal behavioral data. In this study, we examine whether the first snack purchase with a low-fat claim translates in a long-term effect on subsequent purchases in the same category by means of a unique dataset consisting of the purchase behavior of a large panel of households over time combined with product-specific health claim and nutritional information. The first purchase is often considered as an important and risky decision (Rogers, 1995). Moreover, repeat purchases are contingent on trial while trial is not contingent on repeat purchases (Steenkamp & Gielens, 2003).

Our study contributes to the existing literature on the effects of low-fat claims on purchase behavior by showing empirical evidence that the frequently-found single-occasion boomerang effect in experimental studies translates in a long-term overpurchasing effect. Using actual behavioral longitudinal data, we provide strong evidence for the already experimentally reported short-term overconsumption effect of low-fat claims. In addition, we show the persistence of this effect, and, importantly, that the effect is due to adding low-fat to the basket rather than any new SKU. In a more in-depth analysis, we find that this effect mainly arises because consumers start to purchase low-fat items without decreasing their purchases of regular items. The remainder of this paper is organized as follows. In the next section, we provide an overview of different theories explaining a short- as well as long-term impact of the first purchase of low-fat. Next, we describe the data. Subsequently, we describe our structural break methodology and describe its results. We end with a general conclusion of the paper and provide some directions for future research.

2. The impact of the first low-fat purchase on subsequent purchase volume and calories

We study the short- and long-term impact of the first low-fat purchase on subsequent purchase volume and calories. Below, we discuss theories that predict low-fat purchases to translate in overpurchasing in the short and long run.

2.1. How low-fat purchases influence purchase volume and calories in the short run

Previous literature has demonstrated that the purchase of a product with a low-fat claim may lead to a single-occasion snack overconsumption because the claim influences (i) the accessibility of the long-term health goal, (ii) the healthiness perception of the low-fat product, and (iii) the eating intentions of more indulgent choices.

First, hedonic food claims, such as low-fat, highlight the attributes that are strongly associated with the food's tastiness given that individuals operate under the implicit intuition that "unhealthy food = tasty" (Raghunathan, Naylor, & Hoyer, 2006; Wertenbroch, 1998). Therefore, because of the word "fat," low-fat claims direct attention to the hedonic qualities of the food and make the health goal less accessible (Chandon & Wansink, 2007). As a result, low-fat claims turn the focus to the short-term pleasure goal rather than to the long-term health goal, which leads to an increased immediate consumption relative to food without such a claim (Belei et al., 2012).

Second, despite the fact that the actual decrease in calories of food with low-fat claims is much less than generally assumed by consumers (Wansink, 2004), Wansink and Chandon (2006) showed that the mere mention of low-fat significantly decreased the perceived calorie content and the anticipated consumption guilt, resulting in a larger perceived appropriate serving size. The low-fat product is thus perceived as less dangerous to the long-term health goal, prevents self-control mechanisms to intervene (Geyskens, Dewitte, Pandelaere, & Warlop, 2008; Myrseth, Fishbach, & Trope, 2009), and significantly increases the immediate eating intentions of the specific product (Geyskens et al., 2007; Wansink & Chandon, 2006), possibly resulting in a higher purchase volume. Given that the calorie content of products with a low-fat claim typically is only marginally lower than the calorie content of regular products (National Institutes of Health, 2004), the resulting average single-occasion calorie intake of the product might, as a consequence, be higher than when consumers would stick to the regular product.

Third, the consumption of the low-fat product itself may also impact the consumption of the regular or "unhealthier" items in the category (Wilcox et al., 2009). Indeed, research indicates that individual consumers license themselves to indulge in temptations when they previously acted in line with the longer-term goal, that is, purchased a low-fat product (Finkelstein & Fishbach, 2010; Fishbach & Dhar, 2005; Fishbach & Zhang, 2008). This implies that a first low-fat purchase might lead consumers to allow themselves to indulge in regular snack products as well. Therefore, it is of particular interest to explore the effects of low-fat snack purchases on the consumption behavior of the regular versions of these snack products.

To date, experimental research thus indicates that snack products with low-fat claims may increase single-occasion consumption volumes and calories of both low-fat and regular snack products. Most imperative for policy makers, however, is whether or not these single-occasion overconsumption effects translate in a long-term category overconsumption in terms of purchased volume and/or calories.

2.2. How low-fat purchases influence purchase volume and calories in the long run

Several research streams imply that this single-occasion overconsumption of low-fat and regular products might translate in a long-term category overpurchasing in terms of volume and calories. Combining the finding that low-fat claims increase consumption because they turn the focus to the short-term pleasure goal rather than to the long-term health goal (Belei et al., 2012), with research mentally representing habits as goal–action links (Aarts & Dijksterhuis, 2000), suggests that this short-term effect will linger on in the long run. This particular perspective on the development of habits is based on the work of Bargh (1990; see also Bargh & Gollwitzer, 1994), suggesting that when the same choices are frequently pursued and implemented as the result of a given goal, an association between the mental representation of that situation and the representation of the goal-directed action will emerge. The more frequently one engages in a certain goal-directed behavior in similar situations, the stronger the association becomes and, hence, the easier it is to automatically elicit the behavior by activating the goal (Aarts & Dijksterhuis, 2000). This implies that when consumers engage in purchasing an increasing amount repeatedly, this might lead to habit formation (Aarts & Dijksterhuis, 2000; Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989; Verplanken & Aarts, 1999; Wansink, Kent, & Hoch, 1998), making this purchasing of larger amounts an automatic and long-term purchase heuristic.

This prediction can also be derived from state dependence (Frank, 1962; Keane, 1997; Massy, 1966; Seetharaman, Ainslie, & Chintagunta, 1999), a concept closely related to habit formation. In particular, state dependence refers to a causal link between past and present purchase behavior (Keane, 1997). In this respect, the shift to the low-fat product increases the probability that this product will be purchased again in the future. This persistence inertia in product choice has been demonstrated to be consistent with loyalty; when a specific product is purchased, it alters the current utility derived from the consumption of the product (Dubé, Hitsch, & Rossi, 2010). This is consistent with the theory of routinized response behavior (Howard & Sheth, 1969), especially for low-priced, frequently purchased product categories. Accordingly, assuming that the switch to low-fat leads to a single-occasion snack overconsumption, the first low-fat purchase will "cause" the consumer to repeat buying larger amounts of this product category in the long term. In particular, the increase in the purchased amount of the first purchase will lead to a subsequent increase in the next purchase, resulting in subsequent increases in the future purchase moments. This will result in a snowball effect of repeat-purchases in the low-fat category, propagating the effect of the first low-fat purchase over time.

Importantly, this repeated purchase of larger amounts, as predicted by habit formation as well as state dependence theory, is not necessarily limited to the low-fat product only. More specifically, once consumers adjusted their purchasing quantity anchor upwards, they might buy larger quantities of any product in the respective product category (i.e., also the regular products) (Wansink et al., 1998). Hence, even if customers switch back to regular products after the first low-fat purchase, the increased category consumption, due to the first low-fat purchase, might still lead to a new habit of increased chips purchases (of regular or low-fat products). We will explore whether this actually occurs, by investigating short- and long-term effects of the first low-fat purchase on the purchase behavior of regular products.

In addition to this continued volume overpurchasing, the amount of purchased calories may also be affected in the long run. Indeed, individuals are unable to monitor the number of calories they consume (Livingstone & Black, 2003), making them overeat without being aware of it (Wansink & Chandon, 2006). Hence, there seems to be strong theoretical and empirical evidence that the first low-fat purchase can also induce a long-term increase in the subsequent purchase calories.

Table 1
Variable operationalization and descriptive.

Variable	Opera tionalization	Mean	Standard deviation
$\text{Volume}_{i,t}$	The purchased volume of chips in grams for household i in month t.	286.559	452.672
$\text{Calories}_{i,t}$	The purchased number of calories of chips in grams for household i in month t.	1533.911	2441.440
Price $\text{regular}_{i,t}$	The average price per gram of regular items in the chips category in month t. Based on data from the full panel. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	.396	.024
Variation in price $\text{regular}_{i,t}$	The standard deviation of the price per gram of regular items in the chips category in month t. Based on data from the full panel. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	.196	.023
Price $\text{low-fat}_{i,t}$	The average price per gram of low-fat items in the chips category in month t. Based on data from the full panel. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	.595	.032
Variation in price $\text{low-fat}_{i,t}$	The standard deviation of the price per gram of low-fat items in the chips category in month t. Based on data from the full panel. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	.135	.037
$\text{Advertising}_{i,t}$	The total advertising spending in 1000,000 euros in the chips category in month t. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	1.094	.544
Number low-fat $\text{SKUs}_{i,t}$	The number of different low-fat SKUs purchased in the chips category in month t. Based on data from the full panel. Given the household-specific timing of the first low-fat purchase, this variable is specific for household i.	15.149	5.257
Spending other $\text{categories}_{i,t}$	The total budget spent in other grocery categories by household i in month t in 1000 euros.	.270	.017

3. Data

We use data from the Dutch GfK household scanner panel. Apart from the purchase behavior of the household panel, the dataset also contains information on the product-specific health claim and calorie content. Moreover, we have information on the price and advertising spending as delivered by GfK and ACNielsen, respectively.

We focus on the chips/crisps category which offers a large amount of low-fat products and was studied in several experimental papers examining (un)healthy consumer decision making and behavior (e.g. Do Vale, Pieters, & Zeelenberg, 2008; Geyskens et al., 2007; Wertenbroch, 1998). Our sample consists of households who made the first purchase of a low-fat chips/crisps product between 2004 and 2007, were active as a panel member between 1 year before and 1 year after this event, and purchased at least once within the category 12 months before their first low-fat purchase. Using these sample selection criteria, our sample consists of 311 households. Overall, the households in our sample are rather small (average household size is 2.3) and they are quite brand and variant loyal (the average number of brands and variants used in the year before the first low-fat purchase is 2.1 and 2.2, respectively). Table 1 summarizes the descriptives and operationalizations of all variables used in the analyses.

Per household, we calculate the purchased volume (in grams) and the amount of calories purchased in the chips category for each month during 1 year before and 1 year after the first low-fat purchase. To ensure the comparability of months, we define each month as a 28-day period.

We add a number of control variables to our models to ensure their robustness. First, we control for a number of marketing-mix variables. The *Price Regular* is calculated as the per-month average price per gram of regular items of chips (i.e., the total budget spent on non-low-fat items divided by the total volume bought), while the *Variation in Price Regular* is the standard deviation of the different prices per gram paid during the particular month. Given that the latter measures the variability in the price, it gives an indication of the promotion intensity. Similarly, we calculate the *Price low-fat* and the *Variation in Price low-fat* as, respectively, the average and the standard deviation of the prices per gram of low-fat chips paid during the particular month. *Advertising* measures the amount of monthly total advertising spending over all media in the chips category in 1,000,000 euros. Second, we control for the size of the offer of low-fat items. The *Number of low-fat SKUs* is calculated on the basis of the full household panel and measures the total number of different SKUs with a low-fat claim that were purchased during the month. Note that, because the timing of the first low-fat purchase is different for all households, these variables will also be household specific.

Finally, we control for the size of the purchases made in the other categories. Since volume units are not comparable over different categories, we express the purchases in the other categories in terms of the amount spent. *Spending in other categories* is the household's total amount paid in all other categories (thus only excluding the chips category) per month in 1000 euros.

4. Methodology: Structural break analysis

To test whether the event of the first low-fat purchase coincides with a short- and/or long-term change in the underlying data-generating process, we use a structural break unit-root analysis as introduced by Perron (1989, 1994). More specifically, we pool the purchase histories of all households 1 year before and 1 year after the first low-fat purchase to test whether the first low-fat purchase causes a shift to the intercept in the monthly purchases series (see Eq. (1))[1]:

$$\begin{aligned}\text{Log } volume_{it} = {} & \alpha + \beta_1\, trend_{it} + \rho \log volume_{i,t-1} + c_1 \Delta \log volume_{i,t-1} + c_2 \Delta \log volume_{i,t-2} + \textstyle\sum_{q=2}^{4} \sigma_q Q_{qit} + \theta_1 Dpulse_{it} \\ & + \theta_2 Dintercept_{it} + \beta_2 Price\ regular_{it} + \beta_3 Variation\ in\ Price\ regular_{it} + \beta_4 Price\ low\ fat_{it} \\ & + \beta_5 Variation\ in\ Price\ low\ fat_{it} + \beta_5 Advertising_{it} + \beta_6 Number\ low\ fat\ SKUs_{it} + \beta_7 Spending\ other\ categories_{it} \\ & + \alpha_i + \varepsilon_{it}. \end{aligned} \tag{1}$$

Eq. (1) models the monthly purchase volumes (t = month and i = household) and consists of three parts. The first part of the equation coincides with the well-known Augmented Dickey–Fuller (ADF) test, which is commonly used to test for unit root of a time series. Indeed, the ρ parameter can be used to assess whether or not the series is stationary ($\rho < 1$) or unit root ($\rho = 1$). Following standard practice, we add lagged first differences to ensure that the residuals series is white noise. The number of lags is decided upon following a recursive procedure, starting with k equal to 3, and reducing the model successively until the last lag is significant at the 5% significance level (see Deleersnyder, Geyskens, Gielens, & Dekimpe, 2002, for a similar procedure). This procedure resulted in a model with two lagged first differences. We add seasonal dummies (*Qqit*) to control for seasonality (with q = number of season).

In the second part of the equation, we include two dummy variables to test for a structural change in the series. *Dpulse* is a pulse dummy that is one in the month of the first low-fat purchase and zero in all other months. This dummy variable captures the difference in average volume purchases in the first month after the first low-fat purchase and all other months in the sample. As a consequence, θ_1 can be interpreted as capturing the short-term (i.e., first month) effect of the first low-fat purchase. If θ_1 is significantly positive (negative), households, on average, purchase more (less) chips in the first month after the first low-fat purchase. *Dintercept* is a step dummy that switches from zero to one in the month of the first low-fat purchase and stays one afterwards. This dummy variable captures the change in the intercept at the time of the first low-fat purchase. If θ_2 is significantly positive (negative), the household, on average, purchases more (less) chips after than before the first low-fat purchase. We tested for other specifications of our structural break model (see Perron, 1994). As such, we tested whether the monthly trend changed

[1] Following common practice, we add a small number (+1) to $volume_{it}$ to avoid having to take the log of zero.

after the first low-fat purchase by including a variable that is zero before the first low-fat purchase and measures the trend (i.e., the number of the month) after the point of interest. This variable was not significant. For parsimony reasons, and because of a lack of a theoretical explanation of such a shift in the trend, we decided to leave the trend break out of the model.

In the final part of Eq. (1), we add a number of control variables to control for alternative factors that may influence a household's monthly purchase decisions (see Deleersnyder et al., 2002, for a similar procedure). As such, we add the weighted average price of the regular chips products (*Price regular*), the standard deviation of the weighted average price of the regular chips products (*Variation in Price regular*), the weighted average price of the low-fat chips products (*Price low-fat*), the standard deviation of the weighted average price of the low-fat products (*Variation in Price low-fat*), the total advertising spending in the category (*Advertising*), the number of low-fat SKUs present in the category (*Number of low-fat SKUs*), and the spending amount (in 1000 euros) in other categories (*Spending other categories*).

We perform the same testing procedure to test for a structural break in the purchase calories series:[2]

$$\begin{aligned}\text{Log}\, calories_{it} = {} & \alpha + \beta_1\, trend_{it} + \rho \log calories_{i,t-1} + c_1 \Delta \log calories_{i,t-1} + c_2 \Delta \log calories_{i,t-2} + \sum_{q=2}^{4} \sigma_q Q_{qit} + \theta_1 Dpulse_{it} \\ & + \theta_2 Dintercept_{it} + \beta_2 Price\ regular_{it} + \beta_3 Variation\ in\ Price\ regular_{it} + \beta_4 Price\ low\ fat_{it} \\ & + \beta_5 Variation\ in\ Price\ low\ fat_{it} + \beta_5 Advertising_{it} + \beta_6 Number\ low\ fat\ SKUs_{it} + \beta_7 Spending\ other\ categories_{it} \\ & + \alpha_i + \varepsilon_{it}. \end{aligned} \tag{2}$$

Eq. (2) models the monthly number of calories (t = month and i = household) and consists of the same three parts as the volume model specified above (see Eq. (1)). Also for this model, the optimal number of lagged differences is two, and the trend break was not significant. To control for the panel data structure, we use a fixed effects estimation procedure for both models.

5. Results

5.1. A first look at the data

To get a first feeling of the general short- and long-term effects of the first low-fat purchase, we use paired-sample t-tests to compare the total volume and calories during the month (year) before the first low-fat purchase and the month (year) after.

Purchase volumes seem to increase dramatically in the short and long run. Households, on average, purchased 265 g of chips per month in the year before the first low-fat purchase, which increased to 550 g of chips in the month after ($t = 13.50$; $df = 310$; $p = 0.00$). While households, on average, purchased 3177 g of chips during the year before, they significantly increased their purchased volume to 3700 g of chips in the year after their first low-fat purchase ($t = 3.63$; $df = 310$; $p = 0.00$). Households thus, on average, overpurchase chips after they switch to a low-fat variety for the first time. This first result seems to be in line with the experimental literature on the potential boomerang effect of low-fat, as reviewed earlier. Indeed, the immediate single-occasion overconsumption seems to translate in a short- and long-term overpurchase effect in terms of volume.

In line with our results with respect to volume, we find that households on average purchase significantly more calories the month (year) after the first low-fat purchase than the average month (year) before ($t = 11.81$; $df = 310$; $p = 0.00$ and $t = 2.94$; $df = 310$; $p = 0.00$ for the month and year comparison, respectively). While households purchased, on average, 1439 (17,271) calories of chips during the average month (year) before the first purchase of low-fat, this increases to 2771 (19,543) during the month (year) after. This implies that households overpurchase so much within the category that it offsets the lower calorie density of the healthier low-fat products.

These first results indicate that the single-occasion overconsumption effect linked to the first purchase of low-fat—as demonstrated in the experimental literature—translates in a short- and long-term boomerang effect. However, these paired simple *t*-tests do not account for other factors that may influence the household purchase decisions such as a trend, seasonality, advertising, and price. Therefore, we test in the subsequent sections whether the first low-fat purchase causes a structural break in the monthly purchase patterns, while controlling for other potential influential factors.

5.2. Unit-root tests

Before we can interpret the estimated coefficients of our models, we need to assure that our panel datasets are stationary. For both the purchase and volume model, we tested whether or not the series can be considered stationary using the structural-break unit-root test as well as a number of panel unit-root tests that take explicitly the panel structure of the data into account. For both models, the unit-root null hypothesis was rejected for all tests, that is, the traditional structural-break unit-root test (Perron, 1989, 1994) (F (1,6204) = 2279, $p < 0.01$ and F (1,6204) = 2297, $p < 0.01$ for the volume and calories model, respectively), the Levin–Lin–Chu test (adjusted $t = -43.07$; $p < 0.01$ and adjusted $t = -43.94$; $p < 0.01$ for the volume and calories model, respectively), the Harris–Tzavalis test ($z = -65.38$; $p < 0.01$ and $z = -65.73$; $p < 0.01$ for the volume and calories model, respectively), the Breitung test (*lambda* = −29.30; $p < 0.01$; *lambda* = −29.03; $p < 0.01$ for volume and calories, respectively), and the Im–

[2] Following common practice, we add a small number (+1) to $calories_{it}$ to avoid having to take the log of zero.

Pesaran–Shin test (*W-t-bar* = −41.85; $p < 0.01$ and *W-t-bar* = −42.38; $p < 0.01$ for purchases and volume, respectively).[3] The collective evidence from these different unit-root tests provides ample evidence that our time series are stationary, which implies that we can use conventional *t* and *F* tests to test for the significance of the parameters (Perron, 1994).

5.3. Structural break results of the main models

The first purchase of a low-fat product may cause a short- and long-term change in monthly purchases in terms of volume and calories. In the first columns of Table 2, we report the structural break analysis results for the purchase volume series.[4] The *F* test is highly significant and indicates the need to control for fixed effects in the estimation ($F(310,6204) = 4.62$; $p < .01$).

We focus on the two dummy variables that indicate whether or not the first low-fat purchase led to a structural break in the purchase volume series. *Dpulse* is a dummy variable that is one in the month after the first low-fat purchase and zero in all other months. As a consequence, this dummy variable captures the short-term impact of the first low-fat purchase. The coefficient is positive and significant ($\beta = 2.754$; $p < .01$), which indicates that households significantly increase their purchase volume of chips in the first month after the first low-fat purchase. This result is in line with the extant experimental literature that indicated that the consumption of low-fat products may lead to overconsumption (e.g. Chandon & Wansink, 2007; Geyskens et al., 2007).

Next to this short-term effect, we also find evidence for a long-term shift in the average purchase volume after the first low-fat purchase. Indeed, *Dintercept* is a dummy variable that is one in the period after the first low-fat purchase and zero in the period before. Therefore, this dummy variable captures the long-term effect of the first low-fat purchase on volume purchases. As this variable is significantly positive ($\beta = .483$; $p < .01$), we find that households overpurchase in the long term after their first low-fat purchase, which might be due to a habit formation of increased purchases triggered by the low-fat (Aarts & Dijksterhuis, 2000).

Although not the main focus of our analysis, the control variables in our model also provide interesting insights. As such, we find that monthly volume decisions of households are not driven by the regular price of regular and low-fat items ($\beta = 1.619$; $p > .10$ and $\beta = -1.132$; $p > .10$ for regular and low-fat items, respectively) nor the standard deviation of the prices of both types of products ($\beta = 1.853$; $p > .10$ and $\beta = -.823$; $p > .10$ for regular and low-fat items, respectively). The absence of price effects may be due to our focus on category purchase decisions rather than brand level demand, which might be more sensitive to price changes. In addition, we find that an increased offering of low-fat items leads to more purchases in the category ($\beta = .038$; $p < .05$). Households who spend a lot in other categories also buy a lot in the chips category ($\beta = .061$; $p < .01$). Both results confirm the external validity of our findings. Interesting to note is that the estimated trend in the model is significantly negative ($\beta = -.041$; $p < .05$), which indicates that, when controlling for all factors in our model, the households' monthly purchase volume tends to decrease over time. This trend is consistent with Euromonitor reports showing that the total volume of snacks and sweets was decreasing during our time frame (2004–2007).[5]

We repeated the same structural break analysis while focusing on the number of calories purchased per month. The results for this analysis are summarized in the last columns of Table 2. Also for this model, the high and significant F test indicates the need for a fixed effects estimation ($F(310,6204) = 4.55$; $p < .01$).

The results for the monthly calorie purchases are consistent with the results for the monthly volume purchases. Indeed, *DPulse* is also significantly positive for the calories model ($\beta = 3.442$; $p < .01$). This implies that households overpurchase so much that the potential lower-calorie density of low-fat products is offset, which results in a higher purchase of calories in the chips category (see also Chandon & Wansink, 2007). We find that this effect translates in a long-term increase in the average monthly amount of calories purchased (*DIntercept*: $\beta = .608$; $p < .01$).

Also with respect to the control variables added in the model, the results are consistent with the volume model as only the number of low-fat SKUs in the category ($\beta = .049$; $p < .05$) and the spending in other categories ($\beta = .077$; $p < .01$) significantly influence the monthly amount of calories purchased in the category. Also, in this model, the trend, after controlling for potential confounding factors, turned out significantly negative ($\beta = -.052$; $p < .01$).

To assess the robustness of our results, we perform a number of reliability analyses. More specifically, we (i) test whether the long-term increase in purchases is due to adding a new SKU to the basket rather than adding low-fat (Section 5.4), (ii) test whether the overpurchasing is due to extra purchases of low-fat or regular items (Section 5.5), and (iii) test whether the inclusion of other variables changes the substantive insights (Section 5.6).

5.4. Estimating the effect of adding a new SKU versus adding low-fat

We tested whether the long-term overpurchasing is due to the fact of adding a new SKU to the basket rather than switching to low-fat for the first time. Therefore, we selected from the sample of households who did not purchase any low-fat products in the chips category during the observation period, a sample of first purchases of a new (non low-fat) chips SKU. In order for the new

[3] While Perron's structural break unit-root test explicitly accounts for the structural break dummies in the unit-root testing, the panel versions of the unit-root test (i.e.,Levin–Lin–Chu, Harris–Tzavalis, Breitung, and Im-Pesaran-Shin) do not.

[4] The models were also estimated without a lagged dependent variable and lagged differences to ensure that our results are not influenced by the Nickell bias (Nickell, 1981) caused by the inclusion of a lagged dependent variable in a fixed effects model. Since our substantive results did not change, we conclude that our results are not biased.

[5] A detailed analysis on the trend effects in our data can be requested from the authors.

Table 2
Structural break results for volume and calories.

	Volume		Calories	
	Coefficient	Standard error	Coefficient	Standard error
Time series operators				
$Trend_{it}$	−.041**	.012*	−.052***	.016
Q_{2t}	−.036	.092	−.047	.117
Q_{3t}	.012	.093	.008	.119
Q_{4t}	.231**	.090	.286**	.115
Log $volume_{i,t-1}$	.071***	.019		
Log $calories_{i,t-1}$			.064***	.019
Difference log $volume_{i,\ t-1}$	−.004	.016		
Difference log $calories_{i,\ t-1}$			.000	.016
Difference log $volume_{i,\ t-2}$	.030**	.012		
Difference log $calories_{i,\ t-2}$			.031***	.012
Structural change dummies				
$Dpulse_{it}$	2.754***	.157	3.442***	.200
$Dintercept_{it}$	.483***	.133	.608***	.170
Control variables				
Price $regular_{it}$	1.619	2.564	2.025	3.278
Variation in Price $regular_{it}$	1.853	1.686	2.515	2.155
Price $low\text{-}fat_{it}$	−1.132	1.431	−1.471	1.830
Variation in Price $low\text{-}fat_{it}$	−.823	2.116	−1.059	2.706
$Advertising_{it}$	−.027	.067	−.037	.084
Number of low-fat $SKUs_{it}$	.038**	.018	.049**	.023
Spending other $categories_{it}$	.061***	.003	.077***	.004
Constant	.427	1.207	.592	1.544

* Significant result at the 10% significance level.
** Significant result at the 5% significance level.
*** Significant result at the 1% significance level.

chips SKU to be included in this sample, we applied a set of selection rules: (i) the household was part of the sample the year before and after the first purchase of the new (non-low-fat) purchase, (ii) there were no missing calorie data during the year before and after the new SKU was bought for the first time, and (iii) the household made at least one chips purchase during the year before the first purchase. To isolate the effect of the new SKU, we only selected new SKU purchases for households who made only one of those valid new SKU purchases during the observation period. This amounted to a sample of 167 new SKU observations. On average, household sizes in this sample are somewhat smaller (2.072 versus 2.379; $t = 2.65$; $p < 0.01$). The average monthly volume of chips bought is not significantly different between both samples ($t = 1.53$; $p > .10$), while the average number of calories

Table 3
Structural break results for control group.

	Volume		Calories	
	Coefficient	Standard error	Coefficient	Standard error
Time series operators				
$Trend_{it}$	−.033**	.014	−.044**	.017
Q_{2it}	−.161	.111	−.255*	.136
Q_{3it}	−.146	.108	−.211	.133
Q_{4it}	.103	.107	.039	.131
Log $volume_{i,t-1}$	.184***	.021		
Log $calories_{i,t-1}$			.186***	.021
Difference log $volume_{i,\ t-1}$	−.061***	.016		
Difference log $calories_{i,\ t-1}$			−.071***	.015
Structural change dummies				
$Dpulse_{it}$	4.145***	.194	5.545***	.239
$Dintercept_{it}$	−.070	.164	.095	.203
Control variables				
$Price_{it}$	5.431**	2.401	7.209**	2.941
Variation in $Price_{it}$	3.231	1.974	3.596	2.416
$Advertising_{it}$	.064	.065	.115	.079
Number of low-fat $SKUs_{it}$	.003	.005	.002	.006
Constant	−1.501	1.604	−1.853	1.962

* Significant result at the 10% significance level.
** Significant result at the 5% significance level.
*** Significant result at the 1% significance level.

bought in the category is marginally higher for the experimental group ($t = 1.84$; $p < .10$). We applied the same structural break analysis to this sample of first purchases. The results are shown in Table 3. While the pulse dummy for this analysis was significantly positive for the volume ($\beta = 4.14$; $p < .01$) and calories model ($\beta = 5.55$; $p < .01$), the intercept dummy was not ($\beta = -.07$; $p > .1$ and $\beta = .10$; $p > .1$ in the volume and calories model, respectively), indicating that switching to a new SKU involves volume overpurchasing in the short but not in the long run. Hence, the long-term overpurchasing after the first low-fat purchase is not due to the mere act of adding a new SKU to the consideration set.

5.5. The role of low-fat products in overpurchasing

In the previous sections, we demonstrated that the first low-fat purchase leads to an increase in monthly purchase volume and calories in the short and long run and showed the robustness of our results. Previous literature indicates that the short-term overpurchasing of chips after the first switch to low-fat chips can be driven by the overpurchasing of both low-fat and regular products. On the one hand, low-fat products are generally seen as more healthy, and its perceived appropriate serving size is generally overestimated (Wansink & Chandon, 2006). These effects may lead people to overpurchase in terms of low-fat products. On the other hand, the mere choice of a low-fat product may make people feel licensed to indulge on regular products, which may lead to an overpurchase of regular products as well (Finkelstein & Fishbach, 2010; Fishbach & Dhar, 2005; Fishbach & Zhang, 2008; Wilcox et al., 2009). Also in the long run, it is interesting to see whether the overpurchasing is mainly due to overpurchasing of regular or low-fat items.

To shed more light on this issue, we rerun the volume and calories models (see Eqs. (1) and (2), respectively) while focusing on the purchases of regular items only (and thus excluding the purchases of low-fat). As such, we model the monthly purchase volume and calories of regular chips products.

In the first columns of Table 4, we show the results for the volume model for regular products. When focusing on regular items only, *DPulse* is not significant anymore ($\beta = .189$; $p > .10$), which indicates that households do not overpurchase regular products during the first month after the first low-fat purchase. We thus find no evidence for the licensing effect (Finkelstein & Fishbach, 2010; Fishbach & Dhar, 2005; Fishbach & Zhang, 2008; Wilcox et al., 2009). Instead, the short-term overpurchasing measured earlier is due to the overpurchashing of low-fat items. This is in line with the results of Wansink and Chandon (2006) who report that low-fat claims lead to overconsumption because of an overgeneralization of the claim to the overall healthiness of the product.

In contrast to the model on total purchase volume (see Section 5.4), *DIntercept* in the model focusing on regular products only is not significant ($\beta = .062$; $p > .10$). This implies that the overpurchasing in the long run is not caused by a long-term increase in the purchases of regular items. Given that we found evidence for a structural increase in the monthly purchase volume of chips after the first low-fat purchase, this implies that the overpurchasing in the long run is due to adding too much low-fat items to the basket, without decreasing the amount of regular products.

Table 4
Structural break results for volume/cal of regular products.

	Volume		Calories	
	Coefficient	St. error	Coefficient	St. error
Time series operators				
Trend_{it}	−.032***	.012*	−.040**	.016
Q_{2it}	−.069	.093	−.085	.119
Q_{3it}	.014	.094	.012	.121
Q_{4it}	.124	.091	.152	.117
$\text{Log volume}_{i,t-1}$	.117***	.019		
$\text{Log calories}_{i,t-1}$			.110***	.019
$\text{Difference log volume}_{i,\ t-1}$	−.020	.016		
$\text{Difference log calories}_{i,\ t-1}$			−.016	.016
$\text{Difference log volume}_{i,\ t-2}$	.025**	.012		
$\text{Difference log calories}_{i,\ t-2}$			.026**	.012
Structural change dummies				
Dpulse_{it}	.189	.157	.264	.202
Dintercept_{it}	.062	.132	.075	.169
Control variables				
$\text{Price regular}_{it}$	3.493	2.599	4.504	3.328
$\text{Variation in Price regular}_{it}$	2.549	1.707	3.373	2.186
$\text{Price low-fat}_{it}$	−1.462	1.448	−1.865	1.855
$\text{Variation in price low-fat}_{it}$	.670	1.527	.841	2.747
Advertising_{it}	.005	2.145	−.002	.085
$\text{Number of low-fat SKUs}_{it}$	.024	.018	.032	.023
$\text{Spending other categories}_{it}$	.060***	.003	.076***	.004
Constant	−.401	1.223	−.521	1.566

* Significant result at the 10% significance level.
** Significant result at the 5% significance level.
*** Significant result at the 1% significance level.

The results for the calories model are again very consistent as is summarized in the last columns of Table 4. As such, we find that overpurchasing in terms of calories in the short or long run is not due to an overpurchasing of regular items (*DPulse*: $\beta = .264$; $p > .10$; *DIntercept*: $\beta = .075$; $p > .10$).

5.6. Robustness checks for the main models

We performed a number of checks to test the robustness of the results of our main models (see Section 5.3).

First, we tested for extra control variables that could have an influence on the monthly purchase decisions of households. As such, we tested whether the Christmas period is significantly different from the other months, which turned out to be not the case.

Second, we checked for household differences in the short- and long-term effect of the first purchase. As such, we tested the interaction between the pulse (intercept) dummy and the year of the first low-fat purchase. These interaction effects were not significant in either of the two models. Similarly, we tested whether overpurchasing is different for households of different sizes. We find that larger households overpurchase slightly less in the short run, while the overpurchasing in the long run does not depend on the household size. In addition, we tested whether the trend in monthly chips volume/calories purchasing prior to the first low-fat purchase has an influence on the short- and long-run effect of the first low-fat purchase. We find no significant interaction effects between the two structural change dummies and the estimated initial household-specific trend for both the volume and calories model. Finally, we tested the moderating impact of brand and variant loyalty by including the interaction between the two structural change dummies and the number of different brands/variants purchased in the year before the first low-fat purchase. We find that the more variety seeking households are (thus the more brands or variants households purchased in the year before the first low-fat purchase), the lower the overpurchasing becomes in both the short and long run. The overpurchashing effect is still very strong, however, since overpurchasing would result in zero in the short (long) run if a household purchased at least 8 (5) brands in the year before the first purchase, which amounts to 0 (9) households in the sample. Similarly, in terms of number of variants, we find that households who purchase more than 8 (5) variants prior to the point of interest would have no overpurchasing in the short (long) run, which applies to 2 (16) households in the sample.

Third, we tested whether the motivation to buy low-fat for the first time influences its effect in the short and long run. As such, we tested the interaction effect between the pulse/intercept dummies and a dummy variable that indicates whether the first low-fat product was bought on promotion (as indicated by a price that is two standard deviations below the product's average price). None of the interaction effects with the structural change dummies in both models were significant. Furthermore, we tested whether the long-term effect was impacted by the overconsumption of the household in the month of the first purchase (as measured relative to the average monthly purchase quantity in the year before). We find that the interaction between this variable on the intercept dummy is significantly positive, which implies that overpurchasing in the long run is especially bad for households who overpurchase in the short run, which confirms the habit formation theory. In addition, we tested whether overpurchasing is different for households who buy in an out-of-stock situation as calculated on the basis of the average monthly purchase volume/calories in the period before the first low-fat purchase. We find that overpurchasing in the short or long run is not different for these households.

Fourth, we tested the robustness of the substantive findings to the estimation technique chosen. More specifically, we reran our models using a random-effects estimator rather than fixed effects. The results on the short- and long-term effect of the first low-fat purchase were very similar for both the volume and calories model.

6. Conclusion

We examined the short- and long-term consequences of the first choice of a low-fat product on subsequent purchased volume and calories. Our study contributes to the existing literature on the effect of low-fat claims by studying these consequences using a panel of households.

More specifically, we use a structural break analysis to examine whether the first low-fat purchase causes a structural break in the monthly purchase volume and calories of a sample of households. These results confirm the experimentally known short-term effect that low-fat choices increase food consumption (e.g., Wansink & Chandon, 2006). Importantly, our results also show a significant positive long-term effect. This suggests that the overconsumption effect is persistent. We performed several robustness checks, which all supported our findings. Importantly, we also explored which items (i.e., regular versus low-fat) are being purchased more after the first purchase of a low-fat item. These findings suggest that the long-term overpurchasing after the first low-fat purchase is solely due to the overpurchasing of low-fat items.

These results have strong theoretical implications. Beyond the fact that we observe a persistent overpurchasing effect using actual behavioral data, our findings also provide more support for the overgeneralization of claim effects and habit formation resulting in the enduring effect of healthy food choices. Beyond that, we show that this effect solely occurs due to the overconsumption of low-fat products, while no increase in regular product consumption is found. This suggests that our empirical data do not support a licensing effect of low-fat consumption in terms of eating more regular snacks as well (e.g. Fishbach & Dhar, 2005; Wilcox et al., 2009). Note, that this licensing effect could still occur, as consumers might consume more other products (i.e., chocolate). Future research should study these potential cross-category effects.

From a public policy perspective, the results imply that stimulating the switch to low-fat alternatives should be done carefully. Motivating consumers to buy these products (i.e., through promotions or fashionable campaigns) can result in negative long-term consequences, in which consumers persistently continue buying more products and consuming more calories, specifically resulting

from the purchase and consumption of these more healthy items. In the end, it seems that consumers and society are worse off, as the first low-fat purchase increases food consumption and calorie intake. Hence, instead of reducing the obesity problem, low-fat products may enhance this problem in the long run. Policy makers should thus be very careful in embracing the introduction of low-fat products as a solution for the obesity problem. Consumers should get more sound expectations and believes about the healthier variants. This might reduce overconsumption. Still, the psychological mechanisms are rather complex and unconscious and might differ between households. Overall, it seems that promoting healthier variants of unhealthy food can be a risky strategy.

7. Research limitations and future research

While we provide important new insights on the long-term impact of a first switch to a low-fat product, this research is subject to several limitations that offer opportunities for future research. First, we studied purchase behavior in only one category because of the fact that collecting nutritional information on the various product variants in a category is a labor intensive and time-consuming job. Future research could study whether our results generalize to other categories, or whether specific category characteristics moderate the effects of health claims. For example, it would be interesting to find out whether the effects found in a vice product, such as chips, would be replicated in a virtue product, such as yoghurt. Moreover, more research is needed to investigate the effect of health claims across categories. For example, the purchase of low-fat chips could be compensated by the consumption of more regular yoghurt or chocolate, which would provide evidence for the existence of a cross-category licensing effect (Wilcox et al., 2009).

Second, we concentrate on one type of health claim (i.e., low-fat claim). Future research would need to discover whether the established effects are generalizable over various types of health claims. Third, we briefly investigated some differential responses between consumers. More in-depth research is required on differences in short- and long-term effects of healthy food choices between consumers. Specifically, research should focus on the role of internal motivations to switch to low-fat and the beliefs about low-fat claims. Another source of between-household heterogeneity might be due to an intrinsic difference between households that switch to low-fat and those who do not. Indeed, while we show that our experimental and control groups are only marginally different, modeling the decision and the timing to switch to low-fat might reveal new interesting insights into the topic. Fourth, apart from between-household heterogeneity, also within-household heterogeneity may be a fruitful avenue for future research. Our study concentrates on the complete household purchase decision, while it would be interesting to zoom in into the influence of different household members on this decision-making process. In addition, the consumption context may also influence purchase decisions. To answer these questions, more detailed information on household-member and context level needs to be collected.

Fifth, we demonstrate that the first low-fat purchase translates in long-term overpurchasing. Our model did not allow to discover the underlying processes leading to this long-term effect, an area which certainly deserves future research attention. As such, measuring how repeat purchases of low-fat contribute to the long-term habit of overpurchasing would be a next step in understanding the effect of low-fat claims on purchase behavior.

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