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Healthy shopping dynamics: The healthiness of sequential grocery choices

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Abstract

Improving the healthiness of diets can be realized by replacing unhealthy with healthier product alternatives when shopping for groceries. For this strategy to be effective, shoppers need to consistently make healthier choices. However, shoppers may end up balancing the healthiness of their choices throughout the shopping trip, (partly) offsetting the benefits of a healthy product choice (e.g., low-fat milk) by an unhealthy subsequent choice (e.g., sugary cornflakes). Across two studies, one study with purchase data from a brick-and-mortar supermarket and one online experimental study, we empirically demonstrate that the relative healthiness of an initial product choice is indeed inversely related to the relative healthiness of the subsequent choice, regardless of the category of both products. That means: a relatively healthy choice is followed by a relatively unhealthier choice, and vice versa. Furthermore, the strength of this balancing effect differs depending on the nature of the product category; the dynamic effect is less pronounced when subsequently choosing within a vice (vs. virtue) product category. In the brick-and-mortar supermarket, the dynamics also become less pronounced as the shopping trip progresses. These findings contribute to literature on in-store decision-making and within-trip dynamics, and underscore the need for retailers to have a thorough understanding of these healthy shopping dynamics in order to effectively promote healthier baskets in support of the growing demand for healthy diets.

Keywords: Healthy food consumption; In-store decision-making; Sequential choices; Vice and virtue categories.

Driven by a growing awareness of and understanding about the importance of living a healthy lifestyle, the demand for healthy diets is growing. Improving the healthiness of diets can be realized by consistently replacing higher-calorie products with relatively healthier, lower-calorie alternatives within the same product category (e.g., regular cola with diet cola) instead of changing the type of foods consumers are accustomed to purchase and consume (De Boer, Schösler, and Aiking 2014; Hill et al. 2003; Ross and Murphy 1999). Even subtle nutrition shifts can have a critical impact on consumer's healthiness—for example, estimates suggest that a 100-kilocalorie cut in daily calorie intake could prevent weight gain for the majority of the adult population (Hill et al. 2003).

This notion seems to be embraced by today's consumers, policy makers, retailers, and food manufacturers. Tailoring to the recent trend toward healthy eating behaviors (Prasad, Strijnev, and Zhang 2008), Coca-Cola invests an increasing share of marketing dollars into its low- and no-sugar variants and recently witnessed double-digit sales growth for their Zero Sugar Coke (Forbes.com 2018). Furthermore, various popular nutrition interventions, such as the 1–3 star and NuVal score labels, are designed such that they may aid consumers shopping for groceries in selecting healthier products *within* a given product category. Despite such efforts, overall caloric intake has not significantly reduced over the past decades (Ladabaum et al. 2014). One possible explanation is that switching to lower-calorie products stimulates consumers to balance the healthiness of choices throughout the shopping trip (Roberts 2015), offsetting the benefits of a single healthy product choice (e.g., low-fat milk) by an unhealthier subsequent choice (e.g., sugary cornflakes). Indeed, research indi-

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cates that the decision-making process during shopping trips is dynamic, with earlier purchase decisions affecting subsequent decisions (Dhar, Huber, and Khan 2007; Gilbride, Inman, and Stilley 2015; Sheehan and Van Ittersum 2018). However, as of yet we know little about what we refer to as *healthy shopping dynamics*—interdependencies between the relative (i.e., within-category) healthiness of sequential product choices within a major shopping trip.

Previous research acknowledges that a potential caveat of promoting a singly healthier choice is that "consumers may substitute calories to other nontargeted categories" (Khan, Misra, and Singh 2015, p. 24). This would have significant ramifications for retailers supporting consumers in their growing demand for healthy diets. For instance, the health gain as a result of an intervention in one product category may be offset by unhealthier choices in subsequent product categories. This would imply a waste of financial resources to promote products only at the product category level. This notion inspired research calls for a more holistic view of shoppers' nutritional intake (Nikolova and Inman 2015). Despite the theoretical, societal, and practical relevance of these healthy shopping dynamics, to date, such a holistic view remains largely missing in the scientific literature.

Given the critical role of subtle shifts in caloric intake on the development of healthier diets (Hill et al. 2003; Moorman et al., 2012), and given that the majority of consumers strongly associates (un)healthiness with caloric density (Van der Laan, Papies, Hooge, and Smeets 2016; Liu et al. 2019; Werle, Trendel, and Ardito 2013), we focus on the dynamic impact of a product's relative healthiness, which we define as the caloric density (i.e., cal/100 g) of a product compared to the product-category average. Using this definition, we aim to answer the following research questions: How does the relative healthiness of an initial product choice relate to that of a subsequent choice in the same or a different product category? Specifically, do shoppers balance between unhealthier (i.e., more calorie-dense) and healthier (i.e., less calorie-dense) product choices, or do they reinforce an earlier product choice by consistently selecting healthier or unhealthier options in subsequent grocery choices?

In addition, we investigate the possibility that the dynamic effects across product choices depend on the healthiness of the product category. Does the dynamic effect of the initial choice differ depending on whether shoppers next choose from an indulgent *vice* product category (e.g., pizza) or from a healthy *virtue* product category (e.g., yogurt)? A final aim is to explore whether the dynamic effects differ depending on whether the initial choice is relatively healthy or unhealthy (i.e., asymmetrical dynamic effects). We study these research questions in one field study using data from over 5000 actual shopping trips in a brick-and-mortar supermarket (Study 1), and one experimental study (Study 2).

Our research makes various important contributions. Although earlier work has investigated dynamic effects across sequential food choices as well (Huber, Goldsmith, and Mogilner 2008; Hui, Bradlow, and Fader 2009), we extend this work by mainly focusing on the relative healthiness *within* the category as opposed to merely considering *between*-category healthiness. In addition, we contribute by considering both controlled, hypothetical food choices and actual purchases, by controlling for various product, participant, and trip characteristics as well as regression toward the mean, and by investigating a longer range of choices from wider assortments. Across shopping trips with up to 85 product choices, we robustly demonstrate that, overall, the relative healthiness of an initial product choice is *inversely related* to the relative healthiness of the subsequent choice, regardless of the category of both products. Hence, shoppers balance the benefits of a relatively healthy product choice (e.g., low-fat milk) by making an unhealthier subsequent choice (e.g., sugary cornflakes), and vice versa. Demonstrating that the healthiness of a single choice is partly offset at subsequent grocery choices adds to the scarce but growing knowledge on within-trip dynamics (Sheehan and Van Ittersum 2018). Insights on such dynamics also offer important practical implications regarding the effectiveness of in-store health interventions (Cadario and Chandon 2020; Cleeren et al. 2016; Khan et al. 2015).

Apart from demonstrating this overall dynamic effect, we also offer novel insights into how shoppers' product-level decision-making differs depending on the nature of the product category (vice vs. virtue; Dhar and Wertenboch 2000; Hui et al. 2009) and the stage of the shopping trip (Gilbride et al. 2015). Specifically, we find that the balancing effect following an initial choice is less pronounced when the subsequent choice is made within a vice (vs. virtue) product category. We also find evidence that products selected from vice product categories are relatively unhealthier than those from virtue product categories. In addition, in the brick-and-mortar supermarket, the healthy shopping dynamics become less pronounced as the shopping trip progresses. Moreover, in the brick-and-mortar store, consumers' balancing act seems to be performed asymmetrically; healthier choices are subsequently offset to a larger extent than unhealthy choices.

The remainder of this manuscript is organized as follows. First, we review relevant literature on food decision-making and sequential choices to develop a theoretical basis for healthy shopping dynamics. Next, we present two studies that offer consistent empirical evidence for the presence of healthy shopping dynamics while ruling out various alternative explanations for the effects. We end with a general discussion of our findings and the managerial and policy implications of our research.

Theoretical background

When choosing food products, consumers often make trade-offs between health and indulgence (Januszewska, Pieniak, and Verbeke 2011; Steptoe, Pollard, and Wardle 1995). Food choices thus pose a self-regulation dilemma: unhealthy food is perceived to be tastier, and consequently often triggers an impulsive, short-term indulgence goal, whereas healthy food contributes more to a long-term health goal (Dhar and Simonson 1999; Laran 2010; Muraven and Baumeister 2000). This self-regulation dilemma could explain why many consumers continue to overconsume calories, even though they have become more health conscious compared to previous generations (Prasad et al. 2008). Moreover, this self-regulation dilemma may influence how consumers navigate the healthiness of *sequential* food choices from various product categories when shopping for groceries. Most food choices are not made in isolation, but are part of “consumption episodes” (Dhar and Simonson 1999), a sequence of related decisions in terms of temporal proximity. In the context of a grocery shopping trip, sequential choices are also related in terms of a common self-regulation dilemma (health vs. indulgence). At the most basic level, there are two possibilities in terms of how consumers navigate this dilemma across sequential choices (cf., Kim and Rao 2023).

Reinforcement. First, a healthier (unhealthier) initial choice may enhance the likelihood of a healthier (unhealthier) subsequent choice, due to bolstering or highlighting a health (indulgence) goal, which past literature termed *reinforcement* (Dhar and Simonson 1999; Huber et al. 2008). The notion that a healthier (tastier) initial choice may enhance the likelihood of a healthier (tastier) subsequent choice is mostly based on evidence from scenarios where an activated goal has not yet been satisfied and consumers only have to make one single subsequent choice (e.g., Wight et al. 2023). Laran and Janiszewski (2009) for instance find evidence for reinforcement in a single subsequent choice, but only when the activated goal (e.g., indulgent goal) has not been fully satisfied. Akamatsu and Fukuda (2022) replicate this by showing that an indulgent initial choice in one product category increased the likelihood of an indulgent subsequent choice in a different product category when consumers felt that the subsequent choice helped advance the initial indulgent choice’s goal).

Balancing. Instead of making reinforcing choices, consumers may employ a balancing strategy, such that a healthier (unhealthier) initial choice is followed by an unhealthier (healthier) subsequent choice. Huber et al. (2008, p. 230) define balancing as the scenario where “the first choice satisfies the goal, allowing an alternative goal to drive the later choice”. Dhar and Simonson (1999) describe that participants considered it likely that a hypothetical “Mr. A” would choose a tasty chocolate cake over a healthy fruit salad after a previous healthy food choice. Laran (2010) replicates this finding and further illustrates that consumers erroneously believe that other people would prefer an unhealthier choice regardless of their initial choice. Laran et al. (2019) demonstrate a “goal rebound effect” that is akin to a balancing effect, as their participants choose a goal-inconsistent food option following the choice of a goal-consistent food option.

Findings within an actual grocery shopping context and involving longer choice sequences are scarce and mixed. Results are either insignificant or hint at (conditional) balancing. Gilbride et al. (2015) claim that shoppers balance the healthiness of their purchases when the initial purchase is planned, but not when the initial purchase is unplanned. Hui et al. (2009) find that when shoppers’ basket contains a higher share of virtue than vice products, they are marginally more likely to subsequently shop longer in a zone with many vice categories, but they do not find significant evidence that they also *buy* more vice products (i.e., that they actually balance).

Reinforcement versus balancing

As described, consumers have two possibilities to navigate their self-regulation dilemma (health vs. indulgence) across *sequential* food choices: reinforcement versus balancing. Table 1 gives an overview of existing research on reinforcement and balancing involving sequential food choices. Overall, Table 1 suggests that the evidence is in favor of balancing rather than reinforcement in the food domain, especially when the number of sequential choices is relatively large. This may be due to specific context characteristics. Past research demonstrates how the presence of resource constraints (e.g., Dhar and Simonson 1999) and the stage of commitment (e.g., Fishbach and Dhar 2005) determine whether reinforcement versus balancing is more prominent during decision making processes. Given that grocery shopping is a deliberative and cognitive demanding decision task (Leonard & Ariely, 2006), we expect that resource constraints will stimulate balancing more than reinforcement throughout the shopping trip when making a larger number of sequential choices.

Balancing has mostly been established across *category-level* food choices (Dhar and Simonson 1999; Hui et al. 2009). However, many food categories are characterized by significant within-category heterogeneity in terms of nutritional composition (Nikolova and Inman 2015). Consequently, consumers are likely to detect and evaluate differences in the relative (un)healthiness of choices within the product category. Indeed, research has established that consumers perceive significant differences between the healthiness of various product alternatives (e.g., chocolate-covered Oreo cookies vs. 100-calorie Oreo cookies) within the product category (Van der Laan et al. 2016; Wilcox et al. 2009). Furthermore, whereas category-level choices are often planned ahead, specific product alternatives are typically decided upon within the store (Block and Morwitz 1999; Ross and Murphy 1999). Consequently, we focus on relative (i.e., product-level, within-category) healthiness and we hypothesize that similar (or even more pronounced) dynamic effects can be found across product-level decisions in the grocery store.

H1. The relative healthiness of an initial product choice is inversely related to the relative healthiness of the subsequent choice: a relatively healthy choice is followed by a relatively unhealthier choice, and vice versa.

Differences between vice and virtue categories

We expect that the healthy-shopping dynamics will be moderated by the nature of the product category that consumers subsequently choose from. Specifically, we propose that the effect of the healthiness of an initial choice will be

Table 1
Past findings on balancing vs. reinforcement responses in sequential food choice.

Citation	Research method	Outcome measure	Decision level (category vs product)	Number of sequential choices (average)	Balancing vs. reinforcement vs. not significant (n.s.)
Akamatsu and Fukuda, 2022	Field & lab studies d stud	Real & hypothetical choice	Category & Product	2	Reinforcement
Dhar and Simonson 1999	Field & lab studies	Hypothetical choice	Category	2	Balancing
Gilbride, Inman, and Stilley 2015	Field study	Real choice	Category	25	Balancing (>planned purchase) n.s. (>unplanned purchase)
Hui, Bradlow, and Fader 2009	Field study	Real choice	Category	6.7	Balancing (Zone visit likelihood) n.s. (Purchase incidence)
Laran 2010	Lab study	Hypothetical choice	Unspecified	2	Balancing
Laran et al. (2019)	Lab studies	Real choice	Product	5	Balancing
Laran and Janiszewski (2009)	Lab study	Real choice	Product	2	Balancing (>achieved goal) Reinforcement (>activated goal)
Wight et al. 2023	Field & lab studies	Real & hypothetical choice	Product	2	Balancing (>sharing) Reinforcement (>not sharing)
Current research	Field study & lab study	Real choice	Product	21	

smaller when subsequently choosing from a vice versus virtue product category. Products from unhealthy *vice product categories* (e.g., pizza) are typically considered as *fun* and *bad* (Chernev and Gal 2010; Dhar and Wertenboch 2000). Exploring such a category is known to mainly trigger indulgence goals and induce a desire for immediate gratification (Belei et al. 2012; Shiv and Fedorikhin 1999). Hence, health will be a less accessible goal when shopping from these product categories. In fact, information about the healthiness of products in these product categories can be willfully ignored to avoid negative emotions (Ehrich and Irwin 2005). Consequently, these product categories may cause consumers to maximize indulgence and override their tendency to manage or balance the healthiness of previous choices. Thus, the impact of the healthiness of previous choices is hypothesized to be relatively *less* pronounced when shopping from vice product categories.

In contrast, research suggests that consumers who choose from a *virtue product category* (e.g., yogurt) prioritize the long-term benefits of food and therefore focus more on the health aspects of the products they choose (Balasubramanian and Cole 2002). Consequently, they engage in a more thoughtful, health-oriented decision-making process, which is more likely to include consideration of all available information, including one's previous behavior. While it could be argued that consumers may believe that healthiness is not an issue to begin with when choosing from a virtue product category, we do expect that the impact of previous choices is expected to be relatively *more* pronounced when the subsequent choice in a virtue product category. Combing the arguments above, we thus propose:

H2. The dynamic effect of the relative healthiness of an initial product choice on the relative healthiness of the subsequent choice is less pronounced when subsequently choosing within a vice (vs. virtue) product category.

Next, we describe two studies that test our predictions. We report all conditions, measures, and participants sampled in both studies. In Study 1, we investigate the presence, robustness and ecological validity of healthy shopping dynamics using a large data set from a brick-and-mortar supermarket. In Study 2, we further test the validity of the findings from Study 1 using an online panel of primary household shoppers.

Study 1

Data

For Study 1, we acquired a unique data set describing individual grocery trips at a large Dutch supermarket chain, collected via the supermarket's handheld self-scanning devices. Self-scanning has become a popular and engrained alternative to staff checkout scanning in the Netherlands since its introduction about a decade ago (Vuegen et al., 2019). Customers scanned each product as they selected it, before putting it in their shopping basket, thereby recording the exact sequence in which they selected their groceries. As customers were not intercepted during or before their shopping trip, and were not aware they would be part of a study, potential demand effects are ruled out. The supermarket chain supplemented the sequenced handheld scanner data with detailed nutritional information at the product level. We also acquired information on product prices and promotions at the time of data collection. As our data is obtained using handheld scanning devices, we do not have information on the paths shoppers took through the supermarket, nor do we have floorplan information on the stores.

The data covers shopping trips across three different stores during the first six weeks of 2016. Within the initial data file containing 22,773 shopping trips, a random selection of 300 shopping trips per store per week was made of trips with baskets containing 10 or more food product choices, excluding non-food purchases. Each shopping basket represents one unique shopper-trip combination. Given our focus on caloric density, and given that decisions on purchase quantity can be driven by a wide array of factors besides healthiness considerations (e.g., shopping frequency, household size), we do not consider differences in package size or number of units purchased. Hence, a choice occasion in our data concerns the purchase of one or multiple items of the same product (SKU) by a shopper. Purchases of different products (SKUs) in the same product category were coded as separate choice occasions. Some of the selected baskets had to be removed due to missing nutritional information, leading to a final sample of 5041 unique major shopping trips. On average, these shopping trips included 20.96 unique product choices, with a maximum of 85. The data included 105,661 product choices in total. The data does not include any individual shopper information (e.g., demographics and health interest), but we control for unobserved individual heterogeneity across shoppers in our analyses.

Variables

Each product choice was converted into a measure of relative healthiness within the given category. Specifically, we calculated the relative healthiness (RH_{in}) of choice *n* in shopping basket *i* by subtracting the caloric density of each choice (cal/100 g_{in}) from the average caloric density within the relevant product category. To illustrate this with an example, if a shopper would choose a low-fat yogurt option containing 40 kcal/100 g and the average caloric density of the product category is 100 kcal/100 g, this choice contains 60 kcal/100 g less than the baseline. Consequently, the relative healthiness of that specific yogurt choice is operationalized as 60.[1] Hence, higher positive values of RH_{in} represent healthier, less calorie-dense choices.

As we aim to gain insights into the dynamic effect of the relative healthiness across product choices, the lag of relative healthiness ($RH_{i,n\text{-}1}$) is our main independent variable. Furthermore, to assess whether relative healthiness and the dynamic effect of an initial choice differ depending on the nature of the subsequent product category, we classified each product category as either vice or virtue based on Hui et al. (2009) and Van Doorn and Verhoef (2011). This classification formed a dummy variable ($Vice_{in}$) that was set to 1 if current product choice *n* in shopping basket *i* was made within a vice product category, and 0 if it was made in a virtue product category. (See Web Appendix A for an overview of product categories and vice/virtue classifications for both studies, and Web Appendix B for a robustness check against alternative operationalizations.) A summary of these variables and their operationalization can be found in Table 2.

Model

The dependent variable in our model is the relative healthiness of a product choice (Table 2). To accurately analyze the effect of the relative healthiness of an initial choice on the subsequent choice, we need to account for the fact that product choices are nested within individuals' shopping baskets. However, a model that includes a lagged dependent variable and unobserved heterogeneity poses potential endogeneity problems that prevent the use of random-effects estimation (Heckman, 1981). Therefore, we follow the approach by Mundlak (1978) and include both the original time-varying variables (within-effects e.g., RH_{in}) as well as basket-level means of these time-varying variables (between-effects; e.g., RH_i) as covariates in the model. This approach combines the benefits of random-effects and fixed-effects models, as it accurately estimates the effects of time-varying variables while also allowing for the inclusion of time-stable variables (e.g., HI_i).[2]

Furthermore, there may be serial correlation between product choices driven by factors other than the dynamic effects and observed control variables. That is, the choice at occasion t might be impacted by the choice at occasion t-1 by other (unobserved) factors than those included in our model. Consequently, the estimated effect of the relative healthiness of previous choices (i.e., the lag of the dependent variable) will be biased if these unobserved factors result in serial correlation but are not properly modeled. One factor potentially biasing the dynamic effect (or creating a spurious dynamic effect) is statistical regression toward the mean (hereafter RTM). In our setting, the phenomenon would imply that when shoppers initially pick a very healthy or very unhealthy product, the next choice would, on average, be closer to shoppers' average (long-term) relative healthiness due to random error, suggesting a negative relationship between RH_{in} and $RH_{i,n\text{-}1}$ (Barnett, van der Pols, and Dobson 2005; Campbell and Kenny 1999). Following a procedure suggested by Campbell and Kenny (1999, Chapter 7), we therefore de-bias the dependent measure by correcting it based on the average autocorrelation between past and current relative healthiness, the (moving) average relative healthiness, and a resulting expected value of relative healthiness. Technical details can be found in Web Appendix C.

To further account for residual serial correlation, in addition to possible heteroskedasticity, we use cluster-robust standard errors estimation (Arellano 1987; White 1984). These standard errors relax the assumption of error independence and allow for correlation within a "cluster" (in this case,

[1] An alternative approach would be to compute a relative deviation from the product category average. We opted for an absolute deviation instead because this operationalization seems more in line with the way that consumers (particularly those with lower literacy) compare product healthiness and count calories—using concrete reasoning and absolute computations rather than fractional computations (Viswanathan, Rosa, and Harris 2005).

[2] As a robustness check, we replicated the main analyses of Study 1 using a fixed-effects regression (excluding all time-stable variables) and found similar effects. (See Web Appendix F for additional details.)

Table 2
Variable operationalization in Studies 1–2.

Variable	Included in	Description
RH_{in}	All studies	Relative healthiness of product choice n in shopping basket i, calculated by subtracting the caloric density (i.e., cal/100 g) of choice n from the product category average caloric density, with more positive values indicating healthier (less calorie-dense) choices
$RH_{i,n-1}$		Relative healthiness of the previous choice n-1 in shopping basket i
$Vice_{in}$	All studies	Vice dummy variable indicating if product choice n in shopping basket i was made within a vice product category (baseline = virtue)
$Vice_{i,n-1}$	All studies	Lagged vice dummy variable indicating if product choice n-1 in shopping basket i was made within a vice product category (baseline = virtue)
TF_i	Study 2	Dummy variable indicating the front-of-package labeling condition individual i was in (traffic light labeling vs. control)
Control variables		
PI_{in}	All studies	Price index of choice n in shopping basket i, measured as the price of choice n divided by the product category average price
$Choice_{in}$	All studies	Number of choices made up to current choice n in shopping basket i
$Promotion_{in}$	Study 1	Promotion dummy indicating whether choice *n* by individual *i* was on promotion (1) or not (0)
$Store_i$	Study 1	Two store dummy variables indicating if individual *i* was shopping at store 2 or 3 (baseline = store 1)
$Week_i$	Study 1	Five week dummy variables indicating if individual *i* was shopping at week 2–6 of 2016 (baseline = week 1)
POD_i	Study 1	Three part of day dummy variables indicating if individual *i* was shopping in the early afternoon (12:01–3:00 PM), late afternoon (3:01–6:00 PM) or evening (6:01–9:00 PM) (baseline = morning (9:00 AM −12:00 PM))
$Weekend_i$	Study 1	Weekend dummy variable indicating if individual *i* was shopping on Friday or Saturday (baseline = Monday – Thursday; stores were closed on Sunday)
HI_i	Study 2	General health interest of individual *i*, measured with the 8-item General Health Interest scale (Roininen et al. 1999) that includes items such as "I am very particular about the healthiness of food I eat" (1 = strongly disagree, 7 = strongly disagree; α = 0.88).
CF_i	Study 2	Choice format dummy variable indicating if individual *i* was assigned to the condition that included the option to choose none of the presented options (1) or the condition with forced-choice format (0)

within a shopping basket). The use of robust standard errors affects the standard errors and, thus, the t-statistic, but does not change the coefficient estimates.

Finally, we control for a number of additional product and trip characteristics specific to this study (Table 2). First, as a product's relative healthiness may systematically relate to its price, we control for this relationship by including a price index variable (PI_{in}) for each choice *n* in shopping basket *i*, which we calculated by dividing the price of the currently chosen product by the average price of all products in the category. Second, we account for the fact that the healthiness of choices may decline as a function of the number of choices that have been made due to lapses in self-control (Muraven and Baumeister 2000). Specifically, we include the number of choices a shopper has made up to the current choice as control variable ($Choice_{in}$). Third, we control for the presence of any specific product-level promotions by including a dummy variable ($Promotion_{in}$) that is set to 1 if the selected product choice *n* in shopping basket *i* was on promotion, and 0 otherwise. Fourth, we include dummy variables that indicate in which store and in which week the shopping trip took place. Fifth, we control for the part of the day (POD_i) during which the shopping trip took place (early afternoon, late afternoon, or evening, with morning as baseline) to account for underlying differences in, for example, hunger levels, the type of trip, and time pressure. Sixth, we control for whether the grocery trip took place during the weekend or on a week day. Finally, beyond the type of the current category ($Vice_{in}$), we also control for the type of the previous category ($Vice_{i,n-1}$) to separate cross-category dynamics from within-category dynamics.

Results

Descriptive statistics for the focal variables of both studies are summarized in Table 3. In line with the Mundlak approach, we describe the time-varying variables using both a within-basket variable (e.g., $RH_{i,n-1}$) and a between-basket variable (e.g., RH_i). For lagged relative healthiness, for example, the variation from one choice to the next within the same basket (SD = 87.19) is larger than the variation in average relative healthiness between baskets (SD = 21.03).

To test our main predictions, we estimated two models. Model 1, the main-effects model, explains relative healthiness as an effect of lagged relative healthiness and the nature of the product category, while controlling for price index, number of choices made, and health interest. Model 2, the full model, subsumes the main-effects model and adds an interaction effect to assess whether the dynamic effect of the previous choice differs depending on whether the current choice is made within a vice or virtue product category.

The regression models outperform an intercept-only model (Wald $\chi2(21)$ = 1783.37 and Wald $\chi2(23)$ = 1789.59, both p < .001). Maximum variance inflation factors (VIF) are low

Table 3
Descriptive statistics studies 1 and 2.

Variable	Study 1 Mean	SD	Min	Max	Study 2 Mean	SD	Min	Max
RH_{in}[a,c]	1.34	86.87	−657.31	493.02	−0.54	76.28	−308.25	234.75
$Vice_{in}$	0.34	0.47	0.00	1.00	0.47	0.50	0.00	1.00
RH_i	1.52	21.03	−136.93	152.29	−0.55	30.83	−108.45	104.80
$Vice_i$[b]	0.34	0.15	0.00	1.00	0.47	0.50	0.00	0.83
CF_i					0.41	0.49	0.00	1.00
TF_i					0.52	0.50	0.00	1.00

[a] Values refer to the original scores on the dependent measure (i.e., prior to the de-biasing correction).
[b] Shoppers could refrain from choosing within certain vice and virtue categories in Study 2, causing larger variation in those studies (also see Web Appendix A).
[c] Relative healthiness of the current choice.

indicating that there is no multicollinearity problem, namely 1.77 for main-effects model 1 (average 1.38) and 4.23 for the full model 2 (average 1.78). A Wooldridge test provides evidence against the null hypothesis of no serial correlation ($F(1, 5040) = 15{,}096.39$, $p < .001$).

The time-varying effect of lagged relative healthiness is significant and negative ($\beta_1 = -0.13$, $p < .001$; Table 4), confirming H1. Interestingly enough, symmetry analyses of the balancing pattern across healthier and unhealthier choices indicate that the magnitude of the dynamic effect of lagged relative healthiness is significantly different across relatively healthy (>0) and relatively unhealthy (<0) initial choices. Although both parameters confirm a balancing pattern, the negative effect following a healthier choice ($\beta_1 = -0.15$, $p < .001$) is significantly larger than the positive effect following an unhealthier choice ($\beta_2 = 0.10$, $p < .001$; $\chi^2[1] = 24.53$, $p < .001$). These results suggest that shoppers balance their relatively healthy choices to a greater extent than their relatively unhealthy choices. (See Web Appendix D for additional details.) We further reflect on this finding in the General Discussion.

In line with H2, we find that the time-varying effect of lagged relative healthiness appears less pronounced when currently choosing from a vice product category ($\beta_5 = 0.02$, $p = .012$). We thus find initial support for H2. However, as will be discussed below, this effect is further qualified by a three-way interaction effect with the relative number of choices made. Choices from vice product categories are relatively unhealthier than choices from virtue product categories ($\beta_2 = -7.80$, $p < .001$), and we identify a cross-category balancing affect where prior choices in a relatively unhealthier product category increases the relative healthiness of the current choice ($\beta_3 = 4.02$, $p < .001$). Additionally, the effect of the number of choices made suggests a decline in relative healthiness as the shopping trip progressed ($\beta_4 = -011$, $p < .001$). Regarding the basket-mean and other control variables, we find significant basket-mean effects of average relative healthiness, the vice category dummy, price index, the promotion dummy, and various store, week, and part of the day dummies. All other effects were non-significant.

We also performed a simulation with randomized choice sequence to rule out that the dynamic effect is merely due to RTM. As before, we find a significantly smaller negative effect of lagged relative healthiness compared to the original coefficient ($\beta_{1r} = -0.05$, $p < .001$; $Z_{\beta 1r\text{-}\beta 1} = 13.46$, $p < .001$). Hence, though RTM still seems to play some role, the majority of the dynamic effect is due to the specific choice order. (See Web Appendix E for additional details.)

Three-way interaction: the number of choices made as additional moderator

As described, we find in this study that the dynamic effect of lagged relative healthiness is less pronounced when the subsequent choice is made within a vice product category, in line with H2. We sought to qualify further this interaction over the course of a shopping trip (e.g., Sheehan and Van Ittersum 2018), given that Study 1 uses data from a brick-and-mortar supermarket where shoppers are presented with promotions and displays, as well as larger, more vivid assortments compared to online stores. Furthermore, shoppers tend to make a large number of choices. In line with theories on self-control, navigating such an environment and choosing products repeatedly requires significant time and energy (Fasolo et al. 2009; Huyghe et al. 2017; Muraven and Baumeister 2000; Yim 2017). Furthermore, monitoring and regulating consumption becomes more challenging (Robinson et al. 2013). The significant negative effect of the number of choices is in support of such an explanation. Together, these notions introduce the possibility that apart from affecting overall relative healthiness, the dynamic effects also changed as the (physical) shopping trip progressed (Gilbride et al. 2015).

To examine this line of reasoning, we empirically assessed whether the dynamic effects indeed differed as the shopping trip progressed. Specifically, we conducted an additional analysis using the number of sequential choices made as an additional moderator (model 3). We replicated model 2 while additionally incorporating the two-way interaction between $Vice_{in}$ and $Choice_{in}$, the two-way interaction between $Choice_{in}$ and $RH_{i,n-1}$, and the three-way interaction ($RH_{i,n-1} \times Vice_{in} \times Choice_{in}$). This regression model performs better than an intercept-only model (Wald $\chi^2 = 2749.18$, $p <$

Table 4
Regression results for relative healthiness in Study 1.

	Main effects model (1)		Full model (2)		Three-way interaction (3)	
	Parameter	SE	Parameter	SE	Parameter	SE
Time-varying effects						
β_1 $RH_{i,n-1}$	−0.13***	(0.00)	−0.12***	(0.01)	−0.28***	(0.01)
β_2 $Vice_{in}$	−7.80***	(0.78)	−7.79***	(0.78)	−7.15***	(1.66)
B_3 $Vice_{i,n-1}$	4.02***	(0.71)	3.99***	(0.71)	4.27***	(1.10)
β_4 $Choice_{in}$	−0.11***	(0.04)	−0.10***	(0.04)	−0.41***	(0.04)
β_5 $Vice_{in} \times RH_{i,n-1}$			0.22**	(0.01)	0.04***	(0.02)
B_6 $Vice_{i,n-1} \times RH_{i,n-1}$			.002	(0.01)	−0.010	(0.01)
β_7 $Choice_{in} \times RH_{i,n-1}$					0.01***	(0.000)
β_8 $Choice_{in} \times Vice_{in}$					0.81***	(0.09)
β_9 $Choice_{in} \times Vice_{i,n-1}$					−0.063	(0.07)
β_{10} $Choice_{in} \times Vice_{in} \times RH_{i,n-1}$					.004***	(0.001)
β_{11} $Choice_{in} \times Vice_{i,n-1} \times RH_{i,n-1}$					−0.002**	(0.001)
Basket-mean control variables						
β_{12} RH_i	0.23***	(0.02)	0.29***	(0.04)	0.44***	(0.08)
β_{13} $Vice_i$	−26.83***	(7.37)	11.29***	(1.89)	1.76	(3.82)
β_{14} $Choice_i$	0.08	(0.05)	0.08**	(0.04)	0.16	(0.11)
β_{15} $Vice_i \times RH_i$			−0.18*	(0.09)	−0.26	(0.18)
β_{16} $Choice_i \times RH_i$					0.01	(0.01)
β_{17} $Choice_i \times Vice_i$					0.77***	(0.28)
β_{18} $Choice_i \times Vice_i \times RH_i$					0.01	(0.02)
Other control variables						
β_{19} PI_{in}	−5.02***	(0.69)	−5.03***	(0.69)	−5.13***	(0.69)
β_{20} PI_i	11.53***	(1.90)	11.32***	(1.91)	11.47***	(1.82)
β_{21} $Promotion_{in}$	6.65***	(0.82)	6.64***	(0.82)	6.48***	(0.82)
β_{22} $Promotion_i$	−5.34**	(2.48)	−5.38**	(2.43)	−4.99**	(2.39)
β_{23} Store 2	0.58	(0.59)	0.76	(0.60)	0.54	(0.55)
β_{24} Store 3	−1.88***	(0.61)	−1.71***	(0.61)	−1.81***	(0.58)
β_{25} Week 2	−0.43	(0.83)	−0.64	(0.84)	−0.62	(0.78)
β_{26} Week 3	−0.79	(0.83)	−0.87	(0.83)	−0.88	(0.78)
β_{27} Week 4	−0.76	(0.85)	−0.85	(0.83)	−0.99	(0.80)
β_{28} Week 5	−1.65**	(0.83)	−1.75**	(0.82)	−1.83**	(0.78)
β_{29} Week 6	0.82	(0.82)	0.72	(0.83)	0.54	(0.78)
β_{30} POD 2	−1.12**	(0.57)	−1.17**	(0.56)	−1.25**	(0.53)
β_{31} POD 3	−1.09*	(0.61)	−1.16*	(0.61)	−1.13*	(0.58)
β_{32} POD 4	−0.25	(0.96)	−0.31	(0.97)	−0.38	(0.91)
β_{33} Weekend	−0.82*	(0.48)	−0.94*	(0.49)	−0.87*	(0.46)
β_0 Constant	−6.36***	(1.90)	−6.94***	(1.89)	−3.92***	(2.08)
Observations	90,538		90,538		90,538	
Number of individuals	5041		5041		5041	
Adj. R^2	0.017		0.018		0.028	

Cluster-robust standard errors in parentheses. Dependent variable in all models is $RH_{i,n}$.
*** $p < .01$.
** $p < .05$.
* $p < .1$.

.001) and multicollinearity remains below the common threshold (max. VIF = 9.78, avg. VIF = 4.58).

As in models 1 and 2, the effect of lagged relative healthiness is significant ($\beta_1 = -0.28$, $p < .001$; Table 4). Furthermore, the two-way interaction between lagged relative healthiness and the vice category dummy remains significant and positive ($\beta_5 = 0.042$, $p < .001$), suggesting that, overall, the dynamic effect is *less* pronounced among vice categories, consistent with H2. The two-way interaction between lagged relative healthiness and number of sequential choices made is significant as well ($\beta_7 = 0.01$, $p < .001$); the dynamic impact of lagged relative healthiness becomes less pronounced as the shopping trip progresses. The vice dummy also interacts with the number of sequential choices made; the difference in relative healthiness across vice and virtue categories reduces as the shopping trip progresses ($\beta_8 = 0.81$, $p < .001$). These interactions are further qualified by a significant three-way interaction between number of sequential choices made, the nature of the product category, and lagged relative healthiness ($\beta_{10} = 0.004$, $p < .001$). Visualizing this three-way interaction (Fig. 1) illustrates that early in the trip, the dynamic impact of lagged relative healthiness is slightly

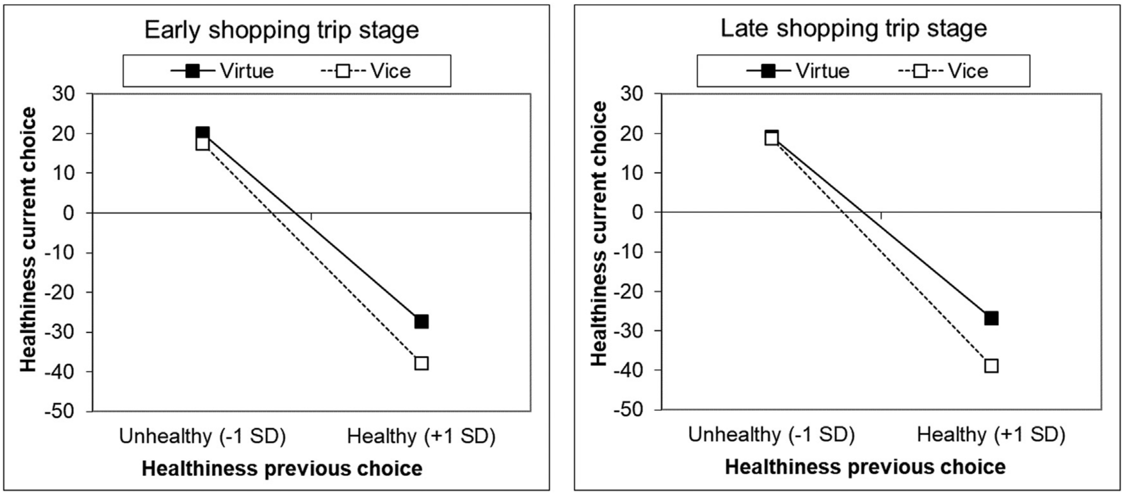

Fig. 1. Effect of lagged relative healthiness, nature of the product category and number of choices made (Study 1).

less pronounced among vice product categories. Late in the trip, however, the dynamic effect of lagged relative healthiness is *more* pronounced among vice product categories. In sum, in the brick-and-mortar store, the effects of lagged relative healthiness and the nature of the category also vary with the number of choices made.[34]

Discussion

Study 1 demonstrates that the hypothesized inverse relationship between the relative healthiness of an initial product choice and the subsequent product choice holds in an actual brick-and-mortar store, highlighting the ecological validity of our findings. Moreover, shoppers appear to balance their relatively healthy choices to a greater extent than their relatively unhealthy choices. This dynamic effect is less pronounced when choosing from a vice product category. We also find evidence of a higher-order interaction between the number of sequential choices made, the nature of the product category, and the relative healthiness of the previous choice, such that the dynamic effect of lagged relative healthiness is less pronounced among vice product categories early, but not late in the shopping trip. Furthermore, the overall strength of the dynamic effect reduces as the shopping trip progresses, as does the difference in relative healthiness across vice and virtue product categories.

Next, to test our hypotheses in a more controlled environment, we conduct an online experiment. The experimental approach allows for a number of checks and corrections. First, the results of Study 1 may in part be driven by the floorplan of the supermarkets, which may introduce a systematic order effect. To address this, we completely randomize the order of all product choices in the Study 2. Second, we use the experiment to research whether front-of-package labels on food products influence healthy shopping dynamics. It may be that the increased salience of the healthiness of products may dampen or magnify healthy shopping dynamics, or for instance reduce the shown asymmetry in these dynamics.

Study 2

Design and procedure

In Study 2, we research healthy shopping dynamics across 25 virtual product choices. Using Amazon Mechanical Turk, we recruited 504 participants from the United States to participate in an online study in exchange for $2.25. Specifically, they completed a computer-simulated grocery-shopping task that mimics an online grocery shopping environment, an increasingly common practice as 49 % of consumers in the United States engage in it and total expenditures are predicted to reach $100 billion by 2022 (FMI-Nielsen 2021). In the title, we stated explicitly that only primary household shoppers were eligible to take part in the study, and we included a screening question at the beginning of the study to screen out participants who did not meet this requirement.

Per product category (e.g., milk, bread, and spaghetti), four products alternatives were presented next to each other (in randomized order) with a picture of the SKU, its price, and nutritional information. Prices of all product options were based on market levels at the time of the study. Brand, package size, and product type were kept constant across product alternatives within each category to assure that the products mainly varied in terms of relative healthiness (i.e., relative caloric density).

[3] We also tested (post-hoc) whether these interactions were significant in Study 2. This was not the case ($p > .10$). Furthermore, we detected higher multicollinearity in these studies (max. VIF values of up to 100). This may be due to the fact that the number of sequential choices remained relatively limited and that these analyses rely on fewer observations. (See Web Appendix I for additional details.)

[4] An additional post-hoc check investigated whether product category choice (vice or virtue) was impacted by the relative healthiness of the prior choice. A logistic regression using $Vice_{in}$ as dependent variable showed no significant effect of lagged relative healthiness ($\beta_1 = -.000$, $p > .10$).

In order to address the potential effects of the floor plan of supermarkets on the healthy shopping dynamics, we presented the product categories in random order, such that each participant viewed a unique sequence of categories. Thus, we eliminate effects that might be attributed to particular sequences of product categories or their relationships. The experiment thus represents a fully unplanned shopping trip, with participants only knowing that choices for 25 product categories would be made. The order of the product options within each product category were also randomized. Different from Study 1, each participant made only choice per category. While this helps to better identify the effect of switching product categories, as each product category is shown only once to a participant, it does present a more restrictive shopping situation than in Study 1 where shoppers could (and did) make multiple choices from the same product category without necessarily switching between categories.

To incentivize participants to purchase as they normally would instead of promoting the selection of expensive alternatives (Ding 2007; Ding, Rajdeep, and Liechty 2005), participants were told that one of them would be randomly selected as the winner of a $75 prize package containing their selected groceries and cash. For example, if participants spent $50, they would receive their selected groceries and $25 in cash.

To align this study with a more realistic brick-and-mortar supermarket scenario where participants also would have the option to not purchase in a particular category and to examine whether and how the no-choice option influences healthy shopping dynamics, we decided to include a no-choice condition in Study 2. Participants were randomly assigned to one of two choice format conditions (with versus without a no-choice option per product choice). 249 participants were assigned to the no-choice condition, while 255 participants were assigned to the forced choice condition. Furthermore, participants were also randomly assigned to one of two front-of-package labeling conditions (traffic light labeling vs. control). 261 participants were assigned to the traffic-light labeling condition and 243 participants were assigned to the control condition. The traffic light label uses the colors red, orange and green to highlight the healthiness of different nutrients (e.g., saturated fat, sugar, salt) (Cadario and Chandon 2020). We were interested to examine whether increasing the salience of the healthiness of food products changes the healthy shopping dynamics.

The study further included demographic questions and participants' food-related health interest, among multiple other measures. These measures were taken after the shopping trip was completed. This health interest was measured using the 8-item General Health Interest scale by Roininen, Lähteenmäki, and Tuorila (1999), which includes items such as "I am very particular about the healthiness of food I eat" and "I always follow a healthy and balanced diet" (1 = strongly disagree; 7 = strongly agree; $\alpha = 0.87$, $M = 3.84$, SD = 0.56). (See Web Appendix G for a full overview of all included measures.)

As we focus on major shopping trips throughout this research and to ensure sufficient within-basket variation, we limit the analyses to baskets containing 10 or more product choices (Anić and Radas 2006; Sheehan and Van Ittersum 2018). Ten participants in the 'no choice' condition (4 % of the condition's participants) selected fewer than 10 products and were removed from the data. The final data set represents an (unbalanced) panel with 10,805 product choices by 504 individuals—those with the forced-choice format made 25 choices and those presented with the 'no choice' option made 18 choices, on average (after excluding baskets containing less than 10 choices).

The variables equal those analyzed in Study 1, except for a few additions (Table 2). First, to assess whether the manipulation of the forced-choice format affects the relative healthiness of each choice, we include a choice format dummy variable (CF_i) set to 1 if the participant was allowed to choose none of the presented food options and 0 otherwise. For the same reason, we include a traffic light dummy variable (TL_i). Second, we investigate whether the choice format and the presence of a traffic light label also affects the dynamic relationship between the relative healthiness of subsequent choices by interacting lagged relative healthiness ($RH_{i,n-1}$) with the choice format dummy variable (CF_i) and the traffic light dummy (TL_i). The choice format and presence of a traffic light label did not affect how we coded relative healthiness and other variables (e.g., price index). Third, we control for participants' food-related health interest (HI_i).

Results

We estimated both a main-effects model (1) and a full model (2) that includes the interaction effects with the vice dummy, no choice condition, and the traffic light condition. The models significantly outperform an intercept-only model ($F(2, 13) = 40.37$ and $F(2, 21) = 28.09$ both $p < .001$). Maximum variance inflation factors (VIF) were 4.83 for model 1 (average 1.68) and 7.48 for model 2 (average 6.70). As in Study 1, a Wooldridge test provides evidence against the null hypothesis of no serial correlation in model 2 (F(1, 10,275 = 169.83, $p < .001$).

The negative effect of lagged relative healthiness hypothesized in H1 and confirmed in Study 1 is corroborated by Study 2 ($\beta_1 = -0.18$, $p < .001$; Table 5), confirming that a healthier initial product choice is followed by an unhealthier subsequent choice, and vice versa. Symmetry analyses of the balancing pattern across healthier and unhealthier choices indicate that the magnitude of the dynamic effect of lagged relative healthiness is significantly different across relatively healthy (>0) and relatively unhealthy (<0) initial choices. Although both parameters confirm a balancing pattern, the negative effect following a healthier choice ($\beta_1 = -0.16$, $p < .001$) is significantly smaller than the positive effect following an unhealthier choice ($\beta_2 = 0.19$, $p < .001$; $Z_{\beta 1-\beta 2} = -16.56$, $p < .001$). These results suggest that shoppers balance their relatively unhealthy choices to a greater extent than their rel-

Table 5
Regression results for relative healthiness in Study 2.

	Main-effects model (1)		Full model (2)	
	Parameter	SE	Parameter	SE
Time-varying effects				
β_1 $RH_{i,n-1}$	−0.18***	(0.01)	−0.26***	(0.03)
β_2 $Vice_{in}$	−6.55**	(1.81)	−6.41***	(1.67)
B_3 $Vice_{i,n-1}$	−1.42	(1.42)	−1.29	(1.41)
β_4 $Vice_{in} \times RH_{i,n-1}$			0.15***	(0.02)
β_5 $Vice_{i,n-1} \times RH_{i,n-1}$			0.04*	(0.02)
Basket-mean control variables				
β_6 RH_i	0.17***	(0.03)	0.09	(0.17)
β_7 $Vice_i$	−8.27	(29.24)	−7.70	(30.19)
β_8 $Vice_{i,-1}$			−1.20	(28.12)
β_9 $Vice_i \times RH_i$			1.30	(0.88)
Effects choice format				
β_{10} CF_i	0.01	(1.54)	0.58	(1.51)
β_{11} $CF_{in} \times RH_{i,n-1}$			−0.04*	(0.02)
β_{12} $CF_i \times RH_i$			0.02	(0.06)
Effects traffic light				
β_{13} TF_i	0.23	(1.49)	0.58	(1.50)
B_{14} $TF_{in} \times RH_{i,n-1}$			0.00	(0.02)
B_{15} $TF_i \times RH_i$			0.03	(0.05)
β_{16} PI_{in}	87.73***	(4.76)	86.08***	(4.75)
β_{17} PI_i	−57.42	(25.80)	−60.47	(25.82)
β_{18} $Choice_{in}$	0.11	(0.12)	0.11	(0.12)
β_{19} $Choice_i$	1.43	(1.00)	1.05	(0.99)
β_{20} HI_i	−1.13*	(1.54)	−1.15*	(1.54)
β_0 Constant	−42.87	(30.58)	−32.86	(30.52)
Observations	10,302		10,302	
Number of individuals	504		504	
Adj. R^2	.047		.052	

Cluster-robust standard errors in parentheses. Dependent variable in both models is $RH_{i,n}$.
*** $p < .01$.
** $p < .05$.
* $p < .1$.

atively healthy choices (see Web Appendix J for additional details). We further reflect on this finding in the General Discussion.

Furthermore, consistent with H2 and the results of Study 1, we find that the dynamic effect of the healthiness of the previous choice is less pronounced when currently choosing from a vice product category ($\beta_4 = 0.15$, $p < .001$) (Fig. 2). The presence of a *none-of-these*-option (i.e., the choice format) has no significant effect on the relative healthiness of the remaining choices ($p > .10$). The interaction between choice format and lagged relative healthiness is marginally significant ($\beta_{12} = -0.04$, $p < .10$). The main and interaction effects of the traffic light condition are not significant (both $p > .10$). As in the previous study, the time-varying effect of the nature of the category is negative ($\beta_2 = -6.55$, $p < .05$), indicating that choices from vice product categories are relatively unhealthier than choices from virtue product categories. In contrast with Study 1, the cross-category balancing effect is not significant here ($p > .10$), likely due to the randomized nature of categories. The basket-level mean effect of the number of choices made was insignificant. The effect of health interest was marginally significant suggesting that with participant's health interest the healthiness of choice reduces.

Finally, to further assess to what extent RTM may account for the dynamic effects, we replicated the simulation described in Study 1 by randomizing the choice sequence in Study 2 as well. As in Study 1, the results indicate a clearly less pronounced, yet significant negative dynamic effect ($\beta_{1r} = -0.05$, $p = .002$). A Z-test confirms that coefficients β_{1r} and β_1 differ significantly ($Z_{\beta 1r\text{-}\ \beta 1} = -9.14$, $p < .001$). Hence, though some RTM pattern remains, the actual choice order again accounts for the majority of the dynamic effect. (See Web Appendix H for additional details.)

Discussion

Together, Studies 1 and 2 offer robust evidence for healthy shopping dynamics across a range of designs and samples. Healthier choices are followed by unhealthier choices, and vice versa. Furthermore, this balancing pattern is less pronounced when shoppers subsequently select a product from a vice (vs. virtue) product category.

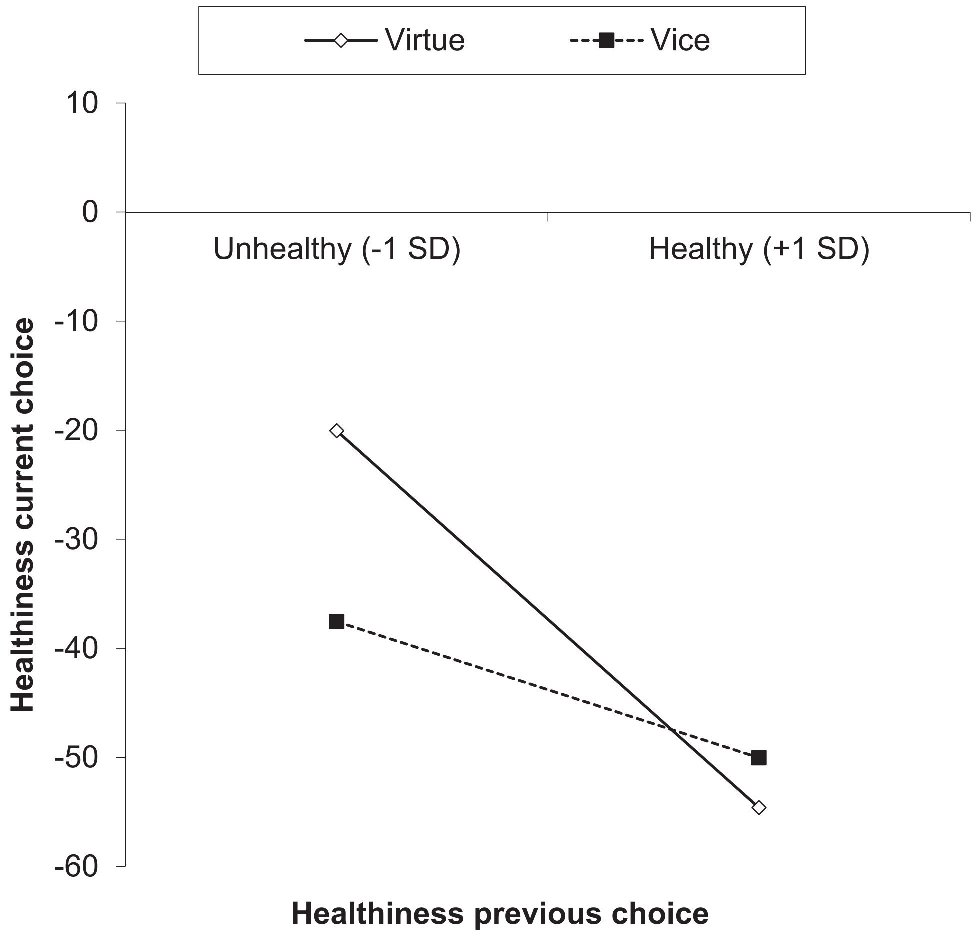

Fig. 2. Effect of lagged relative healthiness and nature of the product category on relative healthiness in Study 2.

General discussion

This research assesses the existence and nature of *healthy shopping dynamics*— interdependencies between the relative healthiness of sequential grocery choices. Specifically, we investigate whether people consistently select healthier or unhealthier product alternatives or whether they balance between relatively healthier and unhealthier alternatives throughout major shopping trips. Across a study using actual purchase data from a brick-and-mortar supermarket (Study 1) and an online experiment (Study 2), we find that the relative healthiness of an initial product choice is inversely related to the relative healthiness of the subsequent choice, regardless of the category of both products. Hence, when shoppers initially select a healthy option, this choice is typically balanced by an *unhealthier* subsequent choice, whereas unhealthier choices in turn are followed by *healthier* subsequent choices. To illustrate the magnitude of this effect, our findings suggest that, for example, a product choice that is 60 kcal/100 g healthier (unhealthier) than the category average reduces (increases) subsequent product choice healthiness by 8–11 kcal/100 g. Hence, the healthiness of an initial product choice is partly offset by a subsequent product choice. Furthermore, the balancing effect depends on the nature of the product category and the stage of the shopping trip; it is less pronounced when the subsequent choice is made within a vice product category (e.g., cookies) and when the (physical) shopping trip progresses. We conducted different robustness checks. One check involved testing the robustness of our findings for longer-period dynamics. For both studies, we conclude that choices beyond the previous choice also (negatively) affect the relative healthiness of the current choice, and this effect is less pronounced when the current product category is a vice category. We provide details on the results in Web Appendix K.

Both studies provide consistent empirical evidence for the existence of healthy shopping dynamics. In addition, the studies consistently rule out various alternative explanations for these dynamics, such as regression toward the mean, product prices, the nature of the product category, and unobserved basket-level heterogeneity. However, each study also offers a unique contribution. Study 1 relies on actual, ordered purchase data from over 5000 baskets from a brick-and-mortar store. Furthermore, it indicates that self-control mechanisms may be at play here, as the specific dynamic effects also depend on how many sequential choices a shopper has made up to the current choice. We find that the dynamic impact of lagged relative healthiness becomes less pronounced as the shopping trip progresses. This result is most consistent with the self-control resources explanation (Muraven and Baumeister 2000). Study 2 replicates the findings of Study 1 in a more controlled setting with a sample of primary household shoppers.

All in all, we believe that the causal nature of our effect is supported by both studies. Specifically, based on our results and the degree to which they match existing theories and empirical research, we do believe that former choices influence subsequent choices. While consumers are known to plan part of their shopping trip ahead, research also suggests that most decisions are taken during the actual shopping trip. The results of Study 2 further justify making causal claims. After all, Study 2 involved what might be considered an unplanned shopping trip, without the opportunity to plan ahead (also as the product order was randomized).

Both studies demonstrate that the balancing pattern is asymmetrical. However, the direction of this pattern differs across studies. Study 1, in the brick-and-mortar store, shows that shoppers balance their relatively healthy choices to a larger extent than their relatively unhealthy choices. If the negative dynamic effect following a healthy choice is not offset to a similar extent by a positive effect following an unhealthy choice, this asymmetry could imply that healthy shopping dynamics lead to an overall decline in relative healthiness as the shopping trip progresses. The negative coefficient of the number of choices made in Study 1 indeed corroborates this overall decline in relative healthiness, which may be attributed to self-control lapses—a reduced ability to monitor and regulate choices (Robinson et al. 2013). It could also relate to healthier choices being more effortful and unhealthier choices being more automatic, as Sachdeva, Iliev, and Medin (2009, p. 528) speculate that "relatively automatic behavior may not warrant the same sort of compensation as effortful behavior". However, in Study 2, we find the opposite effect: shoppers balance their relatively unhealthy choices to a greater extent that their relatively healthy choices. Thus, we call for future research to study the direction and size of this effect in more detail.

Contributions to marketing theory

This research contributes to a growing body of research on within-trip dynamics (Dhar et al. 2007; Gilbride et al. 2015; Sheehan and Van Ittersum 2018). The main contribution of this research is the evidence that goal balancing across sequential product choices is observable when measured at the item-level within a product category rather than taking the entire product category itself. Specifically, we demonstrate that healthier choices are followed by unhealthier choices, and vice versa. This finding is in line with notions that sequential choices may lead to balancing (Huber et al. 2008), due to, for example, the experience of goal progress (Fishbach and Dhar 2005) or licensing effects (Khan and Dhar 2006; Ramanathan and Williams 2007). Furthermore, whereas previous work in the food domain investigated category-level dynamics (Hui et al. 2009; Fishbach and Dhar 2005), the present research focuses on product-level dynamics. This is an important contribution—it allows us to establish healthy shopping dynamics independent of any specific product category characteristics, corresponds with shoppers' healthiness perceptions regarding grocery products, and matches the level at which shoppers decide about products in the store.

The results also extend our theoretical understanding of how shoppers' product-level decision-making differs depending on the product category and the stage of the shopping trip (Dhar and Wertenboch 2000; Gilbride et al. 2015; Hui et al. 2009; Lee et al. 2018; Verhoef et al. 2022). When shoppers choose from indulgent vice product categories, they balance the healthiness of their previous choice to a lesser extent, and they select unhealthier options.

In addition, Study 1 suggests that the balancing pattern becomes less pronounced later in the shopping trip (i.e., when more choices have been made). Although we remain speculative about the process driving these interaction effects, they could relate to changes in shoppers' ability to manage multiple goals across sequential choices (Fishbach and Dhar 2005; Laran 2010) or differences in the tendency to regulate their self-concept (Khan and Dhar 2006; Ramanathan and Williams 2007). They could also represent self-control mechanisms—depletion of limited resources (Muraven and Baumeister 2000) or reduced prioritization of health goals as the shopping trip progresses (Inzlicht, Schmeichel, and Macrae 2014).

Practical implications

Our findings have important implications for organizations and policy-makers aiming to promote healthier food choices. Our research suggests that it is crucial to acknowledge and incorporate the interdependence between sequential food choices to understand how grocery choices come about. Incorporating such dynamics is also essential for providing accurate predictions about the effects of health interventions. Many existing in-store practices, such as offering low-fat versions of products, taxing unhealthy foods, or subsidizing healthy foods, are implicitly based on the notion that improving the healthiness of single choices also leads to healthier baskets. However, our results confirm earlier findings that interventions can in fact lead to balancing effects, which may in turn cause a limited, or even negative effect on total basket-level calorie content (Cadario and Chandon 2020; Roberts 2015; Waterlander et al. 2012). Our findings specifically suggest that the relative healthiness of an initial product choice is partly, but not fully offset at the subsequent product choice. By incorporating and quantifying these balancing effects, organizations can draw more accurate inferences on the net effects of health interventions that target single choices and select those that benefit basket-level healthiness as well.

In addition, our findings can be used to design new types of interventions. In line with research on *smart shopping carts* and real-time feedback (Van Ittersum et al. 2013; Sheehan and Van Ittersum 2018), retailers and policy-makers could utilize the current insights to create interventions that promote healthier choices throughout the shopping trip. One could, for example, provide shoppers with real-time feedback that promotes goal commitment instead of licensing following a healthy choice ("Let's make another healthy choice!"). Building on Garvey and Bolton (2017), another effective way to mitigate licensing effects may be to emphasize the importance of consistently healthy choices ("Please stay committed to your health goals through your other purchases"). Finally, our findings suggest that shoppers choose unhealthier alternatives when they choose from vice product categories and when the brick-and-mortar shopping trip progresses. Corroborated by earlier scientific evidence (Huyghe et al. 2017; Nikolova and Inman 2015), relevant implications are that shoppers may end up with relatively healthier choices by refraining from vice product categories altogether, by shopping online, or by limiting the duration of their trips.

Limitations and further research

As mentioned, our research demonstrates that goal balancing across product categories is observable when measured at the item-level within a product category rather than taking the entire product category itself. Existing research on goal balancing in the grocery shopping setting has focused at the category-level and has yielded largely insignificant results (Hui et al., 2009; Vohs & Faber, 2007). We recommend that future research takes the proposed item-level approach to address some of the research questions on goal balancing that have been studied at the product category level. Moreover, future research could test the robustness of the balancing patterns to other nutritional measures, such as sugar and fat content, or holistic measures of healthiness, such as the Nutri-Score or the NuVal scale.

Next, while our studies consistently show that the relative healthiness of sequential grocery choices is characterized by a balancing pattern, we did not empirically assess *why* relatively healthy choices lead to relatively unhealthy subsequent choices, and the other way around. However, the existing marketing literature offers various theories that support such a pattern (Huber et al. 2008). For example, our findings align with notions on the liberating effects of perceived goal progress (Fishbach and Dhar 2005); when consumers select a healthy alternative, they may feel they have satisfied their health goal sufficiently and change their focus to an enjoyment goal. Alternatively, an initial choice may serve as a license or justification of a dissimilar subsequent choice (Khan and Dhar 2006). To get more specific insights into the underlying processes driving the present results, future research could empirically test whether such processes indeed extend to product-level grocery choices and account for these dynamic effects.

We tried to investigate the underlying cause of the different price responses across studies. One reason could be the higher variation in prices in Study 1 compared to Study 2. Along the lines of Bronnenberg and Vanhonacker (1996), Study 2 presents a more limited choice set compared to Study 1, which, as these authors suggest, can change the impact of price. Also, the fact that price promotions are present (and controlled for) in Study 1, but not in Study 2, could alter the impact of price. At the same time, we should be cautious to causally interpret the sign of this variable, given its role of control variable (Hünermund & Louw, 2022). More research on the effects of prices in the grocery shopping context is warranted, especially in relationship with the healthiness of food choices. For example, future research may investigate if and to what extent the non-linear price sensitivity while shopping for groceries (Sheehan and Van Ittersum 2018) may interact with the reported healthy shopping dynamics.

Furthermore, although we have identified two important situational factors that influence the magnitude of the dynamic effects—the nature of the product category and the stage of the shopping trip—we did not find evidence that these dynamic effects also differ depending on specific individual differences. For example, as previous research has suggested that consumers mainly prefer to balance across sequential choices when two conflicting goals (e.g., both a health goal and a pleasure goal) are salient (Dhar and Simonson 1999), this could imply that the strength of one's health goal influences to what extent a healthy choice leads to balance or reinforcement. Furthermore, whereas self-control varies across situations and over time, consumers also differ in their dispositional self-control (Tangney, Baumeister, and Boone 2004). Hence, our findings from Study 1 could imply that healthy shopping dynamics are chronically less pronounced for people lower in self-control. Future research could profitably investigate whether such individual differences indeed moderate the effects.

Moreover, in addition to individual differences, health interventions (e.g., nutrition labeling and taxes) may also moderate the strength and nature of the dynamic effects (Van Ittersum et al. 2007). The second study of this research presented half the participants with traffic light labeling throughout the shopping trip. The analysis showed no significant effect of labeling condition on relative healthiness. Yet, further research should replicate and extend such analyses across various types of interventions (e.g., category-level interventions versus store-level interventions) to investigate how they dynamically shape the healthiness of food choices.

Finally, whereas we find that shoppers balance the selection of a healthier product alternative with an unhealthier subsequent choice and vice versa, previous research suggests that shoppers may also respond to healthier and unhealthier choices, and to health warnings in particular, by changing *how much* they consume (Cleeren et al. 2016; Hyland and Birrell 1979; Wansink and Chandon 2006). Future studies could incorporate such a "boomerang effect" and test whether consumers also demonstrate a dynamic interplay between what and how much to eat. However, empirically addressing this issue is challenging, as it requires detailed information on actual food intake and related factors such as household size. Furthermore, as people usually have a stronger preference for what to eat relative to how much to eat (Wansink and Chandon 2014), such volume dynamics may have a limited impact on in-store food selection. Finally, as our analyses focus on caloric density instead of calories in an absolute sense, the present findings cannot be explained by changes in the quantity of the selections.

In conclusion, our research illustrates the presence of healthy shopping dynamics; the relative healthiness of a grocery choice evolves as a function of the previous choice. Relatively healthy product choices are partly offset by unhealthier subsequent choices, and vice versa. This balancing effect becomes less pronounced when the subsequent choice is within a vice product category, and in the brick-and-mortar store, it becomes less pronounced as the shopping trip progresses. These results underscore that it is pivotal for theory and practice to take a dynamic perspective and account for dynamic effects across sequential food choices—healthier choices may not necessarily lead to healthier shopping baskets.

Declaration of Competing Interest

None.

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Supplementary materials

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