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Behavioural Innovations in a Supermarket Setting

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Nudging more sustainable grocery purchases: Behavioural innovations in a supermarket setting

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Abstract: Increasing fruit and vegetable consumption in a shift towards more plant-based foods is considered a key component of a healthy and sustainable diet. Recent experimental work suggests that behavioural insights-based interventions in the immediate choice context may create opportunities for sustainable food-behaviour change. Among the many actors and elements of a complex food system, supermarkets are in a unique position as main gatekeepers to curate the interface between supply and demand and steer both in more sustainable directions. Sustainability-oriented retailers can use innovative behavioural tools to promote healthier and climate-friendlier foods (such as vegetables) while meeting the "triple bottom line". A real-life supermarket trial in Denmark tested if multi-layered nudges can increase the purchase of fruit and vegetables. The intervention led to small increases in sales. These findings showcase the possibility that supermarkets, in principle, have agency and ability to nudge consumers towards more sustainable diets. To meaningfully shift consumers' consumption patterns, supermarkets need an open sharing of best practices and the use of a sound methodology to better understand and effectively change consumer behaviour. In partnership with stakeholders, supermarkets could play a more active role in fostering a sustainable food transition by employing "nudges for good".

Keywords (6): Behavioural interventions; healthy and sustainable diets; in-store promotion; behavioural sustainability innovation; sustainable retail; fruit and vegetable consumption.

1. Introduction

The Intergovernmental Panel for Climate Change (IPCC) emphasized the need for fast and large reductions in greenhouse gas (GHG) emissions to limit global warming to 1.5°C (IPCC, 2018). Estimates suggest that up to 60% of global GHG emissions are linked to household consumption, with the largest emissions stemming from mobility, housing, and food (Ivanova et al., 2016). However, due to consumer lock-in and structural constraints, carbon reductions in mobility and housing are challenging to attain (Ivanova et al., 2018). Therefore, the category of food constitutes a promising emissions-reduction potential, particularly with a shift away from meat and dairy-based diets. The IPCC identified that worldwide, 20% of anthropocentric emissions can be attributed to "agriculture activities within the farm gate and associated land use dynamics" (IPCC, 2018, p. 60). Rising worldwide demand for emission-intensive foods such as dairy and meat is likely to increase this contribution (Springmann et al., 2018). Demand for these two food groups is forecasted to double globally by 2050 (WRI, 2018). Hence, together with food-waste reduction and moderating caloric intake, plant-based diets are today regarded as a key component of the transition to a healthy and sustainable food system (Macdiarmid, 2020; Willett et al., 2019). Eating less meat and dairy and more plant-based food (i.e., vegetables, fruits, and grains) has been singled out as one of the most impactful as well as malleable consumer food practices that could potentially be changed through tailored interventions (Guthrie et al., 2015; Hummel and Maedche, 2019; Wynes and Nicholas, 2017).

From a systems perspective, healthy and sustainable food systems that stay within the planetary boundaries and provide a minimum level of safety, access, and equity are more resilient, i.e., more robust in times of shocks and crisis (Burlingame, 2020). Sustainable diets are also scalable: The influential EAT-Lancet Commission on Healthy Diets for Sustainable Food Systems recently presented a concrete sustainable reference diet that, if applied, can be

provided “for an anticipated world population of nearly 10 billion people by 2050 and still stay within a safe operating space on Earth” (Willett et al., 2019).

Demand-side policies targeting consumers (Creutzig et al., 2018) and also large organizations’ procurement units (Goggins, 2018) are increasingly viewed as the essential counterpart of supply-side food and farm policies that can help manifest the necessary transformation to climate-friendly and resilient food systems. In addition to the calls for a carbon tax on food consumption (Moberg et al., 2019; Säll and Gren, 2015), a recent strand of empirical research tried to identify the success factors of effective, practically feasible, economically bearable, and socially accepted demand-side interventions in general (Creutzig et al., 2020) and behaviourally based policies – so-called “nudges” (Thaler and Sunstein, 2008) – in specific (Reisch, 2021; Reisch et al., 2017).

There is increasing evidence that insights into consumer biases and heuristics, habits, and motivations together with an understanding of the impact of the immediate choice environment are highly useful in the design of successful interventions for food-behaviour change (Bauer and Reisch, 2019). What has been called “Behavioural Food Policy” (Reisch, 2021) puts people’s needs, biases, and decisions at centre stage, offering a specific behavioural lens to existing (hard and soft) policies through which they can be made more effective. Behavioural policies rely on governance processes that are based on empirical and often experimental testing, learning, and adaptation (Shafir, 2013). Public deliberation and participation in these processes help consumer-citizens understand and eventually approve of the policies (John, 2018). However, innovative use of nudging and behavioural stimuli are equally attractive means for private-sector actors along the food chain, from farmers to industry, retail, and restaurants (Kraak et al., 2017). The challenge to transform a complex system must be met with shared responsibility and active engagement of all actors along the food chain, not just authors of public policy.

Among the many actors and elements of a complex food system, retailers in general and supermarkets in specific are powerful intermediaries and gatekeepers (Murray and Caraher, 2020). Retail is in a unique position to curate the interface between supply and demand and shift the latter towards more sustainable actions (Escaron et al., 2013; Larson, 2006). With the meat industries under increasing pressure (Schiermeir, 2019), supermarkets are likely to create a competitive advantage by expanding fresh vegetable and fruit zones, often identified as the most relevant area for supermarket selection (Nassauer, 2011), to provide an easy and attractive shopping experience catering to increasingly purchase-relevant environmental consumer values (Ehgartner, 2018; Lloyds's Register, 2019; Terblanche, 2018; Whelan and Kronthal-Sacco, 2019). Behavioural insights-based interventions in the immediate choice context of supermarkets may create opportunities for lasting behaviour change.

Besides contributing to the health of people and the planet, promoting plant-based food is by no means bad for business, as produce items often have above-average profit margins (McLaughlin, 2004). In practice, whether based on profitability expectations, on a "push" led by a corporate sustainability strategy, or on the "pull" from health- and climate-conscious consumers. Supermarkets in Denmark, for instance, have seen increased sales of organic food items (Danish Agriculture and Food Council, n.d.), including vegetables; and they make efforts to cut retail and consumer food waste (The Local, n.d.), another major behavioural driver for unsustainable food regimes (Garnett, 2014).

The double challenge of health and climate is sparking creative modes of cooperation among retail, start-ups, restaurants, and consumers. Successful innovations include the anti-food-waste apps, such as "Too Good to Go", allowing consumers to purchase foods in supermarkets at reduced prices before they expire. The sustainability literature is increasingly investigating sustainability-oriented innovations (SOIs) and also likes to feature innovating actors within the food system. SOIs are defined as intentional changes to the actors'

philosophies and values, as well as to their technologies, products, processes, and practices to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns (Adams et al., 2016). One of these new approaches to sustainability retail marketing is the systematic trial of in-store sustainability nudges that softly steer consumer choice towards more sustainable products.

The literature on choice architecture details a number of theoretical and empirical examples of how in-store choice architecture can affect consumer decisions. There is little doubt that the retail sector has the potential to shift consumer choices, with the help of non-price stimuli, in a more sustainable and healthy direction. However, the same literature makes it clear that consumer choices are complex and highly context-dependent, and that triggering and sustaining behavioural change remains a challenge for behavioural science. Consumers sometimes react differently to an intervention, and the elicited effects can depend on the setting and context (Forwood et al., 2015; Harbers et al., 2020; McGill et al., 2015; Mishra et al., 2012). Hence, there is no general recipe for retailers to shift consumer choices in a more sustainable direction; lack of incentives as well as concerns about potential losses in sales might further deter sustainable innovation and experimentation. As acknowledged by proponents of behavioural public policy, the path to more sustainable consumer choices through supply-side interventions goes through more consumer research to develop and experimentally evaluate in-store interventions for maximum efficiency (Just and Byrne, 2020). In their brick-and-mortar stores, but also online, supermarkets have a unique opportunity to experiment with how features of choice architecture in supermarkets can be changed to foster healthier and more sustainable consumer choices.

Given the overwhelming evidence for the health and environmental benefits of a more plant-based diet and the promising successes of choice architecture to support such changes in consumer choice (Bauer and Reisch, 2019; Cadario and Chandon, 2020), we tested whether

sustainability-focused in-store choice-architecture interventions in Danish supermarkets can increase sales of plant-based food items. The present paper reports on one such exemplary empirical study testing a multilevel nudge intervention that is easy to implement and aimed to increase sales of fruit and vegetables (F&V). The intervention leveraged social-norm messaging, targeting customers through signs in shopping carts and baskets, combined with matching reminders at the respective shelves. While we found the intervention to significantly increase the overall sales of fruit and vegetables, little evidence points to an increase in sales for the five specific target vegetables. The mixed results presented in this paper reinforce prior conclusions that an effective redesign of in-store choice architecture is a challenging endeavour, highlighting the importance of good store-based experimentation to identify the most promising interventions (Carroll and Samek, 2018).

The remainder of the paper is structured as follows: We first embed our work in the present state of the literature regarding behavioural insights-based nudges targeting increases in F&V demand. We go on to present the methods and results of the empirical study and then discuss these results against the backdrop of the needed transformation of the food system. We conclude by evaluating the potential of retail as a key transformative actor and its innovation possibilities for a more sustainable and healthy food system, and we look to the future by sketching policy implications and research directions.

2. Theory and Literature

Many behavioural interventions and nudges are theoretically grounded in dual-process theories of reasoning, where behaviour results from the interplay of contextual features with automatic cognitive processes and algorithmic and reflective thinking (Evans and Frankish, 2012; Kahneman, 2013; Stanovich and West, 2000). These theories emerged to address the limitations of previously developed rationality-based theories of human behaviour that still

dominate approaches to behaviour change in economics and consumer research. The overarching structure of dual-process theories posits two qualitatively different types of cognitive processes involved in decision-making – type 1 processes and type 2 processes. The former are characterised as highly contextualised, autonomous, and relatively undemanding of cognitive capacity, and the latter as analytic, controlled, and aspiring to norms of rationality (Stanovich and West, 2000). The more advanced models in dual-process theories (adopted as the theoretical framework in our experiment) further partition type 2 processes into algorithmic and reflective thinking. In a nutshell, the former sustains working memory and executes specific reasoning procedures, and the latter selects which procedures to reason on (Stanovich, 2011).

Type 1 processes such as habits and affective responses dominate common shopping situations (Houlihan, 2018); they heavily mediate (in)attention and response to stimuli; and they supply algorithmic and reflective thinking with input. Type 1 processes are often targeted through physical alterations of the choice architecture or colourful labelling. However, the roles played by algorithmic and reflective thinking should not be ignored. For instance, consumers reflectively select a recipe to shop for and subsequently relieve the cognitive effort involved by following a written list or cognitively simulating the steps involved in making the dish to remember the ingredients.

Against this theoretical background, a large body of literature on the effects of behavioural interventions and nudges on consumer food choices has been generated and today provides a rich source of practical guidance when designing novel interventions targeting individual food choices (Hollands et al., 2019). The majority of past studies focused on promoting healthier food choices (Bauer and Reisch, 2019), with environmental sustainability becoming an increasingly important topic in recent years (Lehner et al., 2016). Today, health

and sustainability are usually combined in the concept of “planetary healthy diets” needed for the Great Food Transformation (BIT, 2020; Willett et al., 2019).

Interested primarily in health choices, Gittelsohn et al. (2012) reviewed interventions in small food stores and concluded that shelf labels and posters are frequently used interventions for point-of-purchase promotions of healthy foods. The evidence from supermarkets and grocery stores was summarized by Escaron et al. (2013), who reviewed 33 interventions that aimed to promote healthy food choices. The interventions were often multi-layered and included or combined in-store informational campaigns, price reductions, increased availability, and shelf labelling. While some studies showed positive results, the overall evidence was deemed insufficient due to the large heterogeneity in the literature. A more recent review of 50 studies promoting healthier food choices in supermarkets was also unable to identify a clear, robust intervention pattern, yet the authors highlighted the positive evidence regarding the effects of shelf labels on sales (Cameron et al., 2016).

Different types of nudges and choice-architecture interventions have been tested in in-store experiments to assess their effect on the selection of specific products. For instance, priming overweight consumers by handing them a recipe flyer improved the healthiness of their grocery shopping (Papies et al., 2014). Payne et al. (2015) used placards in grocery carts that displayed social-norm messages to increase purchases of produce. While both approaches showed positive effects, another study increasing the salience and convenience of whole-grain bread by providing a better position did not improve sales in two grocery stores (de Wijk et al., 2016). Similarly, in a supermarket study testing the impact of prominent shelf placement on purchases of healthier cereals, Young et al. (2020) found no sales increases of the target products. A recent systematic review of nudges (Harbers et al., 2020), classified according to interventions in proximal physical micro-environments typology (TIPPME) (Hollands et al., 2017), to promote healthy purchases in real-life stores found that information and position

nudges tend to have beneficial effects on intended outcomes, while other types of TIPPME nudges proved to be less impactful.

A growing body of evidence is accumulating from recent studies trying to nudge consumers explicitly towards more environmentally sustainable choices. Vandenbroele et al. (2020) reviewed the emerging literature on sustainable food nudges and categorized them according to their cognitive, affective, and behavioural mechanisms. The review highlighted the potential of nudging to foster more environmentally friendly purchases but concluded that not all interventions were effective, and individual attitudes towards sustainability should not be overlooked. Ferrari et al. (2019) similarly concluded that nudging is a promising tool to supplement hard food policies (such as taxes and laws) for a sustainable food system but will not have the power for sufficient change as a stand-alone tool.

Fewer studies explicitly conducted in-store experiments to nudge supermarket customers towards more sustainable food choices. For instance, combining in-store digital technology with message framing for organic and local products, Jäger and Weber (2020) found mixed results since only a specific combination of nudge treatments improved sales. In another supermarket study, increasing visibility and pairing meat substitutes with their meat counterparts both independently led to a higher uptake (Vandenbroele et al., 2021). Even simply increasing the display area of poultry compared to pork and beef (the latter typically being more carbon-intensive) reduced the carbon footprint of meat purchase in another trial (Coucke et al., 2019).

Despite these promising findings, further research is needed to find cost-effective ways to shift consumption patterns. This need is echoed by the retail sector in claims that despite much consumer talk about sustainability and retail efforts to promote signage in stores, increases in sales of target products are only marginal (Lehner, 2015).

3. The Present Study

The current behavioural-insights literature suggests in different ways that separate and distinct nudges can target a wide variety of the cognitive processes described by dual-process theories (Augenstein et al., 2019; Hansen and Jespersen, 2013; Hansen and Schmidt, 2017; Vlaev, 2016). In the present study, we aimed to develop a multi-layered intervention that encourages customers to buy more fruits and vegetables by addressing customers' potential behavioural barriers of doing so. Also, we only wanted to test interventions compatible with the business interests of the shop owners. Finally, to maximise the chances of success, each of the intervention layers should target one of the three levels of the advanced dual-process theoretical framework as sketched above, namely *salience increase* to capture attention (type 1 processes), *social-norm messaging* to add social comparison and possibly pressure to opt for buying vegetables (type 2 processes, reflective thinking), and *simplification* to relieve cognitive efforts (type 2 processes, algorithmic thinking), which are described below in more detail.

3.1 Mechanisms and nudges

3.1.1 Increasing salience

Attention allocation has been shown to play an active role in the construction of preferences (Armel et al., 2008; Krajbich et al., 2010; Milosavljevic et al., 2012; Shimojo et al., 2003). Particularly under rapid decision making and cognitive load – which arguably characterizes many everyday dietary decisions – participants seem to be more likely to choose the option they had attended to the most (Milosavljevic et al., 2012). Hence, ensuring the salience of a stimulus is crucial for the effectiveness of an intervention, particularly since in the supermarket environment an overwhelming number of products compete for customers' attention. Salience generally refers to any object, attribute, or information that stands out and draws attention relative to its surroundings (Itti et al., 1998). For instance, an object becomes more visually

salient if it contains contrasting features by means of, for example, colour, intensity, or orientation relative to its surrounding visual scene (Itti et al., 1998).

3.1.2 Social-norm messaging

Social norms refer to a set of social expectations concerning appropriate behaviours in a given context. Communicating these norms in the moment of decision-making – by using signs or verbal prompts as a tool for behavioural change – has been tested in a variety of sustainability domains including energy conservation (Schultz et al., 2018), towel reusage (Goldstein et al., 2008), and household recycling (Cialdini, 2003). Such social-norm messages can be categorized as *descriptive*, conveying what most people do in a specific context, or as *injunctive*, where the intervention communicates what most people would consider the appropriate behaviour (Cialdini et al., 1991).

Meta-analyses suggest (Higgs, 2015; Robinson et al., 2014) that descriptive norms are effective in changing dietary behaviours in various contexts. Payne et al. (2015) found initial support for the effectiveness of social norms in promoting fruit and vegetable purchases in a supermarket setting. However, there is also the risk of unintended boomerang effects when using descriptive social norms in supermarket settings (Richter et al., 2018).

Some studies find no effect of social-norm framing on meat consumption (Amiot et al., 2018; Stea and Pickering, 2019). Sparkman and Walton (2017) suggest that integrating dynamic social norms into messages (i.e., "in the last five years, 30% of Americans have made an effort to reduce their meat consumption") could improve the choice of a meatless lunch in a restaurant context.

3.1.3 Simplification

One of the core principles proposed by nudging proponents is to reduce effort, remove the "hassle factor", and "make it easy" to carry out the preferred behaviour (Sunstein, 2014). Subtle

and seemingly irrelevant properties of a decision that slightly increase mental or physical difficulty have been shown to deter behaviour.

In this experiment, we aimed to primarily reduce cognitive effort – a widely debated topic in psychology and decision-making with cognitive capacity being limited and proposed as a depletable resource (Johnson, 2008). People under a high cognitive load are more likely to choose simple and relatively easy options that do not require much mental effort. Vegetables are often purchased as part of a meal or ingredient for a specific dish. If people do not immediately have an idea in mind of what to do with a vegetable, they might not buy it. This could pose a barrier to change from routine shopping behaviour and undermine our efforts to increase the uptake of vegetables. Hence, the third intervention component entailed the provision of several recipes for selected vegetables. We did not provide detailed ingredient lists but merely showcased ideas that served as a reminder that, for example, one could buy this broccoli and make a quiche with it (type 2 processes, algorithmic thinking).

Based on these theoretical considerations, we designed a multi-layered intervention, increasing the salience, leveraging descriptive social norms, and reducing cognitive effort to increase the sales of fruit and vegetables.

3.2 Study design

The empirical test for our choice-architecture innovation was composed of a field experiment conducted in two stores that are part of the same supermarket chain and located within 19 kilometres of each other in two neighbouring cities in Denmark. We implemented the intervention in one store and used sales in the other store as a control. The operationalization of the theoretical constructs resulted in the development of several different intervention components. Two distinct linguistic elements made up the descriptive-norm message. The central element was a sign placed in all shopping carts and baskets saying that “most people

choose fruit and vegetables". Based on the research findings of Goldstein et al. (2008), the second linguistic element specified a proximal social group to whom the social norm applied. Therefore, our message started with "In [our store] we are proud that…" (see Figure 1, left).

To increase salience, the signs used bright colours and were hard to overlook for customers using a shopping cart or basket. Cognitive effort was reduced for customers who did not come with a clear shopping list and needed inspiration. We specifically highlighted five different vegetables, namely tomatoes, cucumbers, peppers, carrots, and broccoli, in each of three recipe ideas that were presented in the bottom of the shopping cart (see Figure 1, right, and Figure 2, left). To remind customers during their shopping trip about our intervention, we added signs prompting the same recipe ideas at the locations of the target vegetables in the supermarket.

Data from the cash registers were collected for both stores beginning on the 24th of March 2017 and ending on the 31st of July 2017. In the treatment store, the intervention was implemented on the 31st of May and remained in place until the data collection ended. During this intervention period, one full-time employee was responsible for maintaining the material in the treatment store.

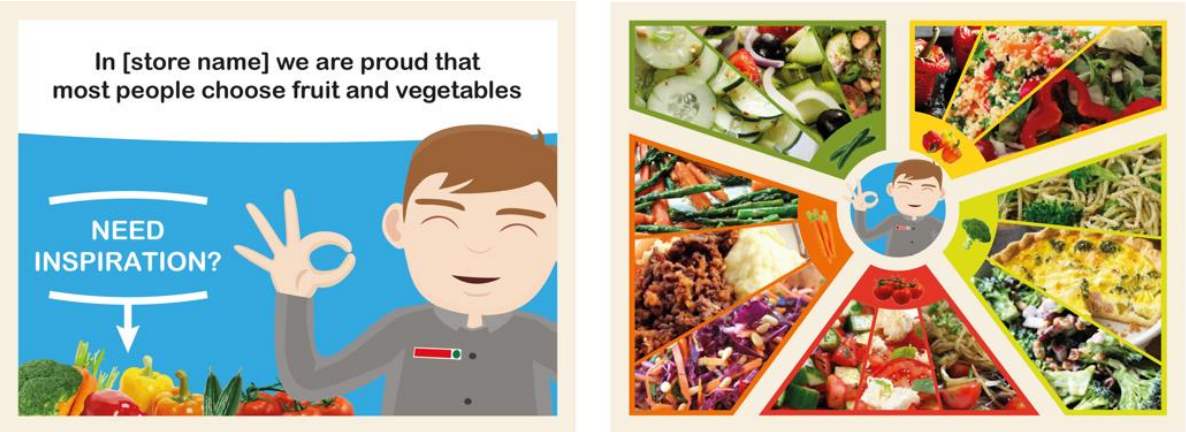

Figure 1. Design of posters

Figure 2. In-store application

3.3 Analytical strategy

A difference-in-difference (DID) approach was employed to estimate the average treatment effect of our intervention. A frequently used method to evaluate field experiments with non-random assignment, the DID approach is particularly compatible with our design comparing two groups (treatment and control) and two time periods (baseline and intervention period) (Lechner, 2010; Shadish et al., 2002).

We mainly rely on Ordinary Least Squares (OLS) regression to estimate the parameter of interest. The regression included two dummy variables: Store (1 = Treatment store, 0 = Control store) and Time (0 = baseline, 1 = intervention period) and their interaction (treatment effect). We control for day of week and time of day fixed effects. A dummy variable was added to capture differences in shopping behaviour during the Easter holiday. To account for the interdependence of the error among customers shopping on the same day in the same store, we cluster the standard errors on the day-store level. While the general analytical strategy was defined prior to data collection, the choice of outcome variables, controls, and how to calculate the standard errors were decided after accessing the data.

3.4 Results

The final sample size was N = 246,940 purchases. As displayed in Table 1, sales of fruits and vegetables differed between control and treatment stores in the baseline period. The treatment

store had a lower number of customers but a higher absolute number of average sales of F&V. Importantly, however, the share of fruit and vegetable sales of total sales was virtually identical: During the baseline period, customers in treatment and control stores both allotted about 7% of their purchases to fruit and vegetables. For both stores, the overall number of customers and sales increased during the intervention period, an observation potentially linked to the fact that the time period included the start of the summer in a location that is a popular holiday destination. The average total sales per customer increased in the control store from 106 to 138 DKK, and from 149 to 169 DKK in the treatment store (see Table 1). Overall, we observe a high level of variability in the supermarket sales data.

Table 1. Descriptive statistics

	Baseline period		Intervention period	
	Control	Treatment	Control	Treatment
Number of customers per day (mean)	856.36	805.26	1253.58	1405.65
	(269.72)	(407.07)	(282.93)	(451.03)
Sales total (mean)	105.99	149.01	138.45	168.63
	(162.69)	(168.82)	(207.18)	(243.50)
Sales F&V (mean)	6.24	11.04	10.57	16.32
	(17.82)	(26.15)	(27.08)	(36.21)
Sales F&V share of total	0.07	0.07	0.09	0.10
	(0.19)	(0.17)	(0.22)	(0.20)
Days of observation	68	68	62	62
Total number of customers	53,225	45,489	73,121	75,105

Note: Standard deviations in parentheses.

To estimate the effect of our intervention, we provide different outcome measurements. The intervention generally encourages customers to buy more fruit and vegetables and offers specific recipe ideas for five selected vegetables. Therefore, Table 2 presents the results on an aggregate level. For all F&Vs, we estimate that the intervention significantly increased total spending. Based on the interaction term between treatment store and intervention period, we find that customers spent on average 1.43 DKK more on F&V relative to the control condition

(Table 2, column 1). Also, the number of customers who purchased at least one F&V item increased by 3% (column 2), while the relative share of spending on F&V compared to total spending was estimated to increase by 1% (column 3). The results further suggest that overall sales were not significantly affected by the intervention. The point estimate, however, indicates an 11 DKK reduction per customer (column 4).

Table 2. Effect of choice-architecture intervention on fruit and vegetable sales

	(1) Spending on F&V	(2) At least one item of F&V (binary)	(3) Share of spending on F&V	(4) Total Spending
Treatment store (TS)	3.77***	0.05***	-0.00*	39.15***
	(0.32)	(0.01)	(0.00)	(2.99)
Intervention period (IP)	4.74***	0.05***	0.02***	36.09***
	(0.42)	(0.00)	(0.00)	(5.64)
TS*IP	1.43*	0.03***	0.01**	-11.32
	(0.61)	(0.01)	(0.00)	(6.46)
N	246,940	246,940	246,937	246,940

Notes: All estimates based on OLS. Additional controls include weekday and hour of day fixed effects. Standard errors clustered on the day-store level. * $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$.

The intervention targeted F&V in general but provided recipe recommendations for five vegetables, namely broccoli, peppers, carrots, cucumbers, and tomatoes. To test whether this element of the intervention was an important driver behind the overall effectiveness, we estimate the effect of our interventions on the sales of these five items. The results, presented in Table 3, offer mixed findings. We observe mostly positive results for the increase in spending; however, they are small and not statistically significant.

We also tested the probability that customers select at least one item of our target five. The estimates suggest small significant increases in the proportion of people selecting a pepper and a carrot, translating into a 1% increase in the probability to take at least one of the five highly promoted items (Table 3, columns 2, 3, and 6).

Table 3. Effect of intervention on specific types of vegetables.

	(1) Broccoli	(2) Pepper	(3) Carrot	(4) Cucumber	(5) Tomato	(6) All five
	Spending on target item in DKK					
Treatment store (TS)	0.07***	0.17***	0.15***	0.12***	0.45***	0.96***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.08)
Intervention period (IP)	0.03**	0.08***	0.06***	0.12***	0.34***	0.63***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.04)	(0.07)
TS*IP	-0.02	0.02	0.02	0.02	0.07	0.12
	(0.01)	(0.03)	(0.03)	(0.03)	(0.06)	(0.11)
	At least one target item					
Treatment store	0.00***	0.01***	0.01***	0.02***	0.02***	0.04***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
Intervention period	-0.00	<0.01**	<0.01	0.01**	0.01***	0.01***
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
TS*IP	<0.01	0.01**	<0.01*	0.01	<0.01	0.01**
	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
N	246,940	246,940	246,940	246,940	246,940	246,940

Notes: All estimates based on OLS. Additional controls include weekday and hour of day fixed effects, and a dummy for the Easter holiday. Standard errors clustered on the day-store level. * $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$.

The analysis of our multi-layered intervention suggests a small but positive increase in sales for F&V. Highlighting five vegetables and providing recipe suggestions increased the share of people selecting at least one of the targeted items. The fact that the share of F&V on total sales also increased, while there was no significant increase in overall sales, is an indication that customers were not only adding more F&V to their purchase but might have substituted them for other products.

4. Discussion and Limitations

The empirical part of this paper reports on the results of a multi-layered choice-architecture experiment that aimed to increase the sales for fruit and vegetables in a retail setting. The data support the hypothesis that a multi-layered nudge intervention using social-norm messaging and prompting recipe ideas can affect F&V sales in Danish grocery stores. We are aware that

this experiment offers only a glimpse of the possibilities and is far from providing robust evidence; however, it adds to the growing literature focusing on behavioural measures promoting modal shifts in diets towards more climate-friendly foods (e.g. Reisch, 2021).

So, what can we learn from this choice-architecture field experiment? While field experiments are rarely suitable to derive sound theoretical conclusions, the insights gained from our study point to a specific direction for further research. Seen through the theoretical lens of dual-process theory, the experiment tested a multiple-layered intervention integrating behavioural insights working at each of the theory's three levels. Per our hypothesis, consumers' attentional type 1 processes were directed to the potential purchase of fruits and vegetables; type 2 reflective processes were targeted for influence by social-norm messages; and, finally, type 2 algorithmic thinking was presented with convenient schemata in terms of recipes. Still, the effects observed were miniscule. Needless to say, the lack of substantial effects does not undermine dual-process theory, nor the specific behavioural insights, as these are well documented in the broader literature mentioned above. Hence, the lesson must be found in the selection, combination and/or application of these insights.

Now, short of smuggling F&V into the bags of consumers, directing consumers' attentional type 1 processes to the potential purchase of fruits and vegetables seems like an essential ingredient in any viable application. Further, our clear impression is that the use of salience for this purpose proved effective in the experiment. Thus, any issues must arise in relation to the behavioural insights aimed at the reflective and algorithmic processes.

As for learnings regarding the algorithmic processes, we stipulate that these are unlikely the issue either by arguing that (1) *if* you usually do not spend much or anything on F&V but are persuaded to do as other people do and buy F&V, *then* being given inspiration should be somewhat helpful. Therefore, we assume that the issues might very well lie at the reflective level, i.e., the level where consumers decide to adopt or reject a purchasing decision made

salient and convenient. We speculate that the match between the behavioural problem faced by a consumer and the behavioural insight integrated to relieve the consumer of this problem is not optimal.

In particular, why should a social-norm message that others tend to buy F&V persuade you to buy F&V if you are already buying *some* F&V? That is, the social-norm message used was mainly tailored to consumers who do not intend to buy F&V as part of a task where others would intend this (shopping for dinner, rather than just buying toilet paper), but we don't know the relative size of this group of customers, which might even be non-existent.

For customers who are motivated or have the intention to adopt a healthier and more climate-friendly diet, it is reasonable to assume that making F&V more salient increases demand. These causal pathways might, however, be blocked at several different stages of a reflective thought process. Customers will not select a specific target product if they or relevant family members have strong preferences against it; or they might lack the required skills to prepare or use the product; or they might be approaching the task of shopping for food differently than is assumed by the choice architects.

Hence, the design of successful interventions needs to consider these important barriers and their distribution within the target population to either overcome or circumvent them. For example, using nudges based on type 1 processes and targeting more sustainable products that either require no preparation or are clear substitutes for commonly used products, e.g., plant-based meat replacements, are less likely to fail because customers do know how to use them. In line with these considerations, we only observed significant, though small, effects on individual vegetables that are snackable (e.g. carrots), which also questions the relevance of the provided recipe ideas for customer decision-making.

What these speculations point to is the often lamented lack of consideration and theory-building concerning "the diagnostic link" between the task conducted by the consumer and the

selection, integration, and application of behavioural insights or nudges chosen in the choice architectural practice (see Hansen and OECD, 2019). That is, whereas theory-oriented experiments usually aim at establishing the existence and influence of behavioural insights, our field experiment demonstrates a related message for future research: We require a better or more complete comprehension of the practical conditions under which a particular behavioural insight may be integrated into the choice architecture so as to successfully nudge consumers into making the targeted choices.

These challenges to identify effective interventions extend recent calls for a heterogeneity revolution in behavioural science (Bryan et al., 2021) and better theorizing that accounts for differences in individual characteristics and choice complexity (de Ridder et al., 2021). Progress in this area will be particularly relevant for designing sustainability-oriented supermarket interventions given that customers enter the choice environment with very different socio-economic backgrounds and motivations; and a supermarket presents a more complex set of potential behavioural barriers compared to restaurants and cafeterias (for example). In such contexts, more consumer research needs to be conducted to better understand these barriers.

Specifically, studies could investigate how the effectiveness of nudges relates to the breadth or magnitude of the target product or behaviour. A narrow target focus, e.g., a specific vegetable, might best be paired with a tailor-made intervention that addresses potential barriers unique to the target, whereas an intervention with a broader focus, e.g., vegetables in general, allows customers to select relevant products based on their lowest subjective barrier to change, such as taste preferences or preparation skills.

When assessing the results of our experiments, several limitations should be considered. Given that the intervention required physical alterations in the supermarket in-store design, it was not feasible to use randomization on the individual customer level. While the

treatment stores were assigned exogenously, we ultimately compared the sales of only two stores. The parallel trend assumption underlying the identification strategy of our treatments is vulnerable if any event uniquely affects the relevant sales of our treatment or control stores.

While there is an overall consensus that an increase of F&V consumption, ideally at the expense of meat (Chai et al., 2019; Lacour et al., 2018), has positive effects on the health and carbon footprint of our target population (Bruno et al., 2019; Willett et al., 2019), the claim that our specific interventions resulted in such benefits rests on a number of assumptions. For instance, eating more F&V has health benefits on its own (Angelino et al., 2019), but we would need a detailed account of the shift in caloric intake and carbon footprint to accurately quantify these benefits on the individual level and assess the total impact of our two interventions. We can say that none of the promoted F&V could be considered an exotic crop, but research has shown that the use of airfreight and heated greenhouses potentially compensates for the general carbon advantages of F&V ((González et al., 2011).

The total net impact will also depend on individual dietary substitution for high health-risk or high-carbon products. Particularly regarding the carbon footprint, red meat is a clear reduction target, and future research should identify the most effective alternatives based on their substitution effect but also considering the environmental impact of the promoted alternatives (Elzerman et al., 2021; Lemken et al., 2019; Michel et al., 2021; Smetana et al., 2015). The fact that customers, in our experiment, did not significantly increase their overall spending provides limited evidence that the target products are not just additional F&V purchases but are substituting for other items in response to our intervention.

Additionally, the analyses of our intervention measured supermarket sales only, which should, however, closely correlate with consumption. Still, some of the F&Vs might become food waste, which would reduce the potential benefits from our intervention. Springmann et al. (2018) note that F&V suffer disproportionally higher waste rates than meat. Hence, before

making concrete managerial suggestions for retail, the full environmental costs and benefits would need to be assessed via a solid life-cycle analysis, case-by-case.

As in most field studies, the present analyses would have greatly benefited from better data, including profit margins, carbon impact of specific items, and customer use of the products, which would shed further light on the exact costs and benefits of such sustainability interventions. Still, the results of our experiment add to the growing awareness in both literature and food policy that there is a currently underleveraged potential for grocery stores to contribute to a healthier and more sustainable food system. To do so, grocery stores need to proactively redirect their in-store choice architecture to foster sustainable products and alternatives. Given their unique position with considerable agency over in-store design and full access to sales data, these stores have the potential to make a large contribution to our collective understanding of consumption choices and our knowledge of how to shift the behaviour of customers to more sustainable consumption patterns.

As sustainability-conscious customers increasingly demand grocery stores that are more aligned with their values (Ehgartner, 2018), an innovative and interactive approach to sustainability-focused choice architecture could provide a competitive edge. A supermarket designed in a way that makes it easy to purchase products in line with individual sustainability goals might increase the shopping experience by reducing goal conflict (Förster et al., 2007) and choice overload; these reductions have been linked to higher choice satisfaction and less regret (Chernev et al., 2012). This transition could involve co-creative processes, so supermarkets become partners asking customers: “Help us to help you towards a more sustainable lifestyle.” Also, supermarkets worldwide are experimenting with SOIs to deliver on their enhanced Corporate Social Responsibility promises (Shaw and Shaw, 2019).

However, designing interventions that effectively shift dietary patterns is challenging. Yet it is ultimately needed to reach the ambitious climate goals. The literature linked to

behavioural food policy is in an early stage. More practical on-site field research and solid hands-on evidence of "what works where and when" are needed to identify interventions that predictably change consumer behaviour across different contexts. This is particularly true for evidence about long-term effects beyond a few weeks. This shortcoming can be explained in part by the challenging conditions researchers face in gaining access to supermarkets and conducting research with strong methodology, i.e., randomization (Carroll and Samek, 2018; Just and Byrne, 2020).

To make progress on environmental goals (and perhaps to benefit retailers' bottom line as well), food retailers could engage in closer collaboration with academic and public health researchers to develop effective practical solutions based on better knowledge of individual factors such as personal preferences, socioeconomic barriers, and level of food skills (Thorndike, 2020). For example, the idea of recipe provision could be refined, and experiments could identify what elements or attributes of a suggested eco-friendly meal encourage consumers to purchase the required ingredients. As some people have already planned their meals at home (in advance of going to the store), these interventions need to reach customers before their shopping trip, potentially via a mobile app. With the increasing share of online supermarkets that already frequently use A/B testing, novel insight can easily be generated by retailers through measuring and reducing the GHG emissions of their customers. Retail could also spearhead the "nudge-for-good" agenda and help research establish a database with studies of food nudges that work, and food nudges that failed in practice. Following the mantra of behavioural policy, "test, learn, adapt, and share the results", such an open knowledge base could help disseminate the latest advances; compile and evaluate empirical evidence; guide research and practitioners; provide a forum for information exchange; and build a stock of cost-effective supermarket nudges for the common good. The Sustainable Development Goals

(SDG 17 in particular) call explicitly for partnerships between different stakeholders and for knowledge sharing for sustainable development.

In Denmark, where this study was conducted, the government recently announced that a climate labelling system on food products will be part of its ambition to become carbon-neutral by 2050 (Foodtank, n.d.). The Danish supermarket group Coop recently introduced a service for customers to track the climate impact of their purchases (State of Green, n.d.). Beyond providing helpful guidance for consumers, such innovations might be used to evaluate novel in-store choice-architecture interventions and help create more impactful supermarket displays that support sustainable choices.

5. Conclusion

The push for healthy and sustainable food systems that facilitate appropriate food choices by individuals is gaining momentum in practice and in the marketplace. As the single strongest lever to optimize both human health and environmental sustainability, the food choices we make matter in multiple ways – for our bodies, the environment, and the economic and social fabric of societies. Actively harnessing co-benefits of "win-win diets" is a major focus of current food, farm, environmental, and health policies that aim to positively influence consumer behaviour. A behavioural turn in food policy that puts individuals and their choices at centre stage holds promise for manifesting the vision of healthy and sustainable food systems. We argue in this paper that retail and supermarkets are particularly well-positioned to help shape more sustainable food purchases (and ideally other behaviours that we do not measure here).

Contributing to the empirical evidence on the effectiveness of behaviourally informed behaviour-change instruments, we tested an in-store nudge-intervention designed to increase healthy and sustainable demand, with promising if small positive results. This was only

possible due to the openness, efforts, and active engagement of our test supermarkets. More research and practical testing of this type is needed, and we suggest increased use of innovative nudge techniques and choice architecture to boost people's fruit and vegetable demand and decrease high-impact purchases, ideally in a close and trusting partnership among retail, research, and third parties such as nudge experts and consumer organizations. This suggestion echoes recent calls for supermarkets to play a more proactive role in the fight against unhealthy diets (Thorndike, 2020; Trafford and de la Hunty, 2021). Fostering local F&V sales could yield double dividends towards public climate and individual health goals.

The European food system is at a structural turning point, facing new demands and challenges stemming from climate change, environmental degradation, animal rights movements, and food-borne health issues such as obesity. Climate scientists see "peak meat" as the next big social, environmental, and economic challenge and are calling for climate political action to reduce livestock (Harwatt et al., 2020). In keeping with the widely accepted principle of 'common but differentiated responsibility' within the food system, supermarkets – as powerful intermediaries between supply and demand – seem to have a particular agency, market power, and also economic interest in spearheading dietary shifts towards health and sustainability (Shaw and Shaw, 2019). The present paper highlights some potential pathways and calls for a systematic collaboration between research and retail to advance the needed transitions for the benefit of all actors.

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