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What factors influence the choice between fish and meat among grocery shoppers? Insights from an unsuccessful nudge intervention.

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Abstract

Food production is the human activity with the greatest impact on the earth systems and account for about a quarter of all greenhouse gas emissions. Reducing consumption of certain meat (e.g., beef, pork and lamb) and replacing it with proteins with less environmental impact has been highlighted as one of the greatest leverage points to achieve a more sustainable food system. In this study we evaluate a nudge intervention at a medium sized grocery store designed to reduce purchases of meat in favour of fish with a lower environmental impact. We also measure other relevant internal and external factors influencing this choice, such as values, attitudes, habits, demographics and price. To explore how the nudge influenced shopping decisions we designed a natural field experiment in the store and measured the effect by collecting data on sales of fish (85 215 items sold over 143 days). To further evaluate the nudge and to explore how the other factors influence the choice of protein we collected data from a selected sample of customers (N=200). The results failed to show evidence for the effectiveness of the nudge intervention, instead we found that values, habits, attitudes and price all significantly influenced this protein choice. Our results highlight the complexity of shopping decisions and how nudge interventions are not always easy to implement, adding important null-findings to the available literature. We discuss policy implications of these findings, possible improvements to the nudge and how interventions that aim to steer similar shopping decisions might need to account for habit breaking to be effective.

Keywords: Nudge intervention, protein choice, field experiment, intrinsic motivators, behaviour change.

1. Introduction

Food is essential for human survival, but our production of food goes far beyond fulfilling basic needs. Today, food is being produced to meet the various demands of an increasing population that is on a diet excessively rich in animal protein, saturated fat, and added sugar. This population has grown accustomed to large varieties of products coming from all over the world. These dietary choices do not only threaten human health but also biosphere integrity (Willet et al., 2019). Food production is currently the human activity with the greatest impact on the planetary boundaries, accounting for about 25% of global greenhouse gas emissions (IPCC, 2019), 70% of global freshwater use (Willet et al., 2019), and being a major driver of biodiversity loss (IPBES, 2019). Achieving a more sustainable food system requires improvements in food production, but also significant changes in global dietary habits (Willett et al., 2019).

When it comes to dietary change, replacing animal-based food products with plant-based alternatives would provide the greatest environmental benefits (Aleksandrowicz et al., 2016; Poore and Nemecek, 2018). But such a shift on a larger scale is easier said than done. Eating animals has throughout history been closely associated with status, power, and wealth. Our improved living standards over the last century, together with an increase in trade and specialization, making meat relatively cheap and easily available, have further consolidated the importance of meat and its role as a central food on most plates. There are strong norms around eating meat in many societies today: people prefer and often even expect, some type of meat with every meal. (Chiles and Fitzgerald, 2018; Graça, 2016).

Norms and routines are hard to change, which has shown to be especially true for those around meat consumption. Studies from several countries show that people's willingness to substitute meat with other sources of protein is strikingly low (see e.g., Hartmann and Siegrist, 2017; Hoek et al., 2011; Hoek et al., 2013). This resistance was showcased after the launch of the Lancet's report, "Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems". A conclusion from this report was that a greatly reduced meat and dairy consumption would improve both human health and environmental outcomes (Willet et al., 2019). In the months following the publication, the number of tweets attacking its findings grew exponentially, reaching over 26 million people on Twitter (Garcia et al., 2019).

People tend to dislike changes because they are often associated with uncertainties which we are inherently averse towards (Samuelson and Zeckhauser, 1988). Theories from behavioural sciences predict that a change in status quo is likely to meet initial opposition, but also that a change can be followed by a gradual acceptance once the new situation feels more familiar (Alesina and Passarelli, 2019). In other words, these theories suggest that if a change or an intervention seems too drastic — one can rely on other more subtle interventions that would reduce the risk of initial backlash and not be exposed to the same resistance (Weber, 2015).

Following this logic, perhaps a path of less resistance could be an initial shift between different types of meats, for example, to shift consumption of meat with high environmental impact, such as red meat (i.e., beef, lamb and pork), towards a protein with less impact, such as seafood — a change that

could have significant environmental impacts on its own (Alexsandrowicz et al., 2016; Poore and Nemecek, 2018). In this study we will begin to explore the possibility of such a shift, in particular, we explore the possibility of changing consumer behaviour at the grocery store.

One seemingly promising way to encourage such a shift is through the use of ´nudges´. Nudges are interventions that build on behavioural insights and that are used to design choice situations in a way that will encourage certain behaviours over others (Thaler and Sunstein, 2008). Nudges have seen massive interest over the past decade from academia, policymakers, civil society and private sector actors and have been successfully applied in various domains e.g., to increase savings behaviour (Benartzi and Thaler, 2013), health behaviour (Ledderer et al., 2020), and various pro-environmental behaviours (Carlsson et al., 2020; Lehner et al., 2016; Lindahl and Stikvoort, 2015; Linder et al., 2018). It has become increasingly clear however, that the implementation of nudges is far from easy, and that the effectiveness of nudges critically depends on boundary conditions (Bruns et al., 2018; Carlsson et al., 2020; de Ridder et al., 2020). Recent research has highlighted the need to further evaluate nudge interventions in the field, after seeing how nudges that have proven successful in laboratory settings sometimes struggle to replicate in more natural environments (Loschelder et al., 2019). For example, Dubois and colleagues (2021) found that a nutrition label nudge had on average a 17 times smaller effect size in store settings compared to the corresponding laboratory setting. One might suspect that people respond differently to nudge interventions in the field where other factors come into play – factors that could have a stronger influence on choice and override the effect seen in the laboratory. And even though nudges were found to be widely applicable and overall effective tools for behaviour change in a recent meta-analysis, the analysis also found strong indications of publication bias in the literature (Mertens et al., 2022). This would mean that it is more likely that the results from successful interventions get published over unsuccessful ones, which could give the false impression that these tools are much more powerful than they actually are. When accounting for this potential publication bias the effect of nudges becomes much more difficult to assess (Maier et al. 2022). These mixed results highlight the need for further testing of nudges in different context, and the importance of publishing null-finding, to contrast the success stories.

In this study, we develop and test a nudge intervention designed to encourage the choice of fish over other types of meat (for simplicity we refer to the protein choice as between “fish” and “meat”, where meat then includes poultry, lamb, beef and pork in the rest of the paper) in the context of a grocery store. To our knowledge, this has not been studied before.

Another contribution from this study is that we explore other potentially important drivers and barriers to switching proteins, such as price, values, attitudes and habits. There is quite some literature investigating behavioural determinants of both seafood consumption (see e.g., Jonell et al., 2016; Richter and Klöckner, 2017; Govzman et al., 2020) and meat consumption (see e.g., Kemper 2020; Cheah et al., 2020; Stoll-Kleemann and Schmidt, 2016; Zur and Klöckner, 2014). However, conclusions from most of these studies have been based on survey results and self-reported dependent variables, only a few studies investigate actual behaviour (Hartmann and Siegrist, 2017). Thus, there is still relatively little knowledge on how much these determinants actually influence people's protein choices in the field, and how much they predict behaviour compared to other variables, such as a nudge intervention and price. To address this research-gap the study aims to add some clarity into what motivates consumers' protein choices in a natural setting — among isles of a grocery store.

The rest of this paper is organised as follows. We begin section 2 by introducing our nudge intervention and the motivation for our choice of nudge design. We then, in section 3, introduce a set of additional factors that could potentially influence the choice of protein (fish over meat) based on insights from previous research. In section 4 we present our expectations around how these factors will influence behaviour and also explain the design of our study and our data collection, including the experimental design. Results are presented in section 5 which is followed by a discussion and conclusion in section 6.

2. Designing the nudge

In the field of nudging the importance of the situation, the immediate decision-making environment, and how it influences peoples' behaviour is central. Situational factors set boundary conditions for behaviour and can be powerful barriers as well as facilitators for behaviour change (Rosenthal and Linder, 2020; Linder et al., 2021). For example, if there are no fish products available or product visibility is low, people will hardly buy fish, even if it is their intent. (Richter and Klöckner, 2017).

To be an active choice architect (or 'nudger') means to be deliberately engaged in the process of changing this context to influence people's decisions in a pre-determined direction (Thaler and Sunstein, 2008). In the context of a grocery store, this could mean making certain products more visible and attractive, e.g., by working with product placement, lightning, or informational prompts.

So, what could make fish the more attractive choice for the customers in a grocery store? To help answer this question we conducted a pilot study before designing our nudge. We interviewed customers in a store that was similar in size and had customers with similar demographics to our experimental store (see section 4.2 for more details). The purpose of the pilot study was to gain information on the most common barriers and potential gateways to an increased fish consumption (by a reduction of meat consumption) for the type of customers that would be exposed to the nudge. The results of the pilot study indicated that an important facilitator for choosing fish over meat is health concerns, where fish is being conceived as the healthier alternative. Furthermore, the pilot study showed that a common barrier is a lack of cooking skills and recipe repertoire for preparing fish dishes that will appeal to the whole family, especially for families with kids. (More details on the pilot study can be found in the supplementary material.)

With this information, and adhering to the limitations set by the collaborating store (e.g., that we were not allowed to be 'too intrusive', not change the actual outline of the store, and had to design a nudge that would fit the current layout) we decided to use visual prompts i.e., information encouraging or reminding people of a specific behaviour, strategically placed at the point of the decision (McKenzie-Mohr and Schultz, 2014), highlighting the health benefits from eating fish. We also provided fish recipes targeted at families with kids. The signs and recipes were put up in the areas where both fresh meat and fish were displayed, as well as by the frozen food counters. See Figures 1 and 2.

Figure 1: *Nudge intervention at the fresh fish counter. The readable text of the picture to the left and the picture in the middle reads 'Frisk med fisk!' which translates to 'Healthy with fish!'. The picture to the right is a sign with a recipe, the readable text says 'Ugnsbakad torsk med pesto och tomat', which translates to 'Oven-baked cod with pesto and tomato'*

Figure 2: *Nudge intervention at the frozen fish counter. The pictures show signs with recipes. The readable text in the middle picture says 'Ugnsbakad lax med soja och ingefära' which translates to 'Oven-baked salmon with soya and ginger'.*

Both these tools involve disclosing information. Information disclosure as a nudge means giving people just the right piece of information at the right time that may make them more likely to carry out one behaviour rather than another. Information disclosure can be a powerful nudge due to specific psychological mechanisms, for instance via a 'self-concept' – the knowledge we have of ourselves (Kenrick et al., 2005). Our behaviour is often guided by how we think of ourselves, and what behaviour we think fits that 'self '. We, humans, often identify our own selves with various groups – for instance

student, friend, or parent – but these roles do not all at the same time guide our behaviour. The social identity approach, first developed by Turner and colleagues (Turner and Reynolds, 2012), suggests that whichever identity is 'active' at a particular time – the so-called salient identity – influences which set of behaviour that is actively guiding a person (Haslam et al., 2010). With that in mind, here is how our informational prompt may work: It may trigger the accessibility of thoughts in the consumers' minds; cues that can activate certain roles (Richetin et al., 2016). It can highlight the notion that a customer is a responsible person who looks after his or her health and the health of his or her family. Furthermore, prompts can make shoppers aware of alternatives they did not consider before or simply be serving as reminders of behaviours people previously thought they ought to be doing, i.e., the prompts could remind grocery shoppers of their intentions to increase fish consumption (or reduce meat consumption), at the point of decision.

3. Influences of choice between seafood and meat in a store environment

Of course, it is not only the immediate store environment that influences consumer decisions. In this section, we introduce other potential influencing factors that may have an effect on the protein choice that we have identified in the literature. Whereas some of these factors are external to the individual such as price, others are internal such as attitudes and values. We also explore the role of automatic decision-making and habits, and list some demographical factors that could influence the choice of protein.

But before we zoom in on some of these factors that may guide the choice between fish and meat, we need address the role of diets. For a person on a vegan, vegetarian or pescetarian diet there is no choice between fish or meat. A person on a vegan or a vegetarian diet will choose neither of them, and a pescetarian will not choose meat, regardless of other factors. Of course, these are not the people we are trying to nudge. Therefore, to fit the scope of our study we are interested in people that could (at least in theory) be nudged to choose fish over meat. Thus, we focus our study solely on people on diets that allow for eating meat, to a varying degree, and that could be influenced by other factors when choosing between fish or meat (including the nudge).

3.1 Price

In a traditional economic model, the choice of a food product would reflect a maximization procedure where the chosen basket of food products maximizes the consumer's utility given a certain budget constraint. Such a rational decision procedure means that price will be an important determinant. In many countries, fish has been perceived as a relatively expensive protein source, and consumers indicate that the price level affects their intention to buy fish negatively (Olsen 2004; Vanhonacker et al., 2010; Govzman et al., 2020). But do these stated preferences match their revealed preferences? We hypothesize that consumers are price-sensitive when it comes to fish consumption and consequently that high prices of fish can act as a barrier for switching from meat to fish.

3.2 Habits

Another potential barrier to a behaviour change is habits. Habitual behaviour is particularly prone to develop for actions we repeatedly do in familiar context (Verplanken and Aarts, 2011) —such as the weekly trip to the nearby grocery store. The store is a quiet unique context, but an environment many of us spend a considerable portion of our time in. Buying our day-to-day food is often done in the same store, with the same route to navigate around shelves, with the likelihood of the same range of products ending up in the basket. Because decisions in grocery stores are regularly repeated in similar context the purchases often become highly automatic (Kalnikaité et al., 2013; Wood and Neal, 2009).

Moreover, research has shown that consumers often feel overwhelmed in information-rich environments, like a store, and tend to make purchase decisions in less than a second and use simple rules of thumb, like relying on former choices or habits (Kalnikaité et al., 2013; Wood and Neal, 2009). Previous studies have shown that seafood consumption is indeed mainly determined by traditions and habits (Honkanen et al., 2005; Verbeke and Vackier, 2005). In an effort to measure and control for the automatic aspect of protein choices in stores we measured the habit strength of meat and fish purchases amongst our participants. We hypothesize that habits could be a strong factor for determining protein choice, and thereby serve as a potential barrier for switching from meat to fish.

3.3 Attitudes and values

Within psychology, there are well-established models used to predict behaviour in general, and pro-environmental behaviour in particular, such as Theory of Planned Behaviour (TPB) (Ajzen, 1991), Norm Activation Theory (NAT) (Schwartz, 1977), and Value-Belief-Norm Theory (VBNT) (Stern et al., 1999). The common denominator of these models is an emphasis on internal factors like intrinsic values, attitudes, and personal norms, and how they can explain intentions and behaviour. We depart from these different theories and together with insights from studies that have explicitly looked at seafood or meat consumption construct a list of potential internal factors that we argue can explain protein choice in the context of a store, focusing on choosing fish over meat.

First, we measure our participants' attitudes towards fish and meat. Attitudes can be defined as a tendency that is expressed by evaluating a particular entity e.g., a food product, with some degree of favour- disfavour, or satisfaction-dissatisfaction polarity (Eagly and Chaiken, 1993)[1]. Research shows that attitudes around food are formed around aspects such as taste, smell, convenience, and nutrition (Richter and Klöckner 2017; Olsen, 2004; Olsen et al., 2007). Fish is for example often regarded to be inconvenient because of the need to invest time and effort in preparation, which has been suggested to negatively influence attitudes towards fish and can be an important barrier towards seafood consumption, especially for certain segments and age groups of consumers (Olsen 2004; Olsen et al., 2007; Verbeke and Vackier, 2005; Govzman et al., 2020). Nutritional aspects and health concerns are additional important factors in explaining attitudes towards different sources of protein, where seafood is often considered a healthier choice compared to meat. (Olsen 2004; Verbeke and Vackier, 2005; Govzman et al., 2020). We measure and control for attitudes towards both fish and meat. We hypothesize that a higher score on attitudes for fish relative to meat will favour choosing fish over meat.

The literature also emphasizes values as a fundamental driver of behaviour. An individual's values function as general guidelines for how thoughts and actions are formed and evaluated. Research on pro-environmental behaviour has highlighted how different values can be important for explaining environmental behaviour, often focusing on four types of values; biosphere values (concern for environment), altruistic values (concern for others), egoistic values (concern for personal resources) and hedonic values (concern for pleasure and comfort) (Bouman et al., 2018). Although individuals often share all these values, they differ in the way they prioritize between them. For example, research has found that a stronger prioritization of biosphere values leads to a higher likelihood of pro-environmental behaviours while strong egoistic and hedonic values can serve as a barrier to pro-environmental actions (see e.g., Karp 1996; Bouman et al., 2018). As reducing meat consumption has been increasingly highlighted as a powerful leverage point for sustainability (Willet et al., 2019) pro-

[1] It can be useful to reflect upon the similarity that exists between the concept of attitude and the utility concept in economics. Both these concepts represent some type of "summary evaluation" of an object where the summary evaluation depends on certain characteristics associated with the object (Antonides, 1989), in our case animal protein.

environmental values could serve as an important predictor for this protein choice. Furthermore, altruistic values have been shown to increase the beliefs that vegetarianism is not only beneficial to the environment, but also to farm animals, health, and a way to reduce world hunger (Kalof et al., 1999; Stoll-Klemann and Schmidt, 2016). In this study, we measure and control for the four types of values mentioned above. We hypothesize that biosphere values and altruistic values will favour a choice of fish over meat, whereas egoistic and hedonic values will act as barriers for choosing fish over meat and favour meat choices. In section 4.3 we detail how we measure these internal variables.

3.4 Demographical factors

Consumers' choices have shown to also depend on characteristics like gender, age, education, income level, and family situation (see e.g., review by Albisu et al., 2012). For example, pro-environmental consumption has been associated with higher education (Panzone et al., 2016) and that women typically are more environmentally friendly (Bloodhart and Swim, 2020). When it comes to food consumption studies show that compliance with health recommendations is higher among women and increases with age. But studies also show that foods that are rejected by most family members are less likely to be served (Koivistro and Sjödén, 1996). The presence of children in a household has e.g., been showed to lower fish consumption. At the same time, other studies show that people with high moral obligations, and who are concerned with the health of their family members have on average a higher seafood consumption (Olsen, 2004). Furthermore, fish is often considered expensive, which may explain why people from lower income groups tend to eat less fish. (Verbeke and Vackier, 2005).

We measure and control for several demographical variables, i.e., age, gender, level of education, income, and family situation. But because of the ambiguity in previous findings, we found no solid basis for formulating hypotheses around how these demographic factors affect the specific choice of fish vs. meat. Instead, we will explore these relationships separately first, and subsequently, if any variables are found to be significant in our sample, we will control for them in our regression models.

4. Research design

In this section we first formulate a set of hypotheses that will guide our empirical analysis before we explain how the data collection worked. The hypotheses are based on the findings in the previous literature (see section 2 and 3). All in all, we test the following hypothesis:

H1: The nudge intervention will increase sales of fish and people will be more likely to choose fish over meat when exposed to the nudge intervention.

H2: Fish consumption is price-sensitive, meaning that the average sales of fish will be lower when the price is higher.

H3: A person with high biosphere values and/or altruistic values is more likely to choose fish over meat.

H4: A person with high egoistic and/or hedonic values is less likely to choose fish over meat.

H5: A person with more positive attitudes towards fish in relation to their attitude towards meat, is more likely to choose fish over meat.

H6: A person with stronger habits of purchasing fish in relation to their habits of buying meat, will be more likely to choose fish over meat.

4.2 Experimental design

We designed our nudge intervention and ran our experiment in collaboration with one of the largest grocery retailers in Sweden with stores located across the whole country; *ICA gruppen*. The experiment was executed in an ICA grocery store in Stockholm. Each ICA store is independently owned, and the stores differ in size — from small and medium to large supermarkets. The grocery store used for the experiment has a wide range of customers with differences in educational background and incomes. It is a medium-sized store, situated within walking distance from some residential areas, public transportation, and easy parking. Within the collaboration, we had to adhere to the limitations set by the store on what type of nudge we could use (as mentioned in section 2), but also how we could implement the nudge, e.g., what type of experimental design we could use, for how long of a time period we could keep the nudge, which in turn affected sample size.

The experiment ran between April 1st and June 30th in 2019. The nudge intervention was implemented from May 26, 2019 until the end date. To evaluate the effect of the nudge we used a Natural Field experiment (NFE), which is an experiment where decisions are observed in a natural environment and where the subjects are unaware of being part of the experiment (Harrison and L ist, 2004). In this effort, we collected data on purchases from the whole store for both fresh and frozen fish. In total, we collected sales data for 85 215 items sold over 143 days. We collected data for the whole experimental period and the same period the year before. This allows us to perform an analysis controlling for both treatment and potential time effects (often referred to as a Difference in Difference analysis (DiD)). A DiD analysis is used in quasi-experimental designs that look at longitudinal data to obtain an appropriate counterfactual to estimate a causal effect (Abadie, 2005). DiD is a quite common approach typically used to estimate the effect of an intervention by comparing the changes in outcomes over time between a population that is exposed to the intervention (the treatment group) and a population that is not (the control group) (see e.g., Card and Kruger, 1994, DiTella and Schargrodsky, 2004, and Galiani et al., 2005, for some applications of DiD analyses in economics). In our case, the control group constitutes of sales from the previous year. Besides controlling for treatment effects, and potential time trend (seasonal) effects, we can also control for potential price effects with this analysis.

In order to further evaluate the nudge, get measurements of demographic variables, and internal variables such as attitudes, values, and habits we also ran a more controlled field experiment with a selection of about 200 customers. This field experiment was designed as follows: We let about 200 people take part in the field experiment of which half participated in a control group (not exposed to the nudge, during the first half of the time period) and half in a treatment group (exposed to the nudge, during the second half of the time period). A convenience sample was used, and all participants were recruited in the store. During the time of the experiment, we aimed to maximize participant enrolment and recruited as many participants as we could, hence the sample size was decided by time (and our recruitment skills). We approached and asked customers if they would be willing to participate in our study as they entered the store. We gave potential participants instructions and a consent form to read. If they agreed to participate, they signed the consent form before commencing with their shopping. The instructions informed them that they were given a budget of ∼ EUR 25 and that with this budget they should buy groceries for a meal for 4 portions, which could be a lunch or a dinner (an english translation of the instructions (that were in Swedish) can be found in the supplementary material). The meal should consist of protein (meat, fish or vegetarian), carbohydrates (e.g., rice, pasta or potatoes), vegetables, and potentially complements. They then went on to do their grocery shopping. Once they had completed this task they returned to the experiment leader, who documented their food choices. The participants then filled in a survey after which they could collect a check of 250 SEK (∼ EUR 25) to be used to pay for the groceries they

choose. Participants with non-meat diets (e.g., vegetarian or vegan) were allowed to partake in the study, but later removed from the analysis.

4.3 Survey design

This survey consisted of several blocks of questions. One block included demographical questions, e.g., age, gender, education, income and family situation, and another block included general questions on their diet (i.e., if vegan, vegetarian, pescetarian, flexitarian or meat-eater). We also had blocks of questions asking about value orientations, attitudes, and habits. An English translation of the whole survey (which was in Swedish) can be found in the supplementary material.

To measure value orientations, we followed De Groot and Steg (2008) and Steg et al., (2014). We asked participants about their "guiding principles in their lives". They responded to each of 16 items on a 7-point point scale ranging from 1 (Not at all important) to 7 (Extremely important). With these 16 items, we measured the 4 different value orientations mentioned above: biosphere values, egoistic values, altruistic values, and hedonic values.

Attitudes towards seafood and meat were measured using statements on two separate 7-point Likert scales ranging from 1 (Completely disagree) to 7 (Completely agree). Following previous research investigating attitudes towards fish consumption (see e.g. Rortveit and Olsen, 2009, Olsen et al., 2007, Nystrand , 2015, Verbeke and Vackier 2005, and Richter and Klöckner, 2017) we constructed the statements on these scales based on the food choice questionnaire (Steptoe et al., 1995) widely used in food consumption research. We included statements like "fish/meat tastes good", "fish/meat is easy to cook", "fish/meat is convenient to prepare", "fish/meat is healthy", "fish/meat is relatively cheap".

Finally, we measured habit strength for meat and fish consumption, using a shortened version of the self-report index of habit strength scale (Verplanken and Orbell, 2003) following (Honkanen et al., 2005). Participants indicated their agreement on a 7-point scale ranging from 1 (Completely disagree) to 7 (Completely agree) that buying fish/meat is something "I do frequently," "I do without having to consciously remember," and "I feel weird if I don't do," and "I don't have to think about doing it."

In the analysis, we are interested in knowing if the participants in our study are more likely to choose fish over meat and what factors that are important for explaining such a choice. We hypothesize that having positive attitudes towards fish *relative* to the attitudes towards meat will favor choosing fish over meat. Likewise having stronger habits of buying fish relative to meat buying habits, will favor choosing fish over meat. To better capture these relational aspects of attitudes and habits we constructed leaning scales, i.e., scales that indicate to what extent the person leans towards having more positive attitudes towards fish over meat, and towards having stronger habits of buying fish over meat (or vice versa).

5. Results

We use STATA 16 for our statistical analyses. We will report on the different tests, regressions, and specifications we use when we report the results[2].

5.1 Descriptive statistics

In total, 200 participants took part in the more controlled field experiment. The mean age was 47 and 44% were female. Overall, about 26% of the participants choose to buy fish and 74% choose meat.

[2] Raw data from the experiment will be made available upon publication. Data from sales cannot be made publicly available.

Table 1 contains a descriptive summary of the differences between the two experimental conditions, the control- and nudge group, for all variables of interest.

Table 1: Descriptive statistics

	Control group		*Nudge group*	
	Mean	St. Dev	Mean	St. Dev
Demographical factors				
Age	47.74	15,57	46,28	17,43
Gender (female =1, male =0)	0,474	0,503	0,403	0,494
Size of household	2,831	1,250	2,528	1,162
Children in household (yes=1, no=0)	0,467	0,502	0,361	0,484
Household income (per household member)	65987	28592	68403	29537
Level of education (1=primary, 2 = secondary 3= higher education)	2,818	0,506	2,806	0,464
Experimental variable				
Protein choice (1= meat, 0= fish)	0,727	0,448	0,750	0,436
Internal motivators				
Biosphere values (min 1, max 7) , cronbachs alpha (0,803)	5,558	0,832	5,406	0,998
Egoistic values (min 1, max 7) cronbachs alpha (0,732)	3,317	0,767	3,294	0,822
Altruistic values (min 1, max 7) cronbachs alpha (0,737)	5,782	0,963	5,722	0,851
Hedonic values (min 1, max 7) cronbachs alpha (0,622)	5,208	0,877	5,296	0,939
Attitudes towards fish (min 1, max 7) cronbachs alpha (0,819)	5,304	1,703	5,204	0,882
Attitudes towards meat (min 1, max 7) cronbachs alpha (0,784)	4,560	1,030	4,707	1,031
Leaning attitudes (fish over meat) (min -2.11, max 3.44)	0,684	1,098	0,534	1,095
Habits				
Fish buying habit strength (min 1, max 7) cronbachs alpha (0,848)	4,140	1,703	4,132	1,465
Meat buying habit strength (min 1, max 7) cronbachs alpha (0,888)	4,146	1,666	4,663	1,662
Leaning habits (fish over meat) (min -5, max 6)	-0,065	2,319	-0,531	2,326

5.2 Demographical variables influence on protein choice.

We first want to see if there are any systematic variations in the demographic variables (listed in Table 1) with respect to the choice of protein. Because the majority of the continuous variables are not normally distributed (according to a Shapiro Wilk's test; Shapiro and Wilk, 1965, see supplementary material) we cannot perform a MANOVA. Instead, we tested for systematic differences between people choosing fish and people choosing meat in the experiment for each demographical variable separately. In particular, we then use a Wilcoxon rank-sum test (MWW; also known as Mann–Whitney two-sample statistic; Wilcoxon, 1945; Mann and Whitney, 1947). For the binary variables, we performed a non-parametric proportion test (Pearson's Chi-square test, Pearson 1900). According to these tests we could not detect any systematic differences. (For details, see supplementary material)

We also ran a logistic regression (McFadden, 1973) with protein choice as the dependent variable controlling for the demographical variables – also here we did not see any significant effect of any of the demographical variables (see supplementary material for more details). Because we cannot detect any systematic patterns in our sample for our demographical variables, we exclude them in our further analysis.

5.3 Hypothesis testing

To test our first hypothesis and explore if the nudge intervention increases sales of fish, we first look at the aggregated sales data and conduct our treatment analysis. With this analysis, we can also test our second hypothesis by controlling for price, hence testing if sales of fish are price sensitive. We use multiple linear regression models to obtain the average treatment effect (ATE). We test the regression models regarding the assumptions of normally distributed residuals and heteroscedasticity. To account for heteroscedasticity, we use robust standard errors (Efron 1982; Long and Ervin, 2000). We report exact p-values.

We obtain the average treatment effect by first comparing the difference in sales per day (in number of packages/items) for fish purchases in the store, before and after the nudge intervention 2019, and then comparing this difference with the difference in sales per day for the same two periods during the year prior. We do this for fresh fish sold over a counter, for fresh fish sold pre-packaged and for frozen fish. The data set covers sales of these different types of items for the period from the 1st of April to the 30th of June 2018, and for the same time period 2019. In total, we have observations of 85 215 items sold over 143 days. The nudge intervention was implemented on the 26th of May 2019. In the regression analysis, we exclude dates for Easter for both years as this is a holiday associated with above-normal fish consumption.

The results of the regressions (see Table 2), show no significant effect from the nudge intervention on sales of any of the three categories of fish (the ATE, the average treatment effect). This is also confirmed visually by looking at the graph showing plots of sales for the three categories for the two years, before and after the nudge intervention (illustrated by the red vertical line) (see Fig. 3). There is no clear sign of the nudge intervention having an effect. The regression analysis does show, however, that the overall price level of fish is significantly affecting sales of fresh fish, where an increase in price leads to a reduction in sales. Price is, however, not a significant predictor for sales of frozen fish in our sample.

Table 2. Analysis testing the effect on the nudge intervention on aggregate sales per day (# of packages per day).

	Frozen fish		*Fresh fish (packaged)*		*Fresh fish (over counter)*	
	Coeff. (Std. err.)	p-value	Coeff. (Std. err.)	p-value	Coeff. (Std. err.)	p-value
Constant	223.841** (76.197)	0.004	272.437** (37.005)	0.000	153.020** (17.781)	0.000
Nudge effect	-39.785** (9.370)	0.000	67.614** (15.335)	0.000	-7.008 (12.924)	0.589
Year effect	3.302 (10.408)	0.751	11.957 (11.414)	0.297	-34.870** (15.713)	0.005
ATE (average treatment effect)	9.569 (14.274)	0.504	-19.562 (22.758)	0.297	-6.503 (15.713)	0.680
Price per post	-2.001 (1.341)	0.138	-2.157*(0. 955)	0.026	-0.344* (0.164)	0.037
F (4,138)	7.69**	0.000	9.54**	0.000	12.41**	0.000
N	143		143		143	

Linear regression model, using robust standard errors. We denote a significance on a 1% level with **, and on a 5% level with *.

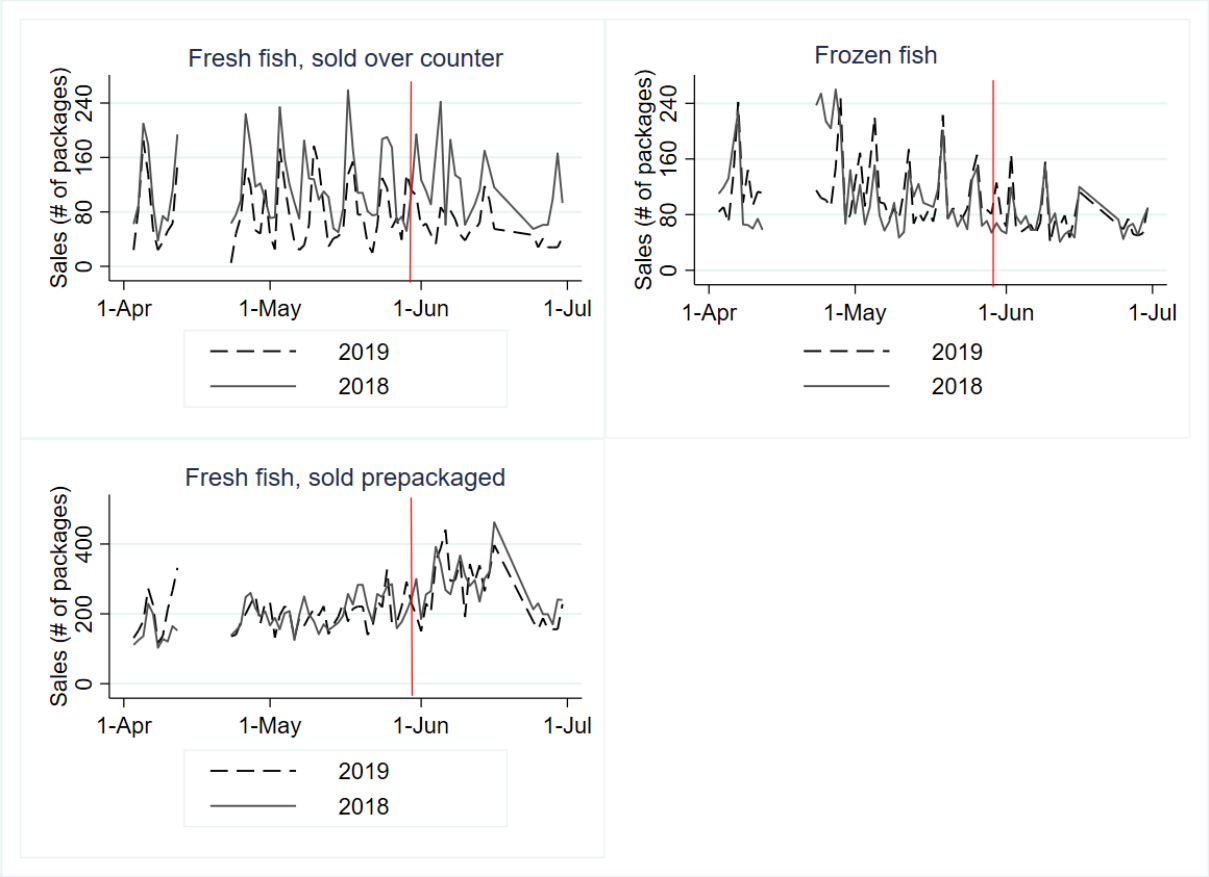

Figure 3. Aggregate sales of fish. Plot of sales of fish (number of packages/items per day) during the period for the year of the intervention (2019) and the year before (2018), before and after the nudge intervention. Easter excluded. The red vertical lines indicate the time of the intervention.

Thus, the analysis fails to support Hypothesis 1. It does however indicate that price can be a predictor of fish consumption, hence we cannot reject hypothesis 2.

To further explore the effect of the nudge intervention (hypothesis 1) and in particular relative to other variables represented in hypotheses 3 to 6 we proceed to our more controlled field experiment and survey data. First, we run two regressions to analyse to what extent the nudge and the internal variables (values, and attitudes) influence the protein choice. See REG 1, and REG 2 in Table 3. Because we are restricted to testing for 4 independent variables at a time given our sample size and the number of observations of each categorical choice[3] we run two regressions. It is of course not ideal to run several regressions, to account for this we use a Bonferroni correction (Dunn, 1961). We may also be concerned about multicollinearity between the internal motivators. However, the variance influence factor (below 2) and the tolerance values (above 0,6) of our VIF analysis (Midi et al., 2013) indicate that this is not an issue (see supplementary material for details). REG 1 shows that the nudge intervention does not have an effect on the protein choice, hence this result together with our previous result from aggregates sales leads us to reject hypothesis 1. The first regression also shows that people with higher biosphere values will be more likely to choose fish. It does not find support however, that altruistic values influence the choice of protein. Hence based on REG 1 we partly reject Hypothesis 3. REG 1 shows that people with more positive attitudes towards fish over meat will be more likely to choose fish in the experiment. Thus, based on this result, we cannot reject hypothesis 5.

[3] Adhering to the "one in ten rule". A rule of thumb for how many predictor parameters can be estimated from data when doing regression analysis. The rule states that one predictive variable can be studied for every ten events. For logistic regression the number of events is given by the size of the smallest of the outcome categories (Peduzzi et al., 1996).

In the second regression, REG 2 we proceed to test if hedonic or egoistic variables influence protein choice, while keeping significant predictors from REG 1. We do not find support that egoistic or hedonic values influence protein choice, hence we reject Hypothesis 4. Having biosphere values and positive attitudes towards fish over meat are still significant predictors (with a Bonferroni correction they are still significant on a 5% level, accounting for two tests).

Table 3: Exploring the role of internal motivators vs. a nudge.

	REG 1			*REG 2*			*REG 3*		
	Odds ratio (std. err)	95%, CI	P-value	Odds ratio (std. err)	95%, CI	P-value	Odds ratio (std. err)	95%, CI	P-value
Constant	0.008** (0.119)	0.000 - 0.145	0.001	0.004 ** (0.008)	0.000 - 0.133	0.002	0.016 ** (0.020)	0.001 - 0.183	0.001
Nudge	0.962 (0.388)	0.437 - 2.119	0.924						
Leaning attitudes fish over meat	1.556* (0.295)	1.073 - 2.256	0.020	1.623* (0.330)	1.089 - 2.418	0.017	1.112 (0.288)	0.670 - 1.846	0.681
Biosphere values	1.742* (0.423)	1.083 - 2.803	0.022	1.693* (0.375)	1.097 - 2.613	0.017	1.703* (0.372)	1.110 - 2.612	0.015
Altruistic values	1.064 (0.274)	0.642 - 1.763	0.809						
Hedonic values				1.234 (0.352)	0.706 - 2.158	0.461			
Egoistic values				0.995 (0.303)	0.548 - 1.809	0.988			
Leaning habits fish over meat							1.313* (0.170)	1.019 - 1.692	(0.035)
Wald chi2	15.75 **		0.003	14.69**		0.005	18.65**		0.000
N	147			147			147		

Binary logistic regressions, with a choice of fish over meat as dependent variable. Robust standard errors. We denote a significance on a 1% level with **, and on a 5% level with *.

Our sixth and final hypothesis is about the role of habits. We thus proceed to test if habits is a significant predictor for protein choice, while testing if positive attitudes towards fish over meat and biosphere values are still significant predictors (see REG 3, in Table 3). We cannot reject Hypothesis 6, habitual leaning towards buying fish over meat is a significant predictor of protein choice, as well as biosphere values (with a Bonferroni correction, accounting for three tests). In this model however, attitudes is no longer a significant predictor, which is most likely a result of a strong correlation between attitudes and habits (we elaborate on this in the discussion).

6. Discussing the results

In this study, we developed and explored the effectiveness of a nudge intervention designed to promote the choice of fish over meat amongst shoppers in a grocery store. We also measured and evaluated the impact of other relevant internal and external variables´ influence on the choice. We failed to find any statistical support for the effectiveness of our nudge intervention. Instead, we saw that other variables significantly affected the consumer's choices; price, biosphere values, habits and attitudes all predicted the choice between the two proteins in our experiments. We did not, however, find any support for our hypothesis that hedonic and egoistic values would increase the likelihood of choosing meat over fish. We will start by addressing potential reasons for the seeming failure of the

nudge intervention, and then briefly expand on the other null findings before addressing the significant results. We finish by discussing potential caveats and end with some policy implications.

6.1 An unsuccessful nudge

We used two different types of experiments and analyses to evaluate the nudge intervention — both the natural field experiment and the more controlled field experiment failed to find a statistically significant effect of the nudge. In both analyses, the nudge showed very small to non-existing effect sizes and no sign of approaching the significant level. These null results are not necessarily a surprising finding — similar results have been reported in several studies, nudges are not always easy to implement (Lindahl and Stikvoort, 2015, Carlsson et al., 2020; De Ridder et al., 2020), and psychological insights from the lab doesn't always translate to the field (Dubois et al., 2021). Of course, one should not typically draw strong conclusions from null findings. We still argue however, that taken together the results from the two experiments indicate that the nudge intervention was ineffective in promoting fish over meat choices in the context of our field experiment.

There are several potential reasons for the seeming failure of the nudge intervention in our experiment, we list three plausible explanations below and they do not necessarily need to be mutually exclusive. *1) Competing Information*: essentially, it is highly likely that the nudge intervention failed to draw enough attention to be effective, at least in an information-rich environment such as a grocery store. Other competing information, such as; campaigns, eco and fair trade labels, price tags, other shoppers' choices, etc. might have been better at grabbing attention and overriding the influence of the nudge. Hence, a much more salient nudge might be needed in these types of store environments to be effective. *2) Competing motivations: W*hereas the prompts highlighted health aspects, provided recipes to make it more convenient (avoid the mental struggle of figuring out what to make with the fish), and served as a reminder to purchase fish (for some). Other motivational factors might have been more prevalent for the choice of our consumers, such as budget constraints, type of protein, attitudes towards the proteins, etc. 3) *Habits and automated decision making:* Research showcased how people tend to use automatic processes and heuristics for shopping decision in grocery stores (Wood and Neal, 2009). This comes as no surprise considering our propensity to develop habits by performing reoccurring actions in stable contexts (Verplanken and Aarts, 2011) such as the weekly trip to our nearby grocery store (Kalnikaité et al., 2013). Habits have long been highlighted as a strong barrier to change (Verplanken and Wood, 2006), and the nudge might not have been strong enough to break these automatic processes. Even if participants had the intrinsic motivation and intentions to reduce meat purchases — a small reminder might not have been strong enough to break already establish purchasing patterns and habits.

6.2 Values influence on shopping decision

Although pro-environmental values could predict an increased fish consumption (and reduced meat consumption) — we did not see any significant relation between hedonic, altruistic and egoistic values and the choice between fish and meat. Since it is not obvious that this choice (between meat and fish) is mainly done in relation to environmental concerns we try to untangle these somewhat unintuitive findings below. As we highlighted in the introduction, reducing meat consumption has been pinpointed as a powerful leverage point for consumers to limit their environmental impacts, so it makes some sense that biospheric values could predict the choice of fish over meat. However, previous research has shown that altruistic values are a strong predictor for vegetarianism (Kalof et al., 1999; Stoll-Klemann and Schmidt, 2016) and egoistic and hedonic values have shown to serve as a barrier for pro-environmental actions (Karp 1996; Bouman et al., 2018) so it is somewhat surprising that we only found biospheric values to be a significant predictor in our sample. Of course, we need to keep in mind that a bigger sample size could have generated different results, and we should be a bit

careful to establish these null results considering our sample size wasn't decided by a proper power analysis. However, it is possible that these null findings stem from the fact that we excluded participants on a vegetarian diet from the data analysis (no participant reported being vegan). This was done since we were merely interested in the choice between fish and meat within the scope of this study. However, it is possible that altruistic values would be better at predicting the choice of being vegetarian — but less able to predict the specific choice between buying meat and fish in the store. Biospheric values, on the other hand, might still be effective in predicting the choice between meat and fish amongst the participants, especially considering that a relatively large sub sample of our participants defined themselves as "flexitarians" (about 43%). Furthermore, although egoistic and hedonic values have been shown to serve as a barrier to act environmentally, it is very possible that the choice between meat and fish is not conceived as a pro-environmental choice for many consumers (especially participants with relatively low biospheric values) and there may be other egoistic and hedonic reasons for the choice of either one of the two proteins. Again, egoistic and hedonic values might be a stronger predictor of choice of diet. To test this possible explanation, we ran an additional analysis (a logistic regression) looking at how value orientations predict being vegetarian vs. non-vegetarian (see supplementary material). We found that no significant effects, however. This is likely a result from the small sample size (only a few participants reported being vegetarian), we argue that this is something to explore in future research.

6.3 Attitudes and habits influence on protein choice

Both habits and attitudes were strong predictors of protein choice in our participants. This is replicating findings from many related studies (see e.g., Honkanen et al., 2005, Rortveit and Olsen 2009, and Nystrand, 2015). It is also clear in our data that these two variables co-vary (the Spearman's rank correlation coefficient equals 0,6399 which is significant on the 1 percent level, p=0.000, but still not sufficient to generate a VIF value higher than 'allowed'). That these variables are correlated then explains the result in REG 3 (when we included habits in the model attitudes was no longer a significant predictor). This is also not surprising, when we repeat decisions in a familiar environment it's no surprise that our habits align with our attitudes. This alignment could be explained both by traditional Attitude-behaviour models such as TPB, or VBNT i.e., how our intrinsic motivation leads to behaviours – and in extension habit formation. But it could also be explained by e.g., Self-perception theory (Bem, 1972), i.e., that we determine our attitudes by observing our own behaviour, as well as cognitive dissonance (Festinger, 1962) which shows how we use post-hoc justification of behaviour to reduce feelings of discomfort. Furthermore, recent research on the identity component in habits highlights how past behaviour can help shape how we perceive our self, e.g., repeating the decision to meat can lead one to conclude that "I am the type of person that like to buy and eat meat" (Gardner et al., 2012). It is clear from our study that both attitudes and habits influence this protein choice, but more research is needed to untangle the direction of the causal relationship between attitudes and habits, and the interlinkages between them.

6.5 Price as a barrier for fish consumption

In support of our Hypothesis 2 the analysis of the field experiment highlighted how fish consumption was sensitive to price changes. This was true both for the fresh fish that was sold over the counter as well as the pre-packaged fresh fish. We did not find a significant relation between frozen fish and price, however, this is most likely because the price fluctuation is much smaller in frozen fish, and the price stayed more or less the same throughout the experiment (see supplementary material).

That price influences shopping decision should come as no surprise and have been highlighted as a barrier for fish consumption in previous research (Olsen 2004; Vanhonacker et al., 2010). Our results

simply showcase that price should be accounted for in behavioural models and nudge design processes to more thoroughly understand and encourage consumer choices.

7 Caveats and Limitation

The field experiment that was used to evaluate the nudge intervention has some clear internal validity concerns. First of all, although we control for some of the more prevalent confounding variables, stores are inherently messy environments and there are always risks for unknown factors affecting the outcome (Harrison and List, 2004). Secondly, due to store restrictions, we had to recruit participants at the store (when they were about to do their shopping), meaning that the sample could be biased, and that we were unable to randomize the time order of the intervention (we could for example not do alternate days, or times during the same day) or randomly divide participants into different manipulation (the store with, and store without the nudge). The NFE we conducted partly accounts for these weaknesses because it allows us to estimate the causal effect of the intervention even if there is no way to randomly assign participants to control- and treatment groups. However, DiDs also have their own inherent weaknesses. The main limitation is the "parallel trends assumptions" (Bertrand et al., 2004) meaning that any change in trends (or lack of change) in the treatment group after the intervention is attributed to the intervention, it is of course impossible to control for all potential confounds and there is a possibility that a potential effect of the nudge is overridden by factors outside of our control, leading to a type two error. For example, even though we control for general seasonal trends by comparing the nudge intervention to the same time period the previous year, we don't control for specific weather events that only happened in one of the years. However, we argue that the methods are somewhat complementary, the field experiment has better control over confounds, and the NFE have a stronger experimental design and a much bigger sample, and the fact that the nudge showed no indication of influencing the decision in either analysis leads us to be at least somewhat confident in our conclusion that the nudge was ineffective.

When evaluating the relations between the other variable´s influence on the choice (viz. demographics, attitudes, values and habits) there are always social desirability concerns, i.e., that the participants answer in line with what they think is expected by the researchers (Furnham, 1986). Furthermore, there is a risk that the choices made in the store influenced the subsequent answers on the survey, increasing the chance of significant relations. On the other hand, if we had given the participants the survey before making their shopping decision, we would have faced the opposite risks, i.e., that their answer on the survey would have influenced their shopping decisions, as well as given away the purpose of the study and increased the risk for social desirability influencing the protein choice. Because we were mainly interested in evaluating the nudge intervention, we considered the later risks to be more detrimental to the study. Furthermore, attitudes, habits and values are stable psychological constructs, and we did not think the consumers' choices were likely to have a big effect on these estimates.

Another limitation is the generalizability of our results, given that our study focuses exclusively on Swedish consumers. Although our results may translate to similar contexts, (e.g., with respect to store environment and the cultural context) studies should be conducted in different settings and especially in countries with different seafood consumption profiles to elaborate further on country-specific and common predictors of sustainable seafood consumption. (Richter et al 2018).

Lastly, we want to underline here that switching from meat to a plant-based diet would still be preferred from an environmental perspective, and that seafood production is associated with negative environmental impacts as well. These impacts can vary greatly, depending on aspects such as the status of fish stock (if wild seafood) and production practice (if cultivated seafood) (Hallström et al.,

2019). Because of the overall negative impacts of seafood production, it is of course not a sustainable option to replace all meat we consume today with seafood. This is not what we are saying, nor what we want. We simply aimed to investigate to what extent a nudge intervention was effective in a store environment and gain some further knowledge on which factors influence this choice in a natural setting. The main aim was to explore the utility of these tools and understand motivations and barriers for such a switch, as well as the potential of using nudges to encourage a gradual switch away from meat amongst consumers.

8 Policy implications

8.1 Subtle nudges may struggle to work in a store environment

Our results give some further support to previous studies showing how nudge interventions are not always easy to implement (de Ridder et al., 2020), and that the effectiveness of nudges critically depends on boundary conditions (Carlsson et al., 2021; Lindahl and Stikvoort, 2015). This is valuable information for policy makers and food system actors that are interested in changing food consumption choices at the point of purchase.

Store environments are full of competing information where decisions are prone to be made quick and automatic, with high reliance on heuristics and habits. In these environments especially, there might be a need for more powerful intervention e.g., ones that account for habit breaking, are better at grabbing attention or interventions that make bigger changes in the physical environment.

Of course, other designs of the nudge could have been effective. It is important to highlight here that this study tested the effectiveness of our nudge — not nudges in general. Furthermore, it is also plausible that a similar nudge could have been effective in another context, as highlighted above, the grocery store is in many ways a unique environment. These results mainly highlight the importance of testing interventions before large-scale implementation and might provide some valuable lessons in what *not* to do. We do see some possible improvements to the nudge design based on our results that could be worth exploring further. A reason (apart from the ones mentioned above) that our nudge seemed to fail could be that the insights from the pilot study failed to generalize to the bigger population of shoppers. I.e., focusing on health aspect and providing recipes might not have been the message needed, even though it was highlighted as a potential important motivator in our pilot study. Seeing how biospheric values was a strong predictor in our bigger sample, designing a nudge that primed pro-environmental values, at the point of decision, might have been more effective. Another approach could be to design an intervention that accounted for habit breaking, as our results clearly show that habit heavily influenced these decisions. Addressing the role of habit has been highlighted as a crucial challenge for behaviour change intervention and conventional approaches to change behaviour often fall short if they don't account for habit breaking (Verplanken, 2018; Linder et al., 2021; Verplanken and Whitmarsch, 2021). Such interventions could for example focus on identifying and impeding the automated cueing of meat purchases, use implementation intention strategies (Gollwitzer and Sheeran, 2006) to bridge the gap between the intention of buying fish and actually putting it in the basket, or substantially change the physical environment to promote fish purchases.

Values, habits, price and attitudes were all shown to be good predictors for protein choices (and potentially overriding our nudge intervention). Unfortunately, for the point of encouraging the switch away from meat, all these variables are inherently hard to change. Furthermore, nudges might be hard to implement in stores where other incentives often are prioritized (e.g., promoting items with the highest profit margins and creating pleasurable experiences for the customers). One major critique addressed towards nudges is that they may serve policymakers with an "*easy way out*", instead of having to use other more restrictive policy instruments, such as regulations and sanctions,

when such policy tools in fact are needed (Hagmann et al., 2019; Bonell et al., 2011). Even if the results from the nudge was disappointing, it is important to report null-findings from these type of behavioural interventions for several reasons 1) contrasts significant findings, help limit publication bias and paint a more realistic picture of nudges as a policy tool, 2) increases knowledge about when and where nudge-interventions are successful and when more powerful interventions are needed, and 3) valuable learning lessons can be drawn from failed intervention e.g., insights on what *not* to do and potential ways to improve on nudges-design processes.

All in all, we don't see targeting individual consumers in a store setting with nudge interventions as a silver bullet solution to curve the negative environmental impact of red meat production, if anything our results indicate the opposite. However, if successfully designed, they could of course serve as a valuable complement to other measures.

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