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Food For Thought

Can Nudging On Food Products Reduce Carbon Footprint?

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Abstract. In addressing ways to reduce greenhouse gas emissions related to private consumption, we test whether nudging can be used to influence Swedish consumers' food choices in a more sustainable direction - that is, reducing their meat and fish consumption. We design two pro-environmental nudge schemes that speak to different decision-making processes: one *cognitive* and one *affective*. An online experiment with 625 student subjects from Stockholm is carried out to assess the effect of these nudge schemes in reducing the CO2 equivalent footprint associated with meat, fish and plant-based substitute consumption in a retail (grocery store) setting among consumers in Sweden. We find that neither nudge scheme has a significant effect on the CO2 equivalent footprint. This is an indication that pro-environmental nudging is not an effective tool to reduce meat consumption and decrease the environmental impact that it is associated with.

Keywords: nudge, behavioral economics, environmental economics, meat consumption, greenhouse gases, online experiment

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1 Introduction

1.1 The Problem Defined

Climate change is clearly one of the most salient political questions in the world today. Humans have contributed to a 1.1°C temperature increase since the 1850-1900 period, while the Paris Agreement from 2015 stipulates that the increase should not rise above 1.5°C (Intergovernmental Panel on Climate Change, 2021). With that limit approaching, efforts to reduce emissions of greenhouse gases (GHG) are more relevant than ever, just as many major world leaders demonstrated recently at the COP26 summit in Glasgow. This thesis seeks to explore one potential way to do just that by addressing an often overlooked source of GHG emissions: food.

While air travel and major industries tend to attract much public attention, a prominent source of GHG emissions in rich countries, like Sweden, is private consumption, which amounts to a share of approximately 60% of Sweden's total GHG emissions; of all products, food is among consumers' main contributing factors to GHG emissions, and thus global warming, equivalent to 16% of Sweden's emissions (Naturvårdsverket, 2020). Meat consumption is the primary driving force in consumers' climate impact from food, with a considerable footprint of carbon dioxide (CO2) and other GHGs emitted per kilogram (kg) of meat produced. The average Swede consumes almost 80 kg of meat per year (excluding fish), of which roughly 40% represent pork consumption and 30% beef and fowl respectively (Jordbruksverket, 2021b). It is further estimated that Swedes eat on average 11 kg of fish per year (RISE, 2017). Meat consumption alone amounts to 15% of their overall consumption-related ecological footprint, approximately half of what relates to their diets (Konsumentverket, 2020). These figures demonstrate the need to reduce the emissions attributable to meat production, which could be done by either reducing meat consumption or ameliorating meat production processes (or both). This thesis addresses the former approach.

Most of the Swedish food consumption occurs in retail stores, where sales amounted to more than SEK 300 million in 2019, of which approximately SEK 40 and 13 million were spent on meat and fish respectively (Statistiska centralbyrån, 2021a). This compares to total sales of some SEK 130 million in the restaurant sector in 2019 (Statistiska centralbyrån, 2021b). The figures do not reveal the exact volumes of meat and fish sold, but they suggest that the major contribution to consumers' meat-related climate impact comes from purchases in grocery stores, where the room for improvement is, consequently, the greatest. In light of the gloomy figures of meat consumption, it is hopeful that Europeans, and Swedes in particular, are both concerned about climate change and open to adjusting their diets to address the issue, including eating less meat or switching to organic meat (European Union, 2021). This gives us good reason to find ways to influence their diets and reduce the climate impact of their food consumption.

Since we wish to reduce consumers' climate impact associated with their food consumption, it is important to note that different types of meat vary in their impact on the environment and in GHGs that they emit.[1] CO2 is often viewed as the main GHG, but meat production also contributes heavily to emissions of other gases, like methane and nitrous oxide (Moberg et al., 2019). *Carbon dioxide equivalents* (CO2e) is a combined metric that expresses total GHG emissions in terms of CO2 and makes emissions comparable across different production processes. To then delineate how one attributes emissions throughout different production processes, the standard approach in the literature is known as Life Cycle Assessment (LCA). LCA essentially takes the entire climate change contribution of a product into account, from farm to store (Röös, Säll, & Moberg, 2021).[2]

Meat production's climate impact can be further divided along the lines of ruminant (beef, mutton) and non-ruminant (pork, poultry, fish) livestock (Clune et al., 2017).

[1] The reader may note that e.g. grazing cattle may affect the local soil climate heavily, but that we are in this thesis concerned with meat production's contribution to GHG emissions.

[2] The authors explain that LCA builds on summation and weighting of all GHG emissions attributable to the production and translates them into a metric per kg produced of a certain food product (for meat, the weight metric excludes bones). This includes all processes — both early and late in the production phase — such as the emissions from input products and those from packaging and transportation to grocery stores. Typically, product standards are applied to different product categories, which facilitates calculations, but also makes them less precise and more general.

Both types contribute to emissions in processes such as breeding, feeding, fertilizer use, powering the farms and transporting, but ruminant livestock cause additional emissions of methane from their digestion, making production even more detrimental. When it comes to fish, the distinction is made between farmed fish, whose emissions follow the patterns of non-ruminant livestock, and wild fish, where the emissions chiefly stem from vessel fuel and refrigeration.

Table 1: CO2e footprints of meat and other foods

Meat type	kg CO2e per kg food Moberg et al. (2019)	kg CO2e per kg food Florén and Sjons (2020)
Beef	35	28
Pork	8	4.1
Chicken	4.5	2.6
Fish & Seafood	6	0.8-6.1[a]
Egg	2.5	1.1
Milk	1.5	0.9
Cheese	13	5.3
Potato	-	0.1
Spaghetti	-	0.8
White bread	-	0.5
Apple	-	0.2
Banana	-	0.7
Tomato	-	0.2
Onion	-	0.1

[a] Florén and Sjons (2020) distinguish between different varieties of fish and seafood, where their smallest footprint comes from herring and their largest from salmon.

Applying LCA, Moberg et al. (2019) estimated average CO2e footprints of different food products on the Swedish market. A selection of these are presented in Table 1 above and compared with the *RISE Climate Database for Food*, which is designed to be an independent and reliable source of climate impact information for different stakeholders that need to assess their environmental impact and how they can make their activities more sustainable (Florén & Sjons, 2020). The database is created by the state-owned Swedish sustainability-focused research institute RISE. Table 1 reveals that beef really stands out in terms of CO2e footprint, whereas the other types of meat are on a relatively even, lower level, and interestingly that consuming cheese as a substitute to meat may result in an even higher CO2e footprint. Clearly, reducing consumption of especially beef is crucial if one seeks to make diets more sustainable. Moreover, animal-based food in general, even excluding cheese, has a much higher carbon footprint than non-animal products, which confirms that meat consumption in general is the aspect of diets that is most urgent to address. Meat can then be substituted by *plant-based alternatives*, whose footprint will be much smaller. This begs the question what the most suitable ways of reducing meat consumption are.

1.2 Approaches to Reducing Food's Carbon Footprint

In terms of economic theory, hefty meat consumption creates a *negative externality*, in the sense that it contributes to an unsustainable carbon footprint (see Section 2.1.1 below). There are several potential approaches to adjusting for that externality and cutting emissions related to meat consumption. Initially, improving production efficiency, thereby reducing the climate impact of meat production processes, will most likely be an expensive and gradual task, involving massive investments in newer and more efficient technologies (Jordbruksverket, 2021a). Garnett (2011) suggests that a change in consumption patterns will, therefore, be necessary. This confirms that policymakers will need to find ways to encourage consumers to substitute meat for plant-based alternatives, which is indeed what we explore in this thesis.

Policymakers could potentially sway consumers' diet habits in the desired way by e.g. taxing meat consumption or subsidizing alternative foods. These may both be viable options, but carry some problems with them. It is important to note, for instance, that the SOM Institute finds that nearly half of Swedes (47%) are negatively disposed to a carbon tax on beef, compared to 27% who are positively disposed (Röös, Larsson, et al., 2021). Hence, such a tax would be politically difficult to levy. Some Swedish simulation studies have investigated how effective a carbon tax on meat might be in reducing consumption and thus carbon footprint (Wirsenius et al., 2011; Säll & Gren, 2015; Jansson & Säll, 2018; Säll et al., 2020). A tax based on the emissions associated with a particular meat type would mean that different types would be hit more or less hard. The estimated changes in meat consumption range from -15% to -19% for beef, +1% to -8% for pork, and +7% and -14% for chicken, depending on tax sizes and elasticity estimates. The reason that pork and chicken consumption may even increase slightly is that substitution from harshly hit beef to these less harshly hit meat types may occur (Wirsenius et al., 2011). A general take from such studies is that the demand elasticity for food is not particularly high and also quite imprecise to estimate (Röös, Larsson, et al., 2021). Thus, it should be interpreted carefully (Wirsenius et al., 2011). To significantly reduce meat consumption and cut emissions drastically, a politically infeasible tax equivalent to roughly SEK 200 per kg of beef would be required (Röös, Larsson, et al., 2021, p. 31). Taxes can do something to reduce emissions related to meat consumption, but have limitations.

Subsidies, on the other hand, have scarcely been studied as a means to promote more sustainable food consumption (Röös, Larsson, et al., 2021). Subsidizing meat substitutes, that may still have a non-trivial carbon footprint (albeit not as hefty as that of meat products), might lead to overall negative impacts on sustainability, if it were to lead to a generally increased consumption. An illustrative case that Nordström and Thunström (2009) studied suggests that a subsidy on fiber-rich foods would be accompanied by an increased intake of fat, salt and sugar. While that study focuses on health rather than environment, it highlights that the gain from any subsidy may be outweighed by a negative substitution effect. With a subsidy on a less climate-unfriendly substitute product, people are left with more money in their wallets — money that may be spent on more fat, salt and sugar, which could be harmful to the environment as well as their health. The good that subsidies can do in this case, therefore, appears to be limited.

Among the alternative approaches to fiscal policy, perhaps the most prominent behavioral method is *nudging*, termed by Thaler and Sunstein (2008)[3]. In simple terms, a nudge aims to influence behavior via a subtle push in a certain direction. Nudging has gained substantial traction among behavioral economists, having been vastly researched in an array of different areas, such as environmental protection, traffic safety and tax policy, supported by governments in the UK, the US, the Netherlands, Australia and more countries (Sunstein, 2019), where citizens have been nudged into making ‘better’ decisions. If we apply nudging to meat consumption, the argument would be that since society wishes and needs to address climate change, to which meat production contributes heavily, it is desirable to consume less meat, thereby requiring less to be produced to satiate the demand. As discussed above, the amount of meat consumed in Sweden is currently unsustainable, which is why a nudge may just be required to push consumers in Sweden into buying ‘better’, i.e. more sustainable, food. We test this proposition by conducting an online experiment that is presented, analyzed and discussed in Sections 3 through 6 below. Thus, the research question of this thesis is:

Which effect can nudging have in a retail setting on the carbon footprint coming from meat and fish consumption among consumers in Sweden?

The concept of nudging will be discussed in more detail in Section 2.3 below.

1.3 The Work’s Relevance

As discussed, it is impossible to ignore the dire salience of climate change, which this thesis addresses directly. To provide a specific example, a US-EU pledge to reduce methane emissions, which meat production contributes to, by at least 30% by 2030 (from 2020 levels) was launched earlier in 2021 and attracted much attention at the COP26 summit in November, being seconded by more than 100 other nations (European Commission, 2021). Learning how to reduce meat consumption should be essential for these countries to meet the pledge’s target. Furthermore, allowing consumers in Sweden to shift their decision-making to being more climate-conscious would be in line

[3] Richard H. Thaler was awarded the Nobel Memorial Prize in Economic Sciences in 2017 for his work in behavioral economics.

with their own concerns, as it is in most of the EU (European Union, 2021).

Regarding our work's academic relevance, few experimental studies have studied anti-meat nudging in a Swedish context. Furthermore, most studies similar to ours across other countries have studied meat consumption in a cafeteria or restaurant environment, where we instead look at the retail setting. An interesting exception is a master's thesis produced at Stockholm University by Lindström (2015), who conducted a field experiment with a research question similar to ours. Conversely, our study is an online experiment, where we compare different types of nudges: *cognitive* and *affective* ones. To the best of our knowledge, this thesis is the first to describe an online experiment about the influence of these two different kinds of nudges on Swedish consumers' choices in grocery stores and linking it directly to their carbon (CO2e) footprint. As such, we measure the outcome of our experiment in terms of carbon footprint, where most similar studies deal with reducing the absolute amount of meat bought or the substitution effect between different kinds of food products. While researching whether nudging for instance leads to a shift in consumption towards chicken and away from pork may be fascinating from a marketing perspective, carbon footprint is the measure that is actually interesting if one wishes to say something about how the results matter in the fight against climate change. Previous relevant studies will be discussed in more detail in Section 2.3.3 below.

1.4 Delimitation

While the fight against climate change certainly is a global one, this thesis has a focus on consumers in Sweden. Nudging is heavily dependent on the setting where individuals make their decisions, which in a culinary context is heavily dependent on national (or regional or local) cultures. Levels of meat consumption in a country obviously influence how responsive people may be to an anti-meat nudge. Diets and consumers' values vary between countries and the retail stores active on national markets are typically very different. It is, therefore, wise to have a specific country in mind, when designing and researching a nudge scheme. Also, policies that could be implemented are usually national, although it is possible to envisage EU-wide legislation. Still, the thesis can inspire similar studies to be conducted in other countries and contexts.

1.5 Thesis Structure

The rest of the thesis will be structured in the following manner: we will discuss the relevant theoretical framework in Section 2, including environmental-economic and behavioral perspectives as well as applied research that has been conducted in the general area related to our research question. We then present the experiment that we conduct to study our research question in Section 3, followed by an explanation of our method and empirical approach in Section 4. In Section 5 we present our research results, which provide no evidence to support our two main research hypotheses. The corresponding discussion and conclusions are addressed in Section 6.

Throughout this thesis, we will generally use *meat* to denote both beef, pork, poultry etc. on the one hand and fish on the other. At times we will, for semantic clarity or conceptual distinction, write *meat and fish* to refer to the same categories. Such distinctions are sometimes made in the literature and in consumption figures, but we maintain that fish is a kind of meat.

2 Theoretical Framework

This section explores the theoretical framework applied to this study. We rely on theories from environmental economics to define the problem and its potential solution in formal terms. We then apply behavioral perspectives to the problem that include decision-making and nudging and relate these to a relevant selection of applied studies. The section concludes by formulating two hypotheses that are based on the theoretical framework presented.

2.1 Theoretical Perspectives on Emissions and Mitigation Policies

2.1.1 The Market Failure of Emissions

With the production and consumption of any good, certain costs and benefits arise. To the producer, it is costly to prepare the good, for which compensation, i.e. a price, is required. The compensation is provided by the consumer, who pays for the utility enjoyed from the purchased good. If they are rational and utility-maximizing, the producer will sell the good at any price greater than or equal to the cost of producing it, just like the consumer will buy the good at any price less than or equal to the utility associated with the good. In the ideal case, this is a functioning market, where the aggregate number of producers and consumers, with all their costs and benefits, determines the equilibrium prices and quantities of the good at hand in a decentralized manner.

In economic theory, there are two so-called welfare theorems that informally imply that complete and perfect markets, coupled with rational and self-interested behavior as well as a decentralized pricing systems, can achieve a *Pareto optimal* allocation of resources, defined as "[a]n economic outcome [where] a reallocation of resources cannot make at least one person better off without making another person worse off" (Phaneuf & Requate, 2017, p. 4). Conversely, if a reallocation of resources does make at least one person better off, while making no one worse off, it is referred to as a *Pareto improvement*.

As touched on in Section 1.2 above, however, overconsumption of meat, that contributes to unsustainable GHG emissions, can be understood as a *market failure*, arising from the negative externalities of meat consumption. Externalities occur whenever two conditions are met (Baumol & Oates, 1975). Firstly, agent A's utility depends on real (non-monetary) variables, whose values are chosen by another agent, B, without particular attention to the impact on A's welfare. Secondly, B does not receive or pay in compensation an amount equal to the value of the benefits or costs to A that result from B's chosen activity.

Applying this definition, say that agent B produces large amounts of meat products — B's production affects A's utility negatively, since A benefits in all sorts of ways from Earth's hospitable climate and B's production harms that climate, without compensating A for the utility loss. It is evident from Section 1.1 that the market for meat products contributes to an unsustainable carbon footprint. This is indeed a negative externality, since society is not compensated for that carbon footprint. Hence, the market fails in capturing all costs and benefits in the price for meat, and an unsustainable amount is produced, with negative effects on societal welfare. Thus, current consumption levels are not Pareto optimal and we can see that a nudge scheme that seeks to reduce consumers' meat consumption would not entail a misallocation of resources or a distortion of a Pareto optimal outcome. Rather, it may be needed to achieve a socially optimal allocation, or a Pareto improvement from current, unsustainable levels of consumption.

2.1.2 Environmental Policy to Handle Market Failure

When it comes to means of dealing with environmental issues that are caused by market failure, we can distinguish between different kinds of economic incentives (such as taxes and subsidies) and what is usually referred to as *command and control*, which is a requirement that polluting producers undertake some sort of compensatory action or face a penalty (Phaneuf & Requate, 2017). Since this thesis is about nudging, we are imagining that the government might implement a nudge scheme, requiring that producers of meat and plant-based substitute products label their goods according to their environmental impact. This is the command part of the policy. The control part would consist of government monitoring of how producers comply with the command, penalizing those who for some reason fail to do so, by for instance not labeling their products at all or using understated figures of the products' environmental impact. An appropriate penalty might be a fine in proportion to the harm caused by the failure to comply with the command.

2.2 Judgment and Decision-making: Two Systems

Leaving market failure aside, our foundation for understanding people's decision-making, which we hope to influence with nudging, will be *dual process theory*, which psychologist and Nobel laureate Daniel Kahneman (2014) formulates as two different ways of thinking, referred to as *System 1*, which is fast and intuitive, and *System 2*, which is slow and reflective. The two systems should not be thought of as competing for domination of the brain, but rather as two (imperfect) actors with different sets of abilities that complement one another. He further states that System 1 is suited to deal with certain kinds of decision-making that require fast responses, such as detecting the source of a sound, answering questions about simple arithmetic and reading simple slogans off advertisement signs. System 2, on the other hand, is more expedient when dealing with situations like evaluating the price-cost benefits of two washing machines, correctly filing one's tax returns or assessing the validity of a logical argument. With the many types of decision-making situations that arise in our daily lives, of varying degrees of complexity, different thought processes will be required, and indeed sometimes at the same time (Kahneman, 2014). Thaler and Sunstein (2008, p. 22) refer to the two cognitive systems as "automatic" (1) and "reflective" (2) respectively and characterize them in the following way:

Table 2: The Two Systems' Characteristics

Automatic System	Reflective System
Uncontrolled	Controlled
Effortless	Effortful
Associative	Deductive
Fast	Slow
Unconscious	Self-aware
Skilled	Rule-following

2.3 Nudge and Behavioral Influences

2.3.1 Nudging in Theory

Having briefly introduced nudge in Section 1.2, the concept deserves to be scrutinized here. Thaler and Sunstein (2008, p. 9) define nudge as "any factor that significantly alters the behavior of [h]umans, even though it would be ignored by [a fully rational agent]". The idea behind it is to affect people's behavior by designing their *choice architecture*, or the setting in which a particular decision is made, in such a way that a certain outcome is more easily attained, without restricting people's freedom of choice or imposing financial burdens on them. A rational agent would for example respond to financial incentives, but would ignore the layout of the choice architecture. Humans, however, can be described according to the principle of *bounded rationality*, which states that our capacity to solve complex problems is limited and, therefore, our resulting behavior cannot always be described as objectively rational (Simon, 1957). This is useful since there is evidence that people often do not act as rational decision makers, as discussed by Kahneman (2014, p. 605) and Thaler and Sunstein (2008, p. 8).[4]

Furthermore, nudging can be relied on to address different kinds of decision-making. For instance, Thaler and Sunstein point to decisions that for various reasons are "difficult and rare, for which [people] do not get prompt feedback, and when they have trouble translating aspects of the situation into terms that they can easily understand" (Thaler & Sunstein, 2008, p. 79). Such decisions seem to be most in line with System 2 (reflective) decision-making, requiring much brainpower. There is a flipside to the nudge coin, though. One of Thaler's dear examples of an everyday nudge revolves around the opening mingle of a dinner party among (otherwise rational) economists, where he had to remove a bowl of cashews to make sure the guests had some appetite left for the actual dinner (p. 43). Human instincts tend to make tasty food hard to resist, even when we have goals that run counter to excessive snacking. In this case, the problem is not a "difficult and rare" one, but rather a familiar, everyday situation, where the problem instead lies in "mindless choosing" (p. 46), which corresponds to System 1 (automatic) decision-making. This distinction between *type 1* and *type 2* nudges is confirmed by Hansen and Jespersen (2013).

Regardless of the type of decision that nudging seeks to influence, the concept implies the idea of *libertarian paternalism* (Thaler & Sunstein, 2008, p. 5). The libertarian dimension functions to preserve people's freedom of choice, i.e. the nudge "must be easy and cheap to avoid" (p. 6), while the paternalistic aspect is there to influence them to make decisions that make them better off "*as judged by themselves*" (p. 5, italics in original). Hence, while retaining liberty, we can interpret libertarian paternalism as arguing that there is an optimal decision that a rational person would make in a given

[4]We are referring to rational behavior in the academic sense that it is logically stringent, in line with a person's preferences, as opposed to the colloquial meaning of rational as "reasonable".

situation, and that one chief reason that some people do not make optimal decisions is that they for various reasons are not rational all the time. If they were, they would simply choose in accordance with the nudge. People may fail to understand all the implications of their actions, or be misled by mindless choosing. This was referred to as bounded rationality above. Still, if people were better off ignoring the nudge, they should be equally free to do so. Thus, a nudge serves to steer momentarily irrational people in a more rational direction, but does not force any particular decision on them.

2.3.2 Behavioral Factors in Sustainability and Food Consumption

It will be useful to briefly account for the factors that influence people's decisions specifically with regard to sustainability and food. Understanding these factors allows us to see where nudging can be applied to elicit the kind of behavior that is needed for sustainable consumption. Kollmuss and Agyeman (2002) show that the psychology determining our pro-environmental behavior is very complex, so much so that constructing a framework that incorporates all factors is probably neither feasible nor helpful. Therefore, we need to be particular and look at specific, major factors to address.

A general obstacle to changing consumers' diets is the existence of a knowledge gap. A literature review by Hartmann and Siegrist (2017) finds that consumer awareness of meat production's climate impact is "surprisingly low", based on studies across several Western countries. This knowledge gap is confirmed by a Chatham study (Bailey et al., 2014).[5] *Konsumentverket* (the Swedish Consumer Agency) similarly finds that consumers in Sweden have a low awareness of alternative diets, as well as norms and habits that favor a meat-heavy food consumption (Konsumentverket, 2020).

In addressing such obstacles, Eker et al. (2019) find that changing social norms, alongside individuals' own self-efficacy, was one of the main drivers in changing people's diets in a pro-environmental direction. In a literature review of experimental studies on meat consumption, Stoll-Kleemann and Schmidt (2017) say that norms indeed are

[5] Both studies exclude Sweden, where the awareness is thought to be low as well, but on the rise, reflecting a slight downward trend in *per capita* meat consumption since 2016 (Röös, Larsson, et al., 2021; Jordbruksverket, 2021b).

key drivers, but that in general, *cognitive dissonance* "between knowledge, conflicting values and actual behavior" influences meat consumption, where emotional messages are especially effective. They suggest, however, that different segments may need targeted approaches. Likewise, Harguess et al. (2020) suggest that knowledge is a key driver in meat consumption specifically, and that increasing people's knowledge of the health and environmental impacts of meat is effective in influencing meat consumption choices, as is evoking emotional responses. Bose et al. (2020) also show that providing scientific information about the relationship between meat consumption and climate change has an impact on people's opinions about consuming meat. Like Stoll-Kleemann and Schmidt, however, they suggest that a targeted approach may be useful, e.g. health-related messages to consumers with health concerns, and they further show in their experiment that people with a higher meat intake are more likely to take offence at being shown the consequences for the climate of their diet. On the other hand, Prusaczyk et al. (2021) find that interventions may influence people's willingness to consume meat irrespective of their personal ideology.

In conclusion, while decision-making is complex, knowledge and social norms as well as emotions appear to be useful in addressing pro-environmental behavior in general, even though it may vary among different segments. Knowledge and emotions can be applied to nudging, while norms are harder to influence.

2.3.3 Nudging Applied to Food Consumption

Having explored factors that influence behavior in our context, we will need to review the literature where nudging has been applied to get an idea of how nudge can influence these factors.

There is quite a rich literature on nudging people into making healthier food choices. For example, studies have explored calorie labeling on restaurant menus with mixed results (see Sinclair et al. (2014) for a review). It has been suggested that a simple informational label is not sufficient to influence people's choices, whereas evaluative labels, such as traffic-lights, show more promise (Fernandes et al., 2016). A traffic-light-like color scheme, developed by Scarborough et al. (2015) to restrict people's intake of fat, salt and sugar has been shown in an online experiment to generally steer people's choices away from the worst (red) label rather than towards the best (green) label.

Another interesting distinction in the literature is made between different types of nudges — chiefly *cognitive*, *affective* and *behavioral* ones, building on what is referred to in psychology as *the trilogy of mind* (Hilgard, 1980). Cadario and Chandon (2020) characterize these different kinds of nudges respectively as; influencing what consumers know (cognitive); influencing what consumers feel (affective), and; influencing what consumers do (behavioral). The authors find that health-promoting food nudges vary in effect sizes, where cognitive nudges have the smallest effect, affective ones a larger effect, and behavioral ones the largest, regarding reducing excessive calorie intake.

On a different but related note, tobacco and cigarettes are in most countries required to feature signs of warning on packages. Hammond (2011) has reviewed evidence from many countries about the effectiveness of different warning designs. He finds, unsurprisingly, that larger text labels are more effective than smaller ones in conveying knowledge of the consequences of smoking to consumers, especially when combined with images. They are shown to be capable of promoting smoking cessation and preventing initiation among youth. In a study on the Canadian pattern, a difference-in-differences approach shows that the introduction of graphic warning labels has caused a decline in smoking rates by approximately 12-20% (Huang et al., 2014).

Nudging can clearly yield results, and the type of nudge designed may be of particular importance. Combining messages with images can be a clever way to both inform, which is mainly cognitive, and emotionally move, which is more affective.

Despite the rich literature on healthy food nudges, there have been relatively few studies on nudging and sustainable food consumption. The majority of this literature has been devoted to nudging people into choosing vegetarian food in cafeterias or restaurants (Slapø & Karevold, 2019; Vandenbroele et al., 2019; Campbell-Arvai et al., 2014; Kurz, 2018). Campbell-Arvai et al. (2014) find that offering a vegetarian default menu in campus dining halls increases students' likelihood of choosing a vegetarian dish, while Slapø and Karevold (2019) find that a traffic-light nudge, combined with additional posters, reduces meat consumption in a university cafeteria by 9% in the short run. Interestingly, the sales of the green meals do not go up by as much as those of the yellow dishes, which can be thought of as a *compromise effect*, where the intermediate option becomes more attractive than either of the two extremes (Carroll & Vallen, 2014). Gravert and Kurz (2021) similarly find that the framing technique, portraying vegetarian food as the restaurant's primary options, also increases the number of vegetarian dishes sold in a Swedish lunch restaurant at the expense of meat dishes. In a very recent field experiment, (Andersson & Nelander, 2021) similarly find that framing a university cafeteria menu in favor of the vegetarian options reduced the share of meat dishes sold by 11%, which translated into a 6% cut of emissions attributable to food.

Closer to our situation, Vanclay et al. (2011) construct a similar nudge, essentially a color-coding scheme, but for use in a grocery store setting in Australia. They find that sales of the worst (black) category go down by six percentage points, the best (green) go up by four percentage points, whereas the intermediate yellow category increases only slightly. In a study exploring online grocery shopping, Demarque et al. (2015) find that displaying descriptive norms about people's attitudes toward sustainable shopping could increase the likelihood that an organic product is purchased, regardless of whether the described norm enforces a pro-environmental stance. In another online, experimental study, Prusaczyk et al. (2021) identify a higher willingness to buy a plant-based alternative (a mushroom burger) among subjects exposed to either a default nudge or an educational message about the environmental impacts of meat production, regardless of personal traits and ideology.

These studies suggest that a nudge can be effective, even when social or ideological preconditions are lacking. All such food-related nudges demonstrate that color-coding can be useful for decision-making consumers, but they generally focus on informing, whether it be about the food product or norms surrounding it, rather than triggering emotional or affective responses.

A related literature has explored the phenomenon of product labeling. An example is the labeling of products in grocery stores as 'fair trade', which is akin to a nudge, although such labels can be said to rather express product differentiation than an objective nudge (Hainmueller et al., 2015). The UK was early in establishing its *Carbon Reduction Label* in 2006, and several countries have followed since (Liu et al., 2016). A familiar label to Europeans is the EU's energy classification label, which has contributed to more efficient, energy-saving electrical appliances (European Commission, 2010). When it comes to food labels, positive climate labeling can have a positive impact on consumer demand, as shown in a randomized control study across 17 Swedish retail stores (Elofsson et al., 2016). Moreover, a general conclusion from the labeling literature is that negative labeling, indicating that a particular product is associated with some danger, is more effective than positive labeling (Röös, Larsson, et al., 2021), which aligns with the findings on color-coding discussed above. An interesting example is Chile, where the law stipulates that products high in sugar, fat, salt and calorie content be labeled with a warning sign since 2016 (Reyes et al., 2019). While little time has passed since 2016 and restrictions on advertisements for the same products were introduced simultaneously, a tentative conclusion is that the labeling law has been effective and contributed to a 25% decrease in sugary beverage sales (Taillie et al., 2020).

While the lacking awareness of the climate impact associated with meat consumption points to the importance of informing consumers, it is crucial to note that mere information is different from a nudge, according to the definition above. It does not have to lead to a discrepancy between human and rational behavior. Presenting a piece of new information may or may not affect human behavior and whether it would influence the behavior of a rational agent would depend on how that information related to his or her preferences. While information and knowledge often are preconditions for sustainable actions, Ölander and Thøgersen (2014, p. 354) suggest that:

> information is often more successful in achieving changes in cognitive elements than in activating behavioural change. Perhaps, the most important task for nudging is to make the provision of information more action-triggering [...] the important task will be to secure [*sic*] that informing and nudging are applied simultaneously.

This begs the question as to how such a concurrent application can be achieved.

2.3.4 Criticism towards Nudge

Having accounted for the theory behind nudging, it is important to also be aware of some of the critiques leveled at the concept. Some voices have expressed concerns that nudging is less benign than typically argued (Rebonato, 2014) or even manipulative (Wilkinson, 2013). Sunstein (2019) himself has summarized, and rebutted, seven typical criticisms: (i) nudges are an insult to human agency; (ii) nudges are based on excessive trust in governments; (iii) nudges are covert; (iv) nudges are manipulative; (v) nudges exploit behavioral biases; (vi) nudges wrongly assume that people are irrational, and; (vii) nudges work only at the margin; they cannot achieve a whole lot. What Sunstein thereby wants to say is that many criticisms are misconceptions that "continue to divert attention [...] and stall progress", while admitting that some lines of critique are "productive objections" to nudging (p. xx). Heeding criticisms and productive objections is necessary to refine the nudge concept, and more specifically in our project, we will use it to design the best possible nudge to address our urgent research question.

One productive criticism is the concept *think*, proposed by John et al. (2019), which is defined as "multiple forms of public engagement [that] rest on the assumption that citizens — given the right evidence, enough time, and an appropriate context — can come to the best judgment about what is good for them and their fellow citizen and then act" (p. 4). Think is clearly different from nudge in that it requires more active participation from the decision maker, often asking them to "debate and deliberate so they can decide for themselves" (p. 3). This is because "Legitimacy [of democratic decisions] rests on the free flow of discussion and exchange of views in an environment of mutual respect and understanding" (p. 17).

When dealing with complex issues, where there are moral aspects involved in policy-making, nudges may struggle to gain legitimacy among citizens and elicit cooperation, think is a useful extension of nudging. Climate change is complex, to say the least, and diets are sensitive in many ways, as discussed in the introduction. Think does, moreover, depend on thought processes that are rather more engaging and reflective, that is system 2, since debate and deliberation is required. Think, therefore, avoids such accusations as being manipulative or exploiting behavioral biases.

As outlined in Section 2.3.1, nudging can be applied to decisions of both system-1 and system-2 types, where the former are fast and automatic and the latter are slow and reflective. A well-known example of a system-2 type is the nudge of presumed consent of citizens to be organ donors, which has been shown to increase donor rates (Johnson & Goldstein, 2003; Abadie & Gay, 2006). It is not obvious that this makes people better off "as judged by themselves", and a participatory decision process, like think, may be preferable in such cases to gain legitimacy. The aforementioned example of system-1 type decisions, whether to leave the bowl of cashews out when the dinner guests would prefer not ruining their appetite, is much less controversial. Think seems superfluous in such cases.

Think may be a useful strategy for certain decision-making policies, where the purpose and cause is anchored in the population whose decisions are affected. Think policies that are explored in John et al. (2019) include charitable giving, organ donations, civic debate, petitioning, political inclusion and other political matters that require commitment and participation from citizens — or indeed a whole lot of system-2 thinking. It is, by contrast, apparent that the focus of this thesis — grocery shopping — which is typically taken care of within individual households on an everyday basis, is a different kind of decision than for instance whether to donate to charity. Grocery shopping can involve both systems' thought processes, e.g. activating deeper reflection when planning what meals to shop ingredients for on the one hand and triggering automatic responses to information and cues seen in the store on the other.

So in order to still heed the criticisms towards nudging as listed above, while sticking to a theory that is relevant to the type of decision-making at hand, we turn to the modified *nudge plus*, which denotes "an element of reflection [brought] into the delivery of a nudge" (Banerjee & John, 2020, p. 13). It is, in other words, a simultaneous combination of type 1 and type 2 nudges that nudges a decision maker's automatic and subconscious thought processes in a certain direction, while also asking them to reflect more deeply on their decision. Nudge plus can, therefore, hope to influence a fast and nearly automatic decision-making and at the same time spark "a conversation between the citizen and those who represent the state and government" (John & Stoker, 2019, p. 221). This would be crucial to gain support for the policy, as opposed to for instance carbon taxes, whose unpopularity and political difficulties were discussed in Section 1.2.

As laid out above, many factors, like social norms and knowledge, influence food consumption. If we are to have long-lasting effects on people's food consumption, they probably need to agree that present norms are problematic, that is, unsustainable. The ten most popular dishes make up nearly 60% of Swedish weekday meals (Food & Friends, 2018), where norms and knowledge are presumably very influential. Simultaneously, food shopping is carried out in commercial emporia, where an array of cues act on consumers at the same time, as discussed by Cohen and Babey (2012). Hence, nudge plus can be used to address both sorts of decision-making, i.e. the two systems, and hopefully be more efficient than ordinary type 1 nudges, but avoid being labeled as manipulative. We will use 'nudge' throughout the remainder of the thesis to refer to a type of nudge plus.

2.4 Hypotheses

Taking the theory and literature laid out above into account, we formulate the following two hypotheses:[6]

H1: A pro-sustainable nudge will on average reduce consumers' carbon footprints, by decreasing the amount or changing the kind of meat or fish they buy.

H2: An affective nudge will on average reduce consumers' carbon footprints more than a cognitive nudge.

[6]To avoid semantic ambiguity, the wording of the hypotheses has been slightly modified from that presented in our pre-analysis plan (discussed in Section 3, included in Appendix A); the original "negatively influence" has been replaced with "reduce". We maintain that the hypotheses nonetheless remain essentially the same.

3 Experiment

In order to research what effect an affective and a cognitive nudge may have on the average carbon footprint coming from retail store consumption of meat, fish or plant-based substitutes among consumers in Sweden, we executed an experiment designed as an online survey by using the tool Qualtrics, where we divided subjects into two treatment groups (one per nudge) and one control group. This chapter begins by discussing our recruitment efforts and the number of subjects that participated in the study. Next, we explain how we designed the experiment and which procedure subjects had to follow during the experiment. Subsequently, we give an overview of our pre-study. In the last subsection we mention why certain results were excluded from the statistical analysis.

The information in this section is based on the pre-analysis plan that we wrote and submitted before conducting the experiment. We primarily wrote this pre-analysis plan to make it verifiable that all our data analysis choices were independent from our data, so that we did not resort to any p-hacking or fishing (Gelman & Loken, 2013). It also made it easier to distinguish the analyses and outcomes that came from post-diction from those that came from prediction (Nosek et al., 2018). The pre-analsyis plan can be found in Appendix A, or online via the following link: `https://osf.io/xqtdy`.

3.1 Subjects

The target group of participants in the experiment was students in Stockholm. We are aware that we have a limited target group that does not fully represent the wider population of consumers in Sweden, the reason being that homogeneity among the three experiment groups (control group, cognitive nudge and affective nudge) is crucial to be able to properly compare them in our statistical analysis. Hence, we had to consider which homogenous group would be the easiest for us to reach out to and obtain responses from. First of all, since we did not receive any funding, our resources were very limited, which affected the sample size we could hope to attain. Moreover, as we were conducting an online experiment, and we attend university ourselves, we figured that it would be convenient to reach out to other young students, who would be responsive to the online format. This seemed like a reasonable choice, moreover, since it is common practice in experiments to use students as subjects (Harrison & List, 2004). Lastly, as the prices in our experiment are based on the prices in supermarkets in Stockholm, we decided to only focus on students in Stockholm, all of whom naturally were consumers living in Sweden.

We first of all tried to gain access to as many e-mail addresses of students in Stockholm as possible. We initially asked study program directors at Stockholm School of Economics if they could provide us with the e-mail addresses of their students. We received the e-mail addresses of students from the Bachelor's Program in Business and Economics, the Master's Program in Economics and the Master's Program in Finance. We also e-mailed Stockholm University and the Royal Institute of Technology about this, and we received the e-mail addresses from all students at the latter school that were in the last year of their bachelor's or master's degree. Apart from e-mailing all the students whose e-mail addresses we had access to, the survey link was sent in the Microsoft Teams groups of the Master's in International Business and Master's in Business Management students at Stockholm School of Economics. We also reached out to a student from each master program at Stockholm School of Economics, and they sent our survey link in either the Facebook or WhatsApp group that they share with their classmates. Furthermore, we posted the message on the discussion wall of the official Stockholm University Facebook page. We did not collect any personalized information, and the data and e-mail addresses were not stored beyond the completion of this project. The content of the messages can be found in Appendix B. To incentivize responses, we donated a small sum of money for every participant to *Barncancerfonden* (the Swedish Childhood Cancer Fund).

With all of these recruitment efforts, we managed to reach out to multiple thousands of students. However, since we had a limited time frame to execute the experiment (11.5 days), and could only donate money to charity for each survey answer instead of giving a more personal financial incentive (for integrity reasons), it seemed unreasonable to expect more than a few hundred answers. A power calculation, where we required *statistical power* $= 0.8$, $\alpha = 0.05$, *Cohen's d* $= 0.35$ (i.e. a medium effect size), suggested that the minimum sample size would be 390 participants, or 130 in each control and treatment group. Our calculation was performed using an automatic online tool (*Free Statistics Calculator*[7]). To be on the safe side, we therefore attempted to get responses of at least 430 participants, assuming that certain participants' responses would have to be excluded from the analysis, based on exclusion criteria that are spelled out in Section 3.4.

At the time of closing the online survey, we had collected 823 responses. After excluding 192 participants, for reasons explained in Section 3.4, we had 631 responses left for our statistical analysis. The control group consisted of 188 participants, the cognitive nudge group of 232 participants, and the affective nudge group of 211 participants, which exceeded our minimum requirement.

3.2 Creating and Conducting the Experiment

3.2.1 Experimental Design

The experiment in this study follows a between-subjects design with three experiment groups: two treatment groups and one control group. In the two treatment groups, the participants got to see pictures of meat, fish and plant-based substitutes *with* nudges on them, whereas participants in the control group were shown the same pictures of the products, but *without* those nudges. The rest of the experimental design was the same for the three groups. Below we explain the experimental design in more detail, and we clarify the differences between the different experiment groups. Note that the experiment is described chronologically in the order that subjects experienced it, which means that the nudges are introduced a couple of paragraphs into the description.

In the opening part of the experiment, the participants were asked to choose a meal that they would like to have for dinner that night. They could choose between hamburgers, salad, spaghetti bolognese, Swedish meatballs and tacos. The five dishes were chosen

[7]Retrieved on October 27, 2021 from: `https://www.danielsoper.com/statcalc/calculator.aspx?id=47`.

based on the report *Matrapporten, 2021* from Swedish consultancy Food & Friends (2021), containing lists of the ten most popular dishes in Sweden in 2021. We chose the particular five dishes specifically based on compatibility with the online survey format and the ease with which both meat or fish and plant-based alternatives could be featured as part of the dish.

After having chosen one of these five options, the participants were shown a pre-specified list with ingredients that they could choose from, including protein products from meat, fish or plant-based sources. Next to the name of each ingredient its price was shown. The purpose of including prices in the survey was to add a sense of realism to the shopping scenario. We manually collected price data from grocery stores in Stockholm (using their online resources) of different grocery chains and used relative prices (i.e. per kg, per liter etc.) as benchmarks. We relied on averages of all the prices collected and included 'modified' average relative prices in Swedish kronor (SEK) in our survey that were rounded to appear more realistic.[8]

Below the ingredients' names and prices, a picture of the respective ingredient was displayed. Pictures were taken from two stock photo websites, *Pixabay* and *Pexels*, which allowed us to use them without copyright issues. Some were also permissibly edited. Only the pictures of meat, fish or plant-based substitutes that the participants got to see differed between the experiment groups. The other pictures were the same for all groups. With respect to the pictures of meat, fish or plant-based substitutes, participants in all groups got to see the same pictures of the ingredients, but for the treatment groups a nudge was visible on them. Furthermore, the two treatment groups differed in nudge design, one group saw a cognitive nudge and the other group an affective nudge.

Subjects assigned to the cognitive nudge group were shown a traffic light nudge with an informative text on it. The informative text explained the number of kilometers driven by car (fueled by gasoline) that producing one kg of the meat, fish or substitute product is equal to (on average). The traffic light nudge part consisted of two bits: a

[8]It is, for instance, common practice to list prices at 90 öre. An average figure of 19.76 would thus be rounded to SEK 19.90 per kg.

picture of a traffic light (red, yellow, green), and the same background color as the color that was illuminated on the traffic light. This means that every concerned ingredient was assigned one of the three traffic light colors. This nudge is cognitive in the sense that the text informs the subject of a particular property of the product (CO2e footprint), and the traffic light interprets how 'bad' this property is in an environmental sense. The nudge helps the consumer make intellectual sense of the product.

We based the color classification on a four-tier grading system which was proposed by the Swedish sustainability research institute RISE (Florén et al., 2021). That grading system rates meals according to their sustainability, in terms of carbon footprint. We used figures for the CO2e footprint of our ingredients and conventional portion sizes from Livsmedelsverket to estimate the footprints of a portion-sized amount of the respective ingredients. If they fell within the bounds stipulated in RISE's grading system, they were labeled accordingly as red, yellow or green. The classification is spelled out in greater detail in Appendix C. To translate the carbon footprints of the different products (we explain the sources of the footprints used for our analysis in Section 4.1) into car distances, we used the average of 122.36 grams of CO2 per kilometer for gasoline-fueled vehicles in Sweden (Transportstyrelsen, 2020).

Subjects in the affective nudge group got to see a nudge consisting of an affective picture, a text, and a certain background color (red, yellow, green). The background colors were the same as the background colors used for the cognitive nudge. Hence, the classification of each of the ingredients was based on the same grading system as the cognitive nudge. We designed three different kinds of nudges: one encouraging nudge (for the products with a relatively low level of carbon footprint), one warning nudge (for the products with an intermediate level of carbon footprint), and one discouraging nudge (for the products with the highest level of carbon footprint). The encouraging nudge contained a positive text ("Make this climate conscious choice!"), as well as a picture of a lush rain forest, a green background color and a green check mark. The warning nudge featured a cautionary text ("Rethink this climate unfriendly choice!"), a picture of a fallen tree, a yellow background and a warning sign with an exclamation point. The discouraging nudge had a negative text ("Avoid this climate damaging choice!"), a picture of a burnt-down forest, a red background and a black X with a red circle around it. This nudge is affective, insofar as it not only suggests to the subject the climate impact of a product, but also seeks to make them respond emotionally to that information. The subject should feel, as well as understand, that a certain product is, for instance, climate damaging.

For clarification, participants in the control group got to see the pictures of the meat, fish and substitute products without any of these nudges on them.

After participants had finished their 'shopping', the second part of the experiment commenced, where we asked participants about their demographic background and attitudes toward (plant-based) diets. Some of the attitude and demographics questions were multiple choice questions (MC) and some were open questions where participants had to enter integers (IG). More specifically, we asked them about their gender (MC), age (IG), which university in Stockholm they were attending (MC), what kind of degree they were pursuing (MC), what best described their nationality (MC), what label best described their diet (MC), how many of their 21 weekly meals (assuming three meals per day) contained meat or fish (IG), and which factors mattered to them when choosing a diet to follow (MC). We also asked them to rate how much they agreed with the statement that their purchase habits are affected by their concern for the environment (MC), to rate how much they agreed with the statement that they are willing to be inconvenienced in order to take actions that are more environmentally friendly (MC), to rate how much they agreed with the statement that there is not much that any one individual can do about the environment (MC), whether they would be in favor of a law making it mandatory to label certain food products according to their climate impact (MC), and, lastly, whether they would be in favor of a 'carbon tax' on food products, that would be proportional to their contribution to CO2 emissions (MC).

Finally, we added a control question to assess whether participants understood what the survey was about. If respondents did not answer this question correctly, they most likely had not read the survey task or questions properly, did not understand the survey tasks well, or did not take the survey seriously. Hence, we created two data sets:

one main data set, in which the responses from the respondents which answered this question wrongly were deleted, and another data set in which those responses were not deleted.

3.2.2 Experimental Procedure

Above, we explained how we designed the experiment. In this subsection, we outline the exact procedure that each participant followed during our experiment.

The first step participants had to take, was clicking on the link that we provided. Qualtrics then randomly assigned each of the participants to the treatment and control groups. We chose the settings “Randomizer” and “Evenly Present Elements”, which made sure that each of the three experiment groups contained roughly the same number of participants. Hence, randomization occurred on the level of all participants that chose to participate in the study.

Once participants had clicked on the link, they would receive a welcome message. In this message, we explained the goal of the experiment and that we would donate money for each participant’s contribution. The exact message was:

> This survey is part of an experiment, conducted as part of a master’s thesis project in economics at the Stockholm School of Economics. We are studying people’s food consumption choices in a retail setting. The survey is completely anonymous, in compliance with GDPR, and the information collected is handled carefully and studied in the aggregate. Completing the survey should take circa five (5) minutes, and for every adequately submitted survey, we donate one (1) Swedish krona to the Swedish Childhood Cancer Fund (Barncancerfonden).

After this introduction, all participants were asked whether they were a student currently enrolled at a university in Stockholm. Only if they answered in the affirmative, they could carry on with the experiment. Otherwise, the experiment was terminated immediately, and participants were thanked for their help.

For all actual participants, who indeed were students in Stockholm, the experiment went on with introducing a scenario, namely:

> Imagine you are in a grocery store, about to buy ingredients for your dinner tonight, and you are walking through the store's different sections. Please select the dish you would prefer from the options below, and proceed by selecting which ingredients you would buy in this scenario, from those presented to you on the following page. Assume that you need to buy all ingredients required to make the dish, except the most basic ones like salt, spices, etc. All prices are relative (e.g. per kg) and are given in Swedish kronor (kr). Please be as realistic as you can, but keep in mind that the store has a limited selection of products to choose from!

Even though the 'shopping' was hypothetical, we aimed to make the task as realistic as possible with this text.

Next, participants were asked to choose between the five dishes that we mentioned in Section 3.2.1. Based on which dish they selected, they got a pre-specified list with ingredients and their respective prices and pictures. The participants had to scroll through all of them before being able to click on the arrow to proceed to the next page. Hence, they had to go through the whole list before being able to answer the demographics and attitudes questions. They also needed to click at at least one ingredient before they could click on the arrow to go to the next page. As explained in Section 3.2.1, which pictures of meat, fish, and plant-based substitutes participants got to see, depended on the experiment group that they happened to be in. The pictures of all other ingredients remained constant for all groups.

After participants had selected ingredients, they would see a message that they were done with shopping for that night, and that they would now be asked about themselves and their attitudes towards food consumption. The subsequent questions asked were those mentioned in Section 3.2.1. Only after they filled out all of those, were the participants able to go to the last question, the aforementioned control question, in which we asked them what the survey was about. After choosing one option and clicking on the arrow to the next page, they received the following message that concluded the experiment:

> Thank you for taking part in this survey and for helping us with our thesis project! If your answers are complete, we will now donate money to the Swedish Childhood Cancer Fund. All the information collected will be handled with care and will not be stored, once we are done with the project. If you have any questions about the survey, please send us an e-mail to 23926@student.hhs.se.

The survey can be found in Appendix D. An example of each form of the two types of nudges can be found in Appendix E.

3.3 Pre-study

Prior to performing the experiment, we conducted a pre-study with 25 subjects. We asked people in Stockholm who are not students anymore, but were recently, as well as people who do not study in Stockholm, but are still students. We thereby tried to get as close to our target group as possible, without having to include people who would be part of the target group, which would have meant decreasing the number of responses we hoped to obtain in the actual experiment. It also assured us that the pre-study participants and the participants of the official experiment would not overlap.

Firstly, Qualtrics recorded how long it took participants to fill out the survey. This information allowed us to set a minimum requirement for the time that participants would need to adequately fill out the survey. The fastest pre-study participant took two minutes and 22 seconds to complete the survey, while all other participants took more than four minutes. Hence, we chose two minutes as the lower-bound time limit that participants would need to spend on the survey for their responses to be included in the statistical analysis. After all, if participants took less time during the experiment, we could reasonably assume that they had not taken the survey seriously, did not fully understand the task, or did not read through it properly. We also asked the pre-study participants if they found any parts of the survey unclear, hard to understand, or if they missed something in the experiment. Based on that, a couple of questions were slightly rephrased, an extra ingredient was added (Mixed minced meat, beef 50%, pork 50%), and the size of the pictures of all ingredients was increased.

3.4 Exclusion Criteria

As explained in Section 3.1, the survey answers from certain participants were excluded from the analysis. This was done in a systematic way, as outlined below.

Firstly, we deleted the survey responses in which participants indicated that they were not a student in Stockholm. Although these participants could not proceed with the survey after this question, Qualtrics still collected all of those responses, and, hence, we had to actively delete them. Secondly, certain responses were deleted on the basis that they were incomplete. Such cases include when people clicked on the survey link but then never filled out the (entire) survey. Thirdly, when subjects answered something completely different from what we asked for (e.g. providing us with their nationality when we asked them for their age), we excluded their responses from the analysis. The reason for excluding these responses was that we needed to have access to all participants' answers to demographic and attitude questions, and we, thus, had to delete the ones that did not include answers to all of those questions. Moreover, as mentioned in Section 3.3, respondents' answers were excluded if they took less than two minutes to answer the survey. As stated in Section 3.2.1, we created a main data set in which all responses that submitted any other answer to the final control question than "Choice of dinner and food products" were deleted. The other data set was kept to confirm that excluding those participants did not drive the results. Lastly, we kept all data points in the analysis that could be viewed as outliers.

4 Method

In this section, we present our methodical approach to answering our research question and evaluating the evidence for our two hypotheses. The method revolves around a multiple linear regression analysis that is introduced after a discussion about what effect we intend to identify from the experiment and how the analysis will be conducted.

4.1 Average Treatment Effect of the Nudges

As already mentioned, the survey experiment in this work distinguishes between one control group and two treatment groups that get exposed to two different nudges on the pictures of meat, fish and plant-based substitute products, whereas the control group does not get to see a nudge on the pictures of such products. Whether they get to observe a nudge in the experiment is the only difference between the groups. The treatment groups vary with respect to which type of nudge a participant gets to view (cognitive or affective). The logic behind having multiple experiment groups in order to find out the effect of a certain treatment was first addressed by Rubin (1977). Many more after him have written about this, e.g. Angrist and Imbens (1991). Below we rely on their frameworks in the context of our experiment.

To recall, according to our hypotheses, the nudges will significantly decrease people's average carbon (CO2e) footprint, and the affective nudge will lead to a significantly larger decrease than the cognitive nudge. Whether this is indeed true is to be tested.

We let Y_0 be the CO2e footprint of a person if they do not get treated, i.e. they do not get exposed to any nudge. It is assumed that Y_0 exists for all persons, even if they get treated in our experiment, in which case we cannot observe their Y_0. We further assume that Y_1 is the value of the same person's footprint if they get exposed to the cognitive nudge, which again is assumed to exist for every person. This means that $Y_1 - Y_0$ is the treatment effect that occurs due to having been exposed to the cognitive nudge (as compared to no nudge). Furthermore, we assume that Y_2 is the value of the same person's footprint if they get exposed to the affective nudge, and the assumption that it exists for every person applies here as well. Hence, $Y_2 - Y_0$ is the treatment effect that occurs due to having been exposed to the affective nudge (as opposed to no nudge), and $Y_2 - Y_1$ is the treatment effect that occurs due to having been exposed to the affective nudge rather than the cognitive nudge. However, we only observe one of Y_2, Y_1 and Y_0 for each person, which means that it is impossible to measure all three for each person. Hence, we need to rely on comparisons between multiple individuals and calculate the average treatment effects (ATE). We achieve this by assigning each subject randomly to one of the treatment or control groups.

The difference in average carbon footprint between the three groups that we measure in the experiment is called the observed difference (OD). If we look at the OD between the cognitive nudge group and the control group, and this OD solely measures the change in average carbon footprint between these two groups due to seeing the cognitive nudge, then the OD corresponds to the ATE. Hence, that OD can then be viewed as the effect on ecological footprint of having seen the cognitive nudge as compared to not having seen it. The equivalent holds when we take the OD between the affective nudge group and the control group. In that case, we measure the effect on carbon footprint of having seen the affective nudge as compared to not having seen it. Lastly, the same holds for the OD between the affective nudge and the cognitive nudge. In that case, the OD represents the effect on carbon footprint of having seen the affective nudge compared to having seen the cognitive nudge.

However, as stated above, the OD is only equal to the ATE if the sole cause of the difference in carbon footprint comes from having been assigned to different experiment groups (control *versus* cognitive nudge *versus* affective nudge). This indicates that it is essential that individuals are randomly assigned to treatment and control groups. Only in that case we can reasonably believe that the following holds:

$$\begin{gathered} E[Y_0|T=0] = E[Y_0] \\ E[Y_1|T=1] = E[Y_1] \\ E[Y_2|T=2] = E[Y_2] \\ \Rightarrow OD = ATE \end{gathered}$$

In practice, we infer whether random assignment has been successful with statistical analysis. More specifically, we check whether average characteristics — which we measure in terms of demographic and attitude questions during the experiment — do not significantly differ between the groups. In case there are significant differences between groups, the characteristics for which this would be the case could bias the coefficients that represent the effect of the cognitive and affective nudge respectively. After all, if having a certain characteristic influences someone's meat, fish or plant-based substitute choice, and this characteristic is disproportionately more present in one than in the other groups, this could influence the OD without the treatment being the cause of it. If so, we are dealing with a correlation between (at least) one of the explanatory variables and the error term, which would cause all OLS estimators to be biased (Woolridge, 2013). This is called omitted variable bias (OVB). Therefore, it is essential to check for significant differences between the control and treatment groups with respect to their average characteristics. After all, although the participants are assigned to a group randomly, we cannot take for granted that an even distribution of all possible relevant characteristics will automatically follow. Hence, when we investigate the differences in average characteristics between the three groups, and it turns out that they are significantly different from zero, we should add them as control variables (coded as vector $\mathbf{X_i}$ in our mathematical model below), so the coefficients belonging to the treatment variables (β_1 and β_2 in our model below) are less biased and reflect the true value of the ATE more closely. In this thesis, we will add controls to reduce the chance of OVB in case two or more of the demographics or attitude variables differ significantly between the groups at the 5% significance level ($p < 0.05$), the reason being that it is most likely random chance if only one of these variables significantly differs from 0 at the 5% significance level, but it seems much less likely that it is random chance in case two or more of these variables differ from 0 at the 5% significance level.

4.2 Mathematical Model and Variable Specification

Based on what we learnt from Section 4.1, we can now specify our mathematical model, given by the following multiple linear regression analysis:

$$F_i = \alpha_0 + \beta_1 \cdot T1 + \beta_2 \cdot T2 + \boldsymbol{\gamma} \cdot \mathbf{X_i} + \varepsilon_i$$

In this case, F_i stands for participant i's ecological footprint in terms of CO2e; α_0 represents the constant term; $T1$ stands for treatment 1 (cognitive nudge), $T2$ stands for treatment 2 (affective nudge), and β_1 and β_2 represent the regression coefficients belonging to the treatment 1 and treatment 2 variables respectively. $\mathbf{X_i}$ is a vector of baseline controls (or fixed characteristics) applied to participant i in order to prevent

OVB. As mentioned in Section 4.1, the controls will only be included in case our analysis shows that the average of two or more demographics and attitude characteristics are significantly different ($p < 0.05$) between the three experiment groups. Which specific variables this vector of baseline controls may include is spelled out in more detail below. To each of the control variables within $\mathbf{X_i}$ belongs a specific coefficient, which is embodied within the vector of control coefficients $\boldsymbol{\gamma}$. Lastly, ε_i represents the residual term. Below we explain the variables and coefficients, where necessary, in more detail.

The dependent variable F_i is coded as the ecological footprint, expressed in terms of CO2e, of a kg produced of the meat, fish or substitute products selected by an experiment subject. In other words, if a subject chooses to buy bacon in the experiment, the dependent variable captures the footprint from producing a kg of bacon. Hence, the dependent variable does not express the total CO2e footprint of all the ingredients that a subject would select for their meal in the experiment, but it is a standard measure of the CO2e footprint of their choice of meat, fish or substitute product (the products that would be labeled in the two treatment groups). It is, therefore, consistent across respondents, regardless of their dish choice, and it clearly disregards the footprint from other food products, since these would not have nudge labels on them.

Moreover, the footprint is a continuous variable that increases as the respondent selects a more environmentally unfriendly product (or more products), where the minimum is zero if no meat, fish or substitute products are selected and the maximum would result if a respondent were to select all such products they were exposed to. The potential footprint size depends on the dish that the respondent chooses to shop for in the experiment, since different dishes involve different possible ingredients. For instance, Swedish meatballs has a larger footprint potential than salad, since beef, which has the largest footprint in our experiment, was available to the meatball subjects and not to the salad subjects. We are, however, interested not primarily in subjects' total footprint, given their chosen dish (which is also why we did not measure the footprint of all ingredients), but rather the change in their footprint that nudging could hope to achieve by altering their meat, fish or substitute choice. If the experiment is adequately randomized, we will end up with comparable proportions of dish choices in each experiment group. Then the differences in footprints across dishes will not need to be controlled for, since the differences would average out.

The figures for footprints were taken from Florén and Sjons (2020) in the case of meat products, Clune et al. (2017) in the case of fish and sea products and from the vegan food brand Anamma (2021b)[9] in the case of plant-based meat substitutes, whose figures were said to be based on RISE estimates (Anamma, 2021a). All estimates rely on LCA. Furthermore, we do not use the extensive figures by Swedish researchers Moberg et al. (2019) for two reasons: firstly, these did not include all products we required for the survey; secondly, the figures applied "land use compensation" for the products studied, which increases those footprints, making them less comparable with figures from other sources. The collection of different footprints that we do use are the most consistent we have been able to come across.

α_0 is a constant term and will, thus, have an invariant value. This value represents the average carbon footprint in terms of CO2e of someone who is in the control group and has value 0 for all control variables. So, in case we do not have to add any control variables, it represents the average ecological footprint in terms of CO2e of someone in the control group.

The independent variable $T1$ is a binary variable that takes on the value 1 if a participant is in the cognitive nudge treatment group; otherwise, it takes on value 0. $T2$ is also a binary variable. It takes on the value 1 if a participant is in the affective nudge treatment group, and 0 otherwise. Our two regression coefficients of interest are β_1 and β_2. These coefficients show participants' average change in ecological footprint in terms of CO2e from receiving treatment 1 and treatment 2 respectively, holding all other potential variables fixed. In case the coefficients are (significantly) positive ($p < 0.05$), this means that, keeping all else equal, participants' ecological footprint in terms of

[9] We use Anamma's figures for products falafel, soy-based vegetarian mince, moldable ditto, vegetarian soy-based 'meatballs' and soy-based burger patties. The 'meatball' and patty figures were generalized across the different kinds of substitute (e.g. soy-based, pea-based etc.) presented in the survey.

CO2e on average (significantly) increases due to the treatments. In case they are (significantly) negative ($p < 0.05$), this means that, keeping all else equal, participants' ecological footprint in terms of CO2e on average (significantly) decreases due to the treatments. Our hypotheses above state that the nudges will reduce participants' carbon footprint, which means that we hypothesize significantly negative beta-coefficients.

The first hypothesis will be tested by checking if β_1 and β_2 are each significantly negatively different from zero ($p < 0.05$). After all, in this case, getting exposed to one of the nudges *versus* not getting exposed to them, all else equal, decreases one's carbon footprint significantly. The second hypothesis will be analyzed by testing whether the coefficient for the affective nudge, β_2, is significantly more negative than the coefficient for the cognitive nudge, β_1. This can be examined by checking whether β_2 has a larger negative value than β_1, and by executing an F-test which tests $\beta_1 - \beta_2 = 0$. Only in case β_2 has a larger negative value than β_1, and the F-test shows $p < 0.05$, we can conclude that hypothesis 2 is supported.

As mentioned above, the vector of baseline controls $\mathbf{X_i}$ is only added in case two or more of the demographics and attitude variables, which are derived from the demographics and attitude questions in our experiment (see Section 3.2.1), differ significantly between the groups at the 5% significance level ($p < 0.05$). As a brief recapitulation, we asked participants about their: gender, age, university (in Stockholm), degree, nationality, diet, number of meals per week containing meat or fish, determinant factors for their choice of diet, how much their purchase habits are affected by environmental concerns, how much they are willing to be inconvenienced for environmentally friendly actions, how much one individual can do about the environment, favorability towards a sustainable food label law and towards a carbon tax. How to treat each of these control variables in the analysis depends on the type of variable that we are dealing with. Regarding the questions that participants had to answer in integers (e.g. age) or in terms of a scalar value (e.g. attitude toward carbon tax), we will add the respective variable as a continuous control variable. Regarding all other questions, we are either dealing with ordinal variables (e.g. pursued degree) or nominal variables (e.g. nationality, gender, university in Stockholm). These variables are automatically coded in Qualtrics as numerically (e.g. 1-4 for gender),[10] and we will add them as dummies to our analysis, leaving out one baseline category. Lastly, where we need to add control variables to our analysis, they come with a corresponding coefficient. Such coefficients are jointly represented by γ in our regression specification.

4.2.1 Interaction Effects

The reason we let participants choose one of five dishes is that we want to provide them with a more realistic, but still research-friendly, environment than one where they would only have one pre-specified dish to shop for that might or might not suit them. Nonetheless, one could argue that the effectiveness of our nudges might differ between the five dishes, where a salad, whose main ingredients typically are vegetables, may be intrinsically easier to turn completely vegetarian than a hamburger. If found, such an observation could be theoretically interesting, but it is not the intention of this paper to specify and research such a model, since our nudges are designed to always appear on the packages of selected products, and not just when a participant picks a particular meal. Actual consumers shop for different dishes, so it would not be realistic to have salad-specific nudges or hamburger-specific ditto in grocery stores. Furthermore, controlling for the effect of our nudges with respect to the different dishes would involve including interaction effects of the treatment variables with dish-specific dummies. Retaining the same level of statistical power, as discussed in Section 3.1, to identify even one interaction term requires something like a fourfold sample size (Leon & Heo, 2009) as compared to identifying simple effects. In our case, interacting effects based on both experiment groups and dishes would involve eight interaction terms. It is needless to say that any estimation of interaction effects would in our case be highly imprecise and hardly informative, given our modest hopes of the size of our subject sample. For these reasons, we do not include the model specification and the results from the regression analysis with interaction effects in the main body of the thesis. Instead, they are added to Appendix F for the sake of transparency of our experimental results. Since we did not mention this type of analysis in our pre-analysis plan, it needs

[10] How each question was coded is specified in brackets behind each choice option in Appendix D.

to be classified as being an exploratory analysis.

4.3 Analysis Technique

As mentioned before, we use multiple linear regression analysis to explain the relationship between getting exposed to a certain cognitive and affective nudge and the ecological footprint from CO2e coming from meat, fish or substitute products. However, four assumptions need to be made in order for multiple linear regression analysis to give us an unbiased estimator of the population parameters (Woolridge, 2013). These four assumptions are the following: (i) linear in parameters, (ii) random sampling, (iii) no perfect collinearity, and (iv) zero conditional mean. Below we explain for each assumption why it is fulfilled in our model.

Our parameters parameters are α_0, β_1, β_2, and γ. As follows from the standard formula as stated in Section 4.1, these parameters are linear and the first assumption holds.

Regarding random sampling, our target group of subjects was of course different from *consumers in Sweden* and therefore not fully representative. Also, among *students in Stockholm*, we were not able to approach all of them, so some students (like SSE students) have a larger probability of being part of the experiment. Among those we did approach, however, all should have been given equal opportunity to participate, and those who did were randomly assigned by Qualtrics to the three different experiment groups, that is, all participants had an equal probability to be assigned to any of the groups. Hence, it is reasonable to assume random sampling.

Moreover, we can reasonably assume that the regression analysis will not suffer from perfect collinearity. Since we dropped the control group variable from the model specification, no exact linear relationship exists between the main independent variables. Furthermore, since constant values cannot significantly differ ($p < 0.05$) between different experiment groups, possible control variables will never be constants. Moreover, exact linear relationships between the different control variables seem highly unlikely.

The final assumption of Zero Conditional Mean (ZCM) states that:

$$E(u|T1, T2, \mathbf{X}) = 0$$

One way for the ZCM assumption to fail is when the dependent and independent variables are miss-specified. This does not seem to be a problem in this work, since subjects cannot be assigned to both treatments, $T1$ and $T2$, and we have no priors to believe that any of the possible control variables are not linear. The second way to violate the ZCM assumption is by omitting an important factor that is correlated with any of the independent variables. This relates to OVB, which we explained in detail in Section 4.1 above. As mentioned repeatedly, we aim to minimize the possibility of OVB by adding control variables in case two or more of them differ between groups at the 5% level. Hence, we are assuming this should not be a concern either.

5 Results

This section presents the results from our econometric analysis, which is chiefly based on a linear regression, where we explore the average treatment effects of our two nudges. We introduce the topic by presenting baseline characteristics from our experiment. We show that randomization has gone quite well, and that we have no evidence for either of our hypotheses.

After excluding the survey responses that did not meet our criteria, we were left with 625 entries for our main data set, and 631 by including the observations from participants that answered wrongly to the control question.[11]

5.1 Baseline Characteristics

The baseline characteristics from the 625 respondents in our main data set are presented in Table 3 below. The primary reason for including this table is to essentially assess whether the degree of randomization in the experiment was satisfactory. We do this by checking whether the baseline characteristics differ statistically significantly between the three experiment groups (control group, cognitive nudge group and affective nudge group) at the 5% level ($p < 0.05$). We conducted two types of tests: χ^2-tests for variables

[11] Since 631 people completely finished the survey, we donated SEK 631 to the Swedish Children's Cancer Fund. Proof of this can be found in Appendix G.

that could be described as categorical (such as *Gender* and *Stockholm University*) and ANOVA for variables that could be interpreted as continuous (e.g. *Age* and the scalar metrics for the degrees of statement agreement).

Significant differences between the groups are depicted by asterisks in the table. As shown, only the two diet factors *Convenience* and *Variety* are statistically significantly different between the experiment groups, indicating that randomization among the participants has gone relatively well. Significantly more respondents in the cognitive nudge group suggested that the convenience diet factor influence their diets than in the other two groups. The same holds for the affective nudge group with respect to the variety diet factor. Therefore, these two variables were included as control variables in our main regression analysis, by which we follow the procedure explained in Section 4.2, which in turn was derived from our pre-analysis plan (see Appendix A).

Furthermore, as can be observed in Table 3, there is a relatively big difference in gender balance between the control and cognitive group. We observe 18.5 percentage points more males than females in the control group, but 2 percentage points fewer males than females in the cognitive group. This could potentially be concerning, as research shows that men's diets typically include more meat than women's Amcoff et al. (2012). Hence, even though we do not observe statistically significant differences in gender between the groups, we want to add an extra analysis with *Gender* as a control variable, so as to make sure that the results from the main analysis are not driven by a bias due to not accounting for the differences in gender balance between the groups.

By looking more closely at Table 3, we observe that participants on average are around 24 years old and eat circa nine meals per week that include meat or fish. For the first three scale questions, a score of 3.5 means that participants are relatively indifferent to the statement. For the last two scale questions, the equivalent would be a score of 2.5. Hence, participants slightly agree with the statement that their purchase habits are affected by their concern for the environment. The same holds for the statement that participants are willing to be inconvenienced in order to take actions that are environmentally friendly, although the average agreement with this latter statement is slightly higher than for the former statement. Furthermore, subjects slightly disagree with the statement that there is not much that any one individual can do about the environment. Taken together, this suggests that our subjects may not be very responsive to our designed nudges, which — as we will show in the next section — our experiment also shows. After all, if people are not particularly eager to change their purchase habits due to their concern for the environment, do not notably want to take inconvenient, but pro-environmental, actions, and do not really think that they can individually change environmental problems, it is an indication that they may be reluctant to change their behavior in favor of environmental sustainability. Furthermore, we observe that the participants are relatively in favor of labeling food products according to their climate impact. The same holds for a carbon tax on food products, but the degree of support for such a tax is lower than for the labeling. This, therefore, supports the use of nudges as compared to a carbon tax.

For the dish choices, we note that spaghetti bolognese is the dish that was chosen the most often, followed by tacos, and then hamburgers. The other two dishes were much less popular, where salad was chosen slightly more often than Swedish meatballs. With respect to the gender variable, we can see that more than half of the participants identify as male, somewhat less than half identify as female, and only seven participants as either non-binary or preferred not to put any label on their gender. Furthermore, we observe that more than half of the participants are students at the Royal Institute of Technology, about 40% are students at Stockholm School of Economics students, and a much smaller group, which made up about 5% of the participants, are Stockholm University students. Less than 0.5% of all participants attend Södertörn University or Karolinska Institutet, and nobody attends any other university in Stockholm. When it comes to diet labels, more than half claim to follow a standard diet. The largest group after that, comprising more than 20% of the total participants, are said to be flexitarian. Less than 10% claim to be vegetarian. The group of vegans, pescetarians, and participants that did not want to attach a label to their diet each consists of about 3% of the participants.

The last variable in Table 3 covers diet factors. As follows, the diet factor that was picked most often with respect to choosing a diet was "health". "habit", "convenience" and "prices" were also very often indicated as important factors. The only factor that was chosen very few times was "variety". The variable that is most interesting for this thesis is environment. Slightly less than 50% of the participants say that they take the environment into account as they observe a certain diet. This is an interesting observation, given the answers to the scale questions, where participants on average only slightly agree that their purchase habits are affected by their concern for the environment, where they on average claim that they were only slightly willing to be inconvenienced for the environment, and where they slightly disagree that they could individually influence environmental problems. However, looking only at this diet factor, we would expect that participants would be willing to change their eating habits with respect to meat, fish and plant-based substitute consumption, once they learn the environmental impacts of these kinds of products. This is, therefore, an observation in favor of implementing the nudges designed in this thesis.

In sum, the average age of participants is 24 years, they eat nearly 9 meals per week that contain meat or fish, slightly more (less) than half are male (female), two thirds of them study a master's degree, and somewhat less than a third study a bachelor's degree. Two thirds have the Swedish nationality, and slightly less than a fifth have an EU/EEA nationality (non-Swedish). More than three fifth say that they have a standard diet and somewhat more than a fifth a flexitarian diet, whereas the other diets are much less popular. Health is the most important diet factor among participants and variety the least popular. Furthermore, participants seem to be somewhat reluctant to change their behavior in favor of environmental sustainability, and they prefer a climate impact label to a carbon tax. During the experiment, participants chose spaghetti bolognese most often, closely followed by tacos.

Table 3: Baseline demographic and attitude characteristics

	All subjects N=625	Control N=184	Cognitive N=230	Affective N=211
Age	24.03 (3.61)	24.18 (3.62)	23.76 (3.19)	24.20 (4.02)
Weekly meat meals	8.85 (5.61)	8.73 (5.51)	9.10 (5.56)	8.69 (5.75)
Scale questions (scale)				
Purchase habits affected by environmental concern (1-7)	4.08 (1.53)	4.12 (1.51)	4.05 (1.62)	4.09 (1.46)
Willingness to be inconvenienced for the environment (1-7)	4.32 (1.58)	4.23 (1.53)	4.37 (1.66)	4.33 (1.52)
Individual influence on the environment (1-7)	3.20 (1.86)	3.17 (1.89)	3.33 (1.88)	3.09 (1.80)
Pro climate impact label (1-5)	4.14 (1.00)	4.15 (1.02)	4.21 (0.95)	4.07 (1.04)
Pro carbon tax (1-5)	3.50 (1.28)	3.47 (1.22)	3.56 (1.33)	3.46 (1.29)
Dish choice				
Hamburger	134 (21.44%)	48 (26.09%)	41 (17.83%)	45 (21.33%)
Salad	60 (9.60%)	15 (8.15%)	22 (9.57%)	23 (10.90%)
Spaghetti bolognese	198 (31.68%)	54 (29.35%)	74 (32.17%)	70 (33.18%)
Swedish meatballs	52 (8.32%)	19 (10.33%)	22 (9.57%)	11 (5.21%)
Tacos	181 (28.96%)	48 (26.09%)	71 (30.87%)	62 (29.38%)
Gender				
Male	333 (53.28%)	108 (58.70%)	112 (48.70%)	113 (53.55%)
Female	285 (45.60%)	74 (40.22%)	116 (50.43%)	95 (45.02%)
Non-binary	4 (0.64%)	1 (0.54%)	1 (0.43%)	2 (0.95%)
Prefer not to say	3 (0.48%)	1 (0.54%)	1 (0.43%)	1 (0.47%)
Stockholm University				
Karolinska Institutet	2 (0.32%)	0 (0%)	1 (0.43%)	1 (0.47%)
Royal Institute of Technology	335 (53.60%)	96 (52.17%)	124 (53.91%)	115 (54.50%)
Stockholm School of Economics	253 (40.48%)	76 (41.30%)	95 (41.30%)	82 (38.86%)
Stockholm University	34 (5.44%)	12 (6.52%)	10 (4.35%)	12 (5.69%)
Södertörn University	1 (0.16%)	0 (0%)	0 (0%)	1 (0.47%)
Other	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Degree				
Bachelor	193 (30.88%)	58 (31.52%)	72 (31.30%)	63 (29.86%)
Master	421 (67.36%)	121 (65.76%)	154 (66.96%)	146 (69.19%)

PhD	2 (0.32%)	0 (0%)	0 (0%)	2 (0.95%)
Other	9 (1.44%)	5 (2.72%)	4 (1.74%)	0 (0%)
Nationality				
Swedish	423 (67.68%)	120 (65.22%)	161 (70.00%)	142 (67.30%)
EU/EEA (non-Swedish)	114 (18.24%)	36 (19.57%)	44 (19.13%)	34 (16.11%)
Non-EU/-EEA	88 (14.08%)	28 (15.22%)	25 (10.87%)	35 (16.59%)
Diet label				
Vegan	18 (2.88%)	4 (2.17%)	5 (2.17%)	9 (4.27%)
Vegetarian	45 (7.20%)	12 (6.52%)	18 (7.83%)	15 (7.11%)
Pescetarian	19 (3.04%)	7 (3.80%)	3 (1.30%)	9 (4.27%)
Flexitarian	134 (21.44%)	38 (20.65%)	52 (22.61%)	44 (20.85%)
Standard Diet	389 (62.24%)	116 (63.04%)	145 (63.04%)	128 (60.66%)
No label	20 (3.20%)	7 (3.80%)	7 (3.04%)	6 (2.84%)
Diet factors				
Prices	433 (69.28%)	120 (65.22%)	166 (72.17%)	147 (69.67%)
Convenience*	429 (68.64%)	120 (65.22%)	174 (75.65%)	135 (63.98%)
Environment	298 (47.68%)	88 (47.83%)	105 (45.65%)	105 (49.76%)
Ethics	165 (26.40%)	51 (27.72%)	59 (25.65%)	55 (26.07%)
Habit	456 (72.96%)	141 (76.63%)	163 (70.87%)	152 (72.04%)
Health	513 (82.08%)	153 (83.15%)	192 (83.48%)	168 (79.62%)
Taste	124 (19.84%)	40 (21.74%)	41 (17.83%)	43 (20.38%)
Tradition	219 (35.04%)	74 (40.22%)	75 (32.16%)	70 (33.18%)
Variety*	14 (2.24%)	3 (1.63%)	2 (0.87%)	9 (4.27%)
Other	332 (53.12%)	97 (53.12%)	129 (56.09%)	106 (50.24%)

Note: The design of Table 3 is based on the table on baseline characteristics from a controlled trial paper by Evins et al. (2008). Just like in that table, continuous and scale variables are presented as mean and standard deviation; others as count and proportion.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

5.2 Main Regression Analysis

As presented in Table 4 under (2) below, our main regression analysis, including treatment dummies and the two baseline characteristics that differed between the experiment groups, shows slightly negative effects of both nudges on participants' footprints, but they are both statistically insignificantly different from zero. Hence, we do not have any robust evidence that the effect sizes, that the two treatment coefficients suggest that our nudges have, are true effects. Performing an F-test for the two coefficients, we find an insignificant p-value of 0.49, which suggests that they are not significantly different in size from each other.

Table 4: Main regression analysis of the effect of nudging on CO2e footprint

	(1)	(2)	(3)
		CO2e footprint	
Cognitive nudge treatment	-0.854	-1.340	-0.749
	(1.541)	(1.532)	(1.528)
Affective nudge treatment	-0.292	-0.268	-0.026
	(1.557)	(1.555)	(1.539)
Diet factor: convenience		4.753***	3.991***
		(1.316)	(1.314)
Diet factor: variety		1.336	2.054
		(5.547)	(5.811)
Gender			
Female			-4.920***
			(1.271)
Non-binary			-6.800
			(7.131)
Prefer not to say			9.589
			(5.962)
Constant	17.35***	14.23***	16.675***
	(1.108)	(1.407)	(1.543)
N	625	625	625
R^2	0.000511	0.0198	0.0463
Type	OLS	OLS	OLS

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

The treatment variable coefficients can be interpreted as the average treatment effect of the two nudges on participants' carbon footprint from meat, fish or substitute products. This is compared to the constant term equal to 14.23, which represents the average footprint size in CO2e (of kg per meat, fish or substitute product chosen) of a person in the control group who has chosen neither variety nor convenience as factors that matter when choosing a diet to follow. Since the average treatment effects that our regression suggests are so minor, we can clearly see that the average subject in either treatment group has a footprint very similar to the average subject in the control group, all other things equal.

Moreover, while we are not interested in the coefficient sizes of the control variables, which are added specifically to control for potential variation arising from unbalanced experiment groups, it is interesting to note that the coefficient on convenience is highly significant. The coefficient is positive, indicating that, all other things equal, considering convenience as an important factor when choosing a diet to follow, increases footprint as compared to not considering it.

As presented in Table 3, both diet factors are only just significantly different between the experiment groups at the 5% level, so to assure the reader that our results do not hinge on the inclusion of the two controls, we run a regression without adding the controls. That second regression is presented in Table 4 under (1). This analysis shows very similar findings as the analysis with the control variables, both with regard to the small coefficient sizes and their statistical insignificance. Furthermore, the F-test from this regression including the two treatment coefficients yields a very insignificant p-value of 0.71, which, like for the model with the two control variables, indicates that they are not significantly different from each other.

Furthermore, in Table 4 under (3) the gender variable is added, in order to account for possible OVB due to not accounting for the differences in gender balance between the experiment groups. The first thing we observe is that average CO2e footprint for women is statistically significantly lower than for men, all else equal. This is in line with previous findings (Amcoff et al., 2012). Apart from that, we observe that the values of the treatment variable coefficients change slightly, but nothing changes with respect to significance. Like before, executing an F-test shows no statistically significant difference between the two treatment coefficients. Hence, adding the gender variable does not drastically change — and, thus, drive — the main results. Hence, excluding it from the main analysis is justified.

Another interesting observation from Table 4 is the R^2-value for each model. We observe that our model without control variables can explain 0.0511% of the variation in CO2e carbon footprint. Even though the R^2-value should not determine whether or not we have chosen the right model, it does indicate to us that negligibly little of the variation in our explanatory variable can be explained by the model. Once we add the two diet factor control variables, we observe that the R^2-value increases to 0.0198, and to 0.0462 when we also add the gender variable to the model, indicating that 1.98% and respectively 4.63% of the variation in CO2e footprint can be explained by the models under (2) and (3) respectively. From this we can infer that the differences in CO2e footprint between participants in our experiment was mostly determined by other factors than whether or not a participant got exposed to one of the nudges. This supports the earlier observed result that the coefficients for both of the nudge treatments are not statistically significantly different from zero at the 5% level. After all, a negligibly small effect of the nudges should not be able to explain much of the variation in participants' CO2e footprints, which is what these R^2-values confirm.

Furthermore, the total number of respondents in Table 4 is equal to 625. This number is based on following all exclusion criteria that we mentioned in Section 3.4, which were in turn based on our pre-analysis plan (see Appendix A). This excludes the responses from the six participants that answered the control question wrongly, based on reasons mentioned in Section 3.2.1. However, it is important to make sure that deleting these responses does not bring about large changes to the sizes and significance of the coefficients. Hence, we executed the same regression analysis as in Table 4, but then without deleting the responses from those six participants. The table containing the exact figures from this marginally extended regression analysis can be found in Table 7 in Appendix F. This shows very similar results as in Table 4, and does not change anything about the significance of the coefficients. Furthermore, like the F-test for the cognitive and affective nudge treatment coefficients from Table 4, the F-test based on the coefficients from Table 7 in Appendix F gives us an insignificant p-value. Hence, it is justified to use the data presented in Table 4 for our analysis. In Appendix F, we also present the results from the interaction effects model that we mentioned in Section 4.1.2. As explained in detail in Appendix F, the results from this exploratory analysis support the results from the main analysis. It also provides *no support* for the statement that the capacity of the nudges to decrease carbon footprint depends on the type of dish that someone chooses.

5.2.1 Evidence for Hypothesis 1

There is *no evidence* supporting the first hypothesis.

The first hypothesis predicted that a pro-sustainable nudge would reduce consumers' carbon footprints, by decreasing the amount or changing the kind of meat or fish they would buy. While our econometric analysis indeed finds a negative, albeit small, effect from the two different nudges on test subjects' carbon footprints, our results show no significant effect.

5.2.2 Evidence for Hypothesis 2

There is *no evidence* supporting the second hypothesis either.

The second hypothesis predicted that the affective nudge would reduce consumers' carbon footprints more than the cognitive nudge. Our results suggest that if anything the opposite might even be true, since the cognitive coefficient was larger in absolute terms than the affective one. However, even though both coefficients were negative, albeit not statistically significantly different from zero, they were not found to be significantly different from each other.

6 Discussion and Conclusion

6.1 Discussion of the Results and Their Limitations

Our experiment was executed much like we had hoped. Few and very minor changes were made after publishing our pre-analysis plan, and the sample size we managed to obtain far surpassed what we anticipated. Randomization, which is the pillar that the experimental procedure rests on, worked to our advantage. The three experiment groups showed similar distributions of the control variables, although we controlled for two that were slightly skewed. All in all, the experiment gives us a good foundation for answering our research question.

Our results suggest that our nudges have tiny negative or no effect on the participants' hypothetical CO2e footprint in the experiment, since the coefficients were small and insignificant. The question is whether these results are *valid* on the one hand, i.e. accurately answer the research question, and *reliable* on the other hand, meaning that they can be generalized across other contexts.

Regarding validity, the first point to make is that we conducted a digital experiment, measuring an immediate — that is, short-term — effect. Our research question is more generally phrased (to wit, *Which effect can nudging have in a retail setting on the carbon footprint coming from meat and fish consumption among consumers in Sweden?*). Our experiment therefore lacks some realism, in the sense that it does not involve actual food purchases in stores on the participants' part, and it also fails to identify a potential long-term effect that being continually exposed to anti-meat nudges every time one goes grocery shopping might have on consumer preferences and behavior. This is potentially problematic for determining the true effect of nudging on consumers' carbon footprint.

One could argue that consumers in real-life situations might perceive their choices as more consequential than in an experimental setting, having real implications for GHG emissions, which would suggest that their willingness to buy meat would be lesser. Alternatively, one could argue, and indeed we will, that real-world situations are more complex and involve economic and sensory aspects that are only imperfectly captured in the digital experiment. If consumers are not willing to change their behavior in the digital setting, it is not likely that they would behave very differently in an equivalent real-world context, where they may simply be in the mood for bacon or may feel stingy when the real sausages are cheaper than plant-based substitute.

Another validity point that we should stress is that we have only investigated nudging as cognitive and affective nudge-plus labels on food products, whereas nudging could be carried out in a myriad of different ways. While our particular nudges seem to have no effect on consumer choices, nudging in terms of e.g. placing meat and fish in obscure sections of the grocery store could in theory yield a different result. Our types of nudge were, however, carefully selected and designed, as discussed throughout Sections 2 and 3, so even if some kind of alternative nudge might hypothetically be more effective in reducing consumers' CO2e footprints, it would likely come at the cost of being practically infeasible or manipulative, thereby losing its appeal as a policy. We do, however, touch the potential of employing health-related nudges in Section 6.2 below.

Moreover, it is clear that our sample population of students in Stockholm did not reflect the overall population of consumers in Sweden. Non-Swedish nationals made up a third of our sample, compared to roughly 20% of the total population being being born outside Sweden (Statistiska centralbyrån, 2021c). Furthermore, students typically are young adults, whose consumption will differ from that of older Swedes due to values, for example. Students also have limited budgets and will be more price sensitive than working adults. Thus, we cannot be sure as to what results we would obtain if the experiment were carried out on a more representative consumer sample, but it appears unlikely that the general population would be more responsive to anti-meat nudges than students in Stockholm. Data from the food industry suggests that vegetarianism in Sweden is primarily driven by young people, by the highly educated and by those living in the greater urban areas of the country (Colombo et al., 2020), all of which fit the description of our sample. This suggests that, if anything, the general population would be even less responsive to our nudges.

When it comes to reliability, we believe that different populations might respond differently to nudging, because of the stark influence of norms on diets, as discussed in Section 2.3.2. If vegetarianism were to grow over the coming years, a similar study two decades hence might find that people respond forcefully to pro-plant-based nudging, for the simple reason that going vegetarian will be more socially convenient than it is today. Similarly, consumers in other countries than Sweden are subject to different norms and would therefore be likely to respond differently to the same kinds of nudge. One can presume, however, that countries that are similar in diet-related norms, eating comparable amounts of meat per person, and are similar in people's attitudes toward climate change and sustainability would find results like ours.

Moreover, inhabitants of Sweden are in general cautiously positive toward nudging (Almqvist, 2020), whereas the populations of countries like China, Brazil, South Africa and South Korea are considerably more positive (Sunstein et al., 2018). How nudges as a policy tool are perceived may very well influence how effective they are — especially in our case where the nudge is purposely perceptible. In countries that tend view nudging more favorably, it would not be unreasonable to assume that visible nudges are to a higher degree responded to in line with policymakers' intention than in countries that have a more skeptical perspective *vis-à-vis* nudges.

Regarding the statistical power of our analysis, we pre-specified that a sample size of 130 participants per experiment group would give us potential to identify a medium-sized effect (equivalent to a Cohen's d of 0.35) with 80% power and an α of 0.05. While our sample sizes amounted to roughly 200 participants per group, the Cohen's d effect size that we could hope to identify would be of roughly the same medium size, given the same level of power and α, namely approximately 0.28 (again, calculated with the same online tool, *Free Statistics Calculator*). Consequently, we do not possess sufficient power to find a small effect. It is possible that the nudges have a true effect similar in size to the insignificant coefficients we have, that is, very small. If so, such an effect could potentially be correctly identified if we had a much larger sample size and more power. For instance, the online tool suggests that an anticipated small effect size equivalent to a Cohen's d of 0.1 would demand a sample size of more than 1,500 subjects per group for the same power and α, which is indeed very far from our modest 200 or so.

While it is in theory possible that our nudges have a small effect that we have not been able to detect, such an effect would be of limited interest, since it would not be of much use in the fight against climate change anyway. As discussed in the introduction, consumers in Sweden eat quite considerable amounts of meat, which in turn contributes to a significant carbon footprint. Thus, a nudge that only slightly reduces meat consumption is indeed a promising start, but far from sufficient as a policy tool.

6.2 Suggestions for Future Research

Following the discussion above, suggestions for future research would include real-life studies, ideally field experiments, that could test whether nudges of our kind would have an effect on actual consumers in actual grocery stores. This could generate more conclusive and exact descriptions of the effect of nudging on consumers' meat and fish consumption. Such fields experiments could also identify effects over a longer period of time, which in the end is what matters for sustainable food consumption.

We do, however, remain skeptical about nudges' potential to change consumers food choices, which is why we would suggest that future research also explore the alternative ways of promoting a more plant-based, i.e. sustainable, diet. We referred in Section 1.2 the (limited) potential of GHG taxes applied to food. While they have certain issues associated with them, it may be necessary to keep searching for the optimal ways to utilize taxes, given that nudging seems to show even less promise.

What is perhaps more promising is a way to directly address the factors that we discussed in Section 2.3.2 as influencing both diets and food consumption: a knowledge gap concerning their environmental effects, social, diet-related norms and so on. As is evident from Table 3, nearly half of our respondents selected *Environment* as a factor that influences their diet, and the respondents on average only slightly agreed with the two statements that their purchase habits were affected by a concern for the environment and that they were willing to be inconvenienced for the sake of the environment. Hence, there is room for improvement. If future research could identify ways to increase people's knowledge of how their diets related to GHG emissions and, in extension, climate change, that could potentially be key to changing their behavior. Such ways may include education or large-scale information campaigns.

Since so many of our respondents said their diets were influenced by health and habit (82% and 73% respectively), however, an alternative approach that future research could choose might be whether it is more efficient to highlight the health benefits of consuming less meat (which could be done via nudging), or to study e.g. whether influencing school children's diets in favor of more plant-based at an early age yields a more environmentally sustainable diet in the long-run.

6.3 Thesis Conclusion

We finally conclude that we have no evidence to suggest that nudging in a retail setting would have a major effect on the carbon footprint of consumers in Sweden coming from meat and fish consumption. Although our experiment has some drawbacks when it comes to determining the true effect size of our nudges, we argue that our results are indicative of a limitation of nudges to radically change consumer behavior. Thus, we would recommend that policymakers consider nudging with caution and not as a panacea for all carbon ills that stem from a high meat and fish consumption. As discussed, we cannot tell whether nudging has a minor effect on reducing food consumers' carbon footprints — it very well may have — however, minor effects are not enough to prevent devastating climate change. Hence, if nudging should be considered as a policy tool, it should not be so alone, but rather as part of a larger policy package, including e.g. a carbon tax.

In light of our cautious conclusions, policymakers and future research may consider alternative ways of affecting the factors that we have discussed as influencing diets and food consumption. Because climate change is a matter of utmost urgency, we encourage readers not to be disheartened by our results, but rather see them as evidence of what does not work and look for other remedies to unsustainable meat consumption instead.

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Appendix A: Pre-Analysis Plan

Metadata

Title Decreasing people's carbon footprint by nudging them into eating less meat or fish

Description

In this paper, we are investigating whether a cognitive and/or an affective nudge can decrease people's carbon footprint from meat/fish consumption in a retail setting. With respect to the cognitive nudge, we designed a label disclosing the carbon footprint of the product, including a 'grade' that takes the color red, yellow or green depending on the size of the carbon footprint. The affective nudge also includes this 'grade' and has an encouraging text (for plant-based substitutes), a warning text or a discouraging text (animal-based meat/fish products).

In order to test our hypotheses, we designed a survey, in which we ask subjects to imagine that they are buying ingredients for tonight's dinner (we present a number of dishes from which they choose their preferred one). In the experiment, there are two treatment groups, one group for each nudge, and one control group, in which people do not get to see any nudge.

Contributors

Eugénie de Jong and Carl Widstrand

Category

Project

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Year

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Subjects

Social and Behavioral Sciences, Economics

Study Information

Hypotheses

The project's research question is: Which effect can nudging have in a retail setting on Swedish consumers' carbon footprint coming from consumption of meat, fish and plant-based substitutes?

H1: A pro-sustainable nudge will on average influence consumers' carbon footprints negatively, by decreasing the amount or changing the kind of meat or fish they buy.

H2: An affective nudge will on average influence consumers' carbon footprints more negatively than a cognitive nudge.

Design Plan

Study type

Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

Blinding

For studies that involve human subjects, they will not know the treatment group to which they have been assigned.

Personnel who interact directly with the study subjects (either human or non-human subjects) will not be aware of the assigned treatments. (Commonly known as "double blind")

Is there any additional blinding in this study?

In this experiment, no personnel/human-being will interact directly with the study subjects at all. After all, the subjects are randomly assigned to one of the three experiment groups by Qualtrics. Hence, it is impossible that subjects are treated differently based on the experiment group they are assigned to (except for the type of nudge that they get or do not get to see). We, the researchers, will only get to see the results on the aggregate and after the experiment has ended.

Study design

Our experiment is in the form of an online survey. The tool we are using to execute this online survey is Qualtrics. Attached to this question, you can find a detailed overview of the experiment we designed in Qualtrics. The file is called "Experimental Design Qualtrics". Important to note, however, is that we have not added the pictures of the ingredients that participants get to see during the experiment in this file, because we did not want to make the file too extensive. However, examples of the pictures (with nudges on them) can be found in the file "Examples of the nudges".

In our experiment, participants get to decide which meal they want to eat that evening (they can choose between 5 pre-specified meals), and which pre-specified ingredients they want to buy for that meal. We manipulated whether or not participants get to see a nudge on the pictures of (animal-based) meat and fish products, and (plant-based) meat/fish alternatives (which we call "substitutes" from hereon) which they get exposed to during the experiment. We designed two different types of nudges (a cognitive and an affective nudge), and we are testing the effectivity of each of these in a separate treatment group. Both types of nudges aim to decrease participants' carbon footprint from meat/fish consumption by stimulating them into eating more substitutes instead of meat/fish products.

Participants in the control group do not get to see any of our designed nudges on the pictures of the meat/fish/substitute products that they get to pick during the experiment. Participants in each of the two treatment groups get to see one of the two types of nudges on the pictures of the meat/fish/substitute products that they get to pick during the experiment. To be more specific, participants in the "cognitive nudge group" get to see a cognitive nudge on the pictures of the meat/fish/substitute products, whereas the participants in the "affective nudge group" get to see an affective nudge on the pictures of all such products.

All pictures of the products that participants get to choose during the experiment are the same for the three groups, apart from the fact that the pictures of the meat/fish/substitute products in the two treatment groups also contain a nudge. The procedure that the subjects need to follow during the experiment are exactly the same for all groups. Hence, there is no counterbalancing required. This means that our independent variable is treatment, which exists on 3 levels: control group (no nudge), affective nudge group, and cognitive nudge group. We also have a between-subjects design, since all participants only get assigned to one of the experiment groups and we are comparing the differences between these different groups.

Subjects assigned to the cognitive nudge group get to see a nudge in the form of a traffic light nudge (a real traffic light (green, yellow, red) and the same background color as the color that is showing on the traffic light, depending on the size of its carbon footprint) plus an informative text on how relatively much the nudge contributes to the emission of greenhouse gases. More specifically, for each type of meat/fish product the informative text explains the number of kilometers driven by car (fueled by gasoline) that producing one kg of the product is equal to (on average).

Subjects in the affective nudge group get to see a nudge that aims to create certain feelings among consumers during their decision-making. This nudge comes in three forms: an encouraging form (for the products with a relatively low level of carbon footprint), a warning form (for the products with an intermediate level of carbon footprint), and a discouraging form (for the products with the highest level of carbon footprint). The first version of the nudge aims to encourage people to buy the product, by showing an encouraging text ("Make this climate conscious choice!"), a picture of a flourishing rain forest, a green background color and a green check mark. The second version of the nudge aims to warn consumers about their choice, by displaying a cautionary text ("Rethink this climate unfriendly choice!"), with a picture of a fallen tree below it, a yellow background and a warning sign with an exclamation point. The third version of the nudge aims to discourage people to buy the product, by presenting a discouraging text ("Avoid this climate damaging choice!"), a picture of a burnt-down rain forest, a red background and a black X with a red circle around it. An example of each type of nudge and their three different versions is attached to this question in the file "Examples of the nudges". The participants in the control group get to see the exact same pictures, but then without any of the nudges on them.

Pictures were taken from two stock photo website (Pixabay.com and Pexels.com). Some were also permissably edited, which allow us to use them without copyright issues.

We also ask respondents some general questions about their demographic background (e.g. age) and their attitudes toward (plant-based) diets. More about these questions follows in the subsections below.

- Examples of the nudges.pdf
- Experimental Design Qualtrics.pdf

Randomization

Since we are doing our experiment in Qualtrics, we can let the program randomise the participants among the treatment and control groups. We chose "Randomizer" and "Evenly Present Elements", which makes sure that each element (= each of the nudge treatments/control) is presented a roughly equal number of times across all respondents.

We will not randomize with respect to who we recruit for our experiment. We will ask all students that we are able to reach. However, once participants have chosen to participate in our survey, they will be randomly assigned to one of the three groups (one of the two nudge treatment groups or the control group). So, we randomize on the level of participants that we have approached and "choose" to partake in our survey.

Sampling Plan

Existing Data

Registration prior to creation of data.

Explanation of existing data

We conducted a pre-study with 25 subjects. We asked people that are not a student anymore but were one recently, and people who do not study in Stockholm, but are still students. In this way, we tried to get as close to our target group as possible, without having to include people who are part of the target group, and, therefore, decreasing the amount of responses in the real experiment. It also assured that the pre-study participants and experiment participants do not overlap.

Firstly, Qualtrics records how long it takes participants to fill out the survey. Using this, we were able to set a minimum requirement for the time that participants need to take in order to fill out the survey. The fastest pre-study participant took 2 minutes and 22 seconds to answer the survey. However, all other participants took more than 4 minutes. Hence, we decided that 2 minutes will be the lower-bound with respect to the time that participants need to take in order for their survey responses to be analyzed. After all, if participants take less time during the experiment, we can reasonably assume that they haven't taken the survey seriously enough or did not understand properly what they were asked, and, hence, we will not analyze the results from such a participant.

We also asked the pre-study participants if they found any parts of the survey unclear, or if they missed something in the experiment. Based on that, we made some (minor) changes to our survey (increasing the size of the pictures somewhat, slightly changing the wording of a few questions, and adding an ingredient to some of the dishes).

The pre-analysis also made it easier for us to decide on other reasons for which we will exclude certain participants' results. However, we did not quantitatively analyze the results of the pre-study, so we still have not assessed anything with respect to the effectiveness of our nudges. Even if we would do such a thing, this does not seem to add anything to our current knowledge, since the group of pre-study participants was very small, the participants were from a different target group, and we explained the questions we wanted to ask them after they had done the experiment already before they started. Hence, their view on and approach to our survey will most likely differ from the subjects in our official experiment.

Data collection procedures

The population from which we will obtain subjects is students in Stockholm, of which most students will most likely be from Stockholm School of Economics (since we can more easily approach them via multiple channels) and the Royal Institute of Technology (Since we received 4331 student e-mail addresses).

Participants from Stockholm School of Economics and the Royal Institute of Technology will be recruited by sending out e-mails with our survey link to their student e-mail address. We obtained the e-mail addresses of students from the Bachelor Program in Business and Economics, the Master Program in Economics and the Master Program in Finance at Stockholm School of Economics by requesting them from the different program directors. We received the e-mail addresses from all students at the Royal

Institute of Technology that are in the last year of their bachelor's or master's degree. Apart from this, the message will be sent in the Microsoft Teams groups from the MIB and MBM students. Another method we will use is sending the link through different social media channels. We reached out to students from each master program at Stockholm School of Economics, and they will send our survey link in either the Facebook or WhatsApp group that they share with their classmates. We will also post the message on the Facebook wall of the group for Stockholm University students. We will not be collecting any personalized information, and the data (and e-mail addresses) will not be stored beyond the completion of this project. Respondents will be informed of their anonymity in the survey. The content of the messages can be found in the file "E-mails", attached below this subsection on Data collection procedures.

For each finished survey, we will donate 1 Swedish Krona to the Swedish Childhood Cancer Foundation (Barncancerfonden). Participants will be notified of this before they start with the experiment and after they have finished it. We will also mention this when we recruit participants.

We make sure that only (bachelor, master, PhD) students in Stockholm can finish our survey by starting with a question in which we ask whether they are students that are currently enrolled at a university in Stockholm. If respondents answer that they are not, the survey gets terminated. They get a final message in which we thank them for their cooperation. Thanks to this, we can assure that only eligible subjects (i.e. students in Stockholm) are able to fill out the survey.

We acknowledge that we have a limited target group. Important to note is that our resources are rather limited and homogeneity among the three different groups (control group, cognitive nudge and affective nudge) is crucial in order to be able to compare them properly in our statistical analysis. Hence, we had to consider which homogenous group would be the easiest for us to reach out to and get responses from. Since it is common practice in experiments to use students as subjects, and since they are the group that we can reach the easiest, we decided to stick to students as our participants. Also, as the prices in our experiment are based on the prices in supermarkets in Stockholm, we only focus on students in Stockholm.

With respect to our study timeline, we will start with recruiting people to take part in our experiment on October the 27th. The first action we will take is sending the link of the experiment to the students at Stockholm School of Economics whose e-mail addresses we received. We will do this at 15:00. We also instructed the MAVFM students that we reached out to to post the link to our survey in their Facebook groups around the same time that day. Right after that, we will post the survey link on the Stockholm University Facebook group wall. We instructed the students of all master programs, except for MAVFM, to send the survey link in their Facebook/WhatsApp groups on October 28 in the afternoon. We will also send the e-mail to KTH students on October 28 at 15:00. We decided to e-mail them one day after the SSE students, since we received all their e-mail addresses on paper and had to type all of them out in only a couple of days. Hence, to reassure that we would do this thoroughly, we decided to give ourselves one more day to type out the e-mail addresses. On November 3 at 13:00, we will send SSE students a reminder by e-mail, and on November 4 at 13:00, we will send KTH students a reminder by e-mail (we already announce this to the students in the first e-mail we send out). This e-mail will have the exact same layout as the e-mail we sent the week before, except that it doesn't include the sentence: "We will send you a reminder seven days from now." We will send the e-mail reminder, provided that we have not yet received 1500 responses (this is specified below under "stopping rule"). On November 7 at 23:59 - provided that we have not received 1500 responses, we will deactivate the experiment. So, participants get 11.5 days' time to respond to the survey. During those 11.5 days, it is possible to click on the link and to fill out the survey 24 hours a day. In this way, we make it as easy as possible for students to fill out the survey when it works best for them.

- E-mails.pdf

Sample size

Our target sample size is 390 participants, or 130 per each control and treatment group. For a small-medium effect size (Cohen's d equal to 0.35), this gives us a statistical power level of 0.8 for an alpha level equivalent to 0.05. This calcualtion was performed using an automatic online tool ("Free Statistics Calculator"). To be on the safe side, we will attempt to get responses of at least 430 participants, assuming that not all will take enough time (less than 2 minutes) to respond to our survey, will respond wrongly to the last question or will not (properly) answer all questions.

Adding up all our recruitment efforts, we will reach out to multiple thousands of respondents (by e-mail, Facebook and/or WhatsApp). However, since most of the recruitment efforts happen online and not face-to-face, we are aware that many of them will not fill out the survey. Hence, we think it is unreasonable to hope to get many more than 430 responses, which explains our target sample size.

Sample size rationale

An important reason to not recruit more participants is time constraints, as we only have a limited time (11.5 days) to execute the experiment. Also, we did not receive all e-mail addresses of the students at Stockholm School of Economics, and only from the last year bachelor and master students at one other university in Stockholm (KTH). Furthermore, since we have to adhere to GDPR rules, we are not allowed to collect any personal information of participants, e.g. e-mail addresses or phone numbers. Hence, it is rather hard to give students a very effective financial incentive, e.g. a lottery ticket that would give them a chance at winning SEK 1500 cash. That is why the only economic incentive we could think of giving them is donating money to charity. However, it seems likely that this does not reach as many students as a more personal economic incentive would have. Therefore, it does not seem reasonable to expect to receive many more than 430 responses.

Stopping rule

There are two situations in which we will stop collecting data. The first one is when 11.5 days of releasing the experiment and sending the survey link via e-mail have passed (period: October 27 - November 7). The second situation applies in case we have received 1500 survey responses before these two weeks have passed. The rational behind this is that we have not received any funding for our experiment, which means that we have to pay for the economic incentive ourselves. Hence, it will become too expensive for us if we have more than 1500 responses (roughly 500 respondents per each control and experiment group).

Variables

Manipulated variables

As explained before, in our experiment, participants get to decide which out of five pre-specified meals they want to eat that evening, and which pre-specified ingredients they want to buy for that meal. The only thing we manipulate is whether or not participants get to see one of two designed nudges on the pictures of meat/fish/substitute products they get exposed to during the experiment.

The first type of nudge is a cognitive nudge, in the form of a traffic light nudge (a real traffic light (green, yellow, red) and the same background color as the color that is showing on the traffic light) plus an informative text on how relatively much the nudge contributes to the emission of greenhouse gases. More specifically, for each type of meat/fish/substitute product the informative text explains the amount of kilometers driven by car that producing one kg of the product equals to (on average). In this way, consumers have a tangible way to understand how much the product contributes to greenhouse gas emissions. It also makes it easy to compare the damaging impacts of meat/fish/substitute products.

The second type of nudge is an affective nudge. For this nudge, three types exist. The first one has an encouraging text (for substitutes), namely: "Make this climate conscious choice". It also has a green check mark, the picture of a flourishing rain forest, and a green background color. The second version of the nudge is colored yellow and has a warning text (for meat/fish products with carbon footprints at the lower end), namely: "Rethink this climate unfriendly choice!". The picture on the nudge is a fallen tree of which you can see the roots. It also contains a warning sign in the form of an orange triangle with a black exclamation mark in it. The nudge has a yellow background color. The third version of the nudge contains a highly discouraging text (for meat/fish products with carbon footprints at the higher end), namely: "Avoid this climate damaging choice!". Furthermore, it has a picture of a burnt-down rain forest, a red background color and a black X with a red circle around it.

Participants in the control group get to see the same product pictures as the participants in the treatment groups, but without the cognitive or affective nudge on it. Hence, the only difference between the three groups is whether or not they get exposed to our designed nudges and which type of nudge (cognitive versus affective) this comprises. The rest of the choice architecture that the participants get exposed to is exactly the same.

An example of each form of both nudges can be viewed by clicking on the file "Examples of the nudges" in the Design Plan section.

Measured variables

The single outcome variable measured is coded as "the ecological footprint, expressed in terms of CO2 equivalents (CO2e), of a kilogram produced of the meat, fish or substitute products selected by a consumer in the experiment" (hereafter "carbon footprint"). The dependent variable does not express the footprint of the hypothetical meal that we are asking respondents to purchase in the experiment, but a standard measure in kilograms per product. It is therefore consistent across respondents. The footprint measure is a continuous variable that increases as the respondent selects a more environmentally unfriendly product (or more products), where the minimum is zero if no meat, fish or substitute products were selected and the maximum would result if a respondent were to select all such products they were exposed to.

Like we explained before, there are three experiment groups in this online experiment. The first group is the control group, in which the participants do not get to see any nudge while they are picking out ingredients for their meal that evening, The second group is the cognitive nudge group, in which participants get exposed to a cognitive nudge on meat/fish/substitute products while they are picking out ingredients for their meal that evening. The third group is the affective nudge group, in which participants get to exposed to an affective nudge on meat/fish/substitute products while they are picking out ingredients for their meal that evening. For these three groups we have two independent variables, one of them being treatment 1 (being exposed to the cognitive nudge) and the other one being treatment 2 (being exposed to the affective nudge). In order to avoid perfect multicollinearity, the control group is not added as a separate variable but is a part of the constant term in the mathematical model (this model is explained in more detail in the Analysis Plan section). People receive a 1 for the variable treatment 1 if they are part of treatment 1 (and thus are exposed to the cognitive nudge), and a 0 otherwise. Similarly, people receive a 1 for the variable treatment 2 if they are part of treatment 2 (and thus are exposed to the affective nudge), and a 0 otherwise.

Like mentioned before, we ask people some demographics and attitudes questions during the experiment. The reason for asking people about these demographics and characteristics, is that they can all influence whether someone chose a certain meat/fish/substitute product during grocery shopping; and if they are not balanced between the groups, omitted variable bias can occur. In case more than one of these demographics and/or attitudes differ significantly between the groups at the 5% significance level ($p<0.05$), we will add these as control variables to our statistical model. The reason behind this is that it is most likely random chance if one of these variables significantly differs from 0 at the 5% significance level, but it seems less likely it is random chance in case two or more of these variables differ from 0 at the 5% significance level. Hence, we will only start controlling for these variables if more than one variable significantly differs from 0 at the 5% significance level. However, we do not know yet whether this will happen, and if it will be, which variables will significantly differ from 0 at the 5% significance level. Therefore, to make sure that we can code all variables as explained in our pre-analysis-plan, we will now mention all possible control variables (that follow from the questions in the experiment) and how we will code them in case we need to add them.

Some of the attitude and demographics questions are multiple choice questions (MC), and some are open questions where participants had to enter integers (IG). To be more specific, we ask them about their gender (MC), age (IG), which university in Stockholm they are attending (MC), what kind of degree they are pursuing (MC), what best describes their nationality (MC), what label best describes their diet (MC), how many of their 21 weekly meals contain meat or fish (IG), and which factors matter to them when choosing a diet to follow (IG). We also ask them to rate how much they agree with the statement that their purchasing habits are affected by their concern for the environment (MC), to rate how much they agree with the statement that they are willing to be inconvenienced in order to take actions that are more environmentally friendly (MC), to rate how much they agree with the statement that there is not much that any one individual can do about the environment (MC), whether they would be in favor of a law making it mandatory to label certain food products according to their climate impact (MC), and, lastly, where they would be in favor of a 'carbon tax' on food products, that would be proportional to their contribution to CO_2 emissions (MC). With respect to how we will code these different possible control variables, we are dealing with two different types of variables. When it comes to questions that people have to answer in integers, we add the respective variable as a continuous control variable. For the questions that are MC, we have certain ordinal variables (e.g. pursued degree, rating question about the extent to which participants agree to a certain statement, favorability towards a carbon tax) and certain nominal variables (e.g.

nationality, gender, university in Stockholm, diet factors). All these possible ordinal and nominal control variables are already coded by Qualtrics in a certain way, namely with numbers (e.g. 1-9 for diet factors, 1-4 for gender). Which numbers belong to each question are specified in brackets behind each choice option in the file "Experimental Design Qualtrics". We will use these pre-coded numbers for our statistical analysis in case we need to add certain control variables.

However, we are not interested in the numbers that we find for these control variables. We are solely interested in how the different treatments affect people's meat/fish choices, and, therefore, their carbon footprint. So, our only variables of interest are the outcome variable, carbon footprint, and the independent variables treatment 1 (cognitive nudge) and treatment 2 (affective nudge).

Indices

With respect to the dependent variable, carbon footprint, people get the possibility to choose multiple meat/fish/substitute products for their dinner. This means that for one person the carbon footprint of all those products needs to be combined into one number. Qualtrics does this by adding up the carbon footprints from the different products that a participant chose, and then outputs this to us as one number for carbon footprint.

Analysis Plan

Statistical models

We start off by explaining the multiple regression analysis that we are interested in. This will be the following: $Footprint_i = \alpha_0 + \beta_1.T1 + \beta_2.T2 + \gamma.X_i + \epsilon_i$, where In this case, $Footprint_i$ stands for the carbon footprint; T1 stands for treatment 1 (cognitive nudge), T2 stands for treatment 2 (affective nudge) and X_i is a vector of baseline controls. These baseline controls will only be included in case our analysis shows that we need to control for certain demographics and attitudes that the participants were asked about during the experiment. In the section on Variables we explained thoroughly which variables we are referring to, in which case our analysis indicates that we need to control for them, and how they will be controlled for.

After specifying the model, we will run a regression analysis in R. We will use regular Huber-White ("robust") standard errors, since the treatment is randomized at the individual level. After all, Qualtrics will randomly assign each individual to one of the three experiment groups when they decide to participate in the experiment. So, we do not have clustered treatment assignment, since we do not group individuals into clusters before the start of the experiment.

R will then give us a coefficient for β_1 and β_2. It will also indicate the p-values belonging to the null hypothesis that the respective coefficient is equal to 0. We will check whether we can reject these null hypotheses at the 5% level ($p < 0.05$) [Below we specify in more detail how we will handle the inference criteria]. In case we cannot reject the null hypothesis that the coefficient is equal to 0 for both β_1 and β_2, we will write down in the results section that for neither nudge we are able to conclude that they have significantly impacted on participants carbon footprint from meat/fish/substitute consumption. In case we see that one or both of the beta-coefficients is/are significantly different from 0 at the 5% level, we will explain in the results section that the nudge(s) for which we have found a significant beta-coefficient is/are shown to have had a significant impact on participants carbon footprint from meat/fish/substitute consumption.

Lastly, we will use R to test whether the β_1 and β_2 coefficients differ significantly from each other in size. Only in case this test indicates $p < 0.05$, we will write down in the results section that the nudge with the larger absolute beta-coefficient value has had a significantly larger effect on participants' carbon footprint from meat/fish/substitute consumption than the nudge with the smaller absolute beta-coefficient value. Otherwise we will say that we are not able to conclude that the nudges have impacted the participants in a significantly different way.

Important to notice is that as of now we cannot be sure that our hypotheses (mentioned under Study Information) will turn out to be true, i.e. that the nudges decrease average carbon footprint (significantly). It is possible that the nudges increase average carbon footprint (significantly). That would mean that our nudges have the opposite effect of what we designed them for, but we cannot exclude this possibility. Hence, we only speak about absolute values in this subsection, and not about direction. This also implies that we will execute all statistical analysis, independently from whether or not we find negative or positive beta-coefficients.

Moreover, we will check the adjusted R-squared of our chosen model once we have decided whether we need to add control variables, and - if we need to add control variables - which ones to add. However, this will not influence which model we choose. We will solely base this on whether or not there are significant differences among the different groups with respect to the demographic variables that we have asked them about. Mentioning the adjusted R-squared solely serves as a way to indicate to the reader how much of the variation in the dependent variable - carbon dioxide emissions from meat/fish choice - is caused by the variation in the independent variables - treatment and possible control variables.

Transformations

When participants choose a certain meat/fish option, they do not get to see the exact amount of greenhouse gas emissions that the product of their choosing emits per kilogram. However, we programmed "Qualtrics" in such a way that each choice is immediately transformed to a number of greenhouse gas emissions per kilogram of the product once the respondent has handed in the survey. We use these numbers in order to calculate whether the different treatments significantly affect average greenhouse gas emissions per kilogram product from meat/fish/substitute choice.

The different experiment groups will also be assigned a number, so that the three groups can be properly analyzed in comparison to each other. The control group will be 1, the cognitive nudge group will be 2, and the affective nudge group will be 3.

Furthermore, it is possible that any of the demographics and attitudes questions need to be added as control variables to the statistical model. For such variables, we check whether they are categorical variables or continuous variables (i.e. age and number of meat/fish meals eaten on average). In case we are dealing with categorical variables, we will dummy code them, and we will use the first category as specified in our experimental design as the reference category. The questions in the experimental design and the order of the possible answers (in case of a categorical variable) can be find by clicking on the file "Experimental Design Qualtrics" in the Design Plan section.

Inference criteria

In our tables, we will use the standard $^*p < .0.05$, $^{**}p < 0.01$, $^{***}p < 0.005$ criteria for determining if the t-tests suggest that the results are significantly different from those expected if the null hypothesis were correct. Hence, the highest p-value that we classify as statistically significant is $p < 0.05$. We chose this level, since this is the standard criteria for determining if results are significantly different from those expected if the null hypotheses were correct. Furthermore, we will always explicitly mention in the result section at which level (5%, 1% and 0.5% respectively) the results are significant.

Data exclusion

Before we start analyzing the data, we will exclude all surveys in which the respondents answered something else for the final control question than "Choice of dinner and food products". After all, if respondents do not answer this question correctly, it shows that they have not really read the survey task/questions, have not understood the survey at all, or have not taken the survey seriously. Hence, his question serves as a verification that the subjects understood what they were asked during the survey.

Furthermore, if respondents take less than 2 minutes to answer the survey, their answers will be excluded from the analysis. This exact time has been determined by asking 25 participants in a pre-study to answer our survey. We collected the amount of time it took each one of them and then checked what the fastest time was. This was 2 minutes and 22 seconds. However, all other participants took at least 4 minutes to answer the survey. Hence, we have decided to take 2 minutes as the absolute minimum that people should spend on the survey in order to qualify for data analysis.

Moreover, when subjects do not provide an answer to all questions, or answer something completely different than what we ask for (e.g. providing us with their nationality when we ask them for their age), we will exclude their survey answers from the analysis. After all, we cannot analyze the data properly if we do not have all the answers to our demographic and attitude questions, since this will make it impossible to correctly assess whether the three different experiment groups are comparable.

Other responses will be analyzed in the results section, which means that we will include outliers.

Missing data

If a respondent does not fill out every answer in the survey or does not answer them properly (e.g. providing us with their nationality when we ask them for their age in integers), we are dealing with missing or incomplete data for a subject. In such cases, we will exclude all survey answers from that subject from our analysis. Hence, we will only include the data in our analysis from participants that answered something (sensible) for every question.

Appendix B: E-mails

SSE, e-mail:

Dear fellow SSE students,

Our names are Eugénie de Jong and Carl Widstrand. We are researching consumption choices in a retail setting, as part of a master's thesis project in economics here at Stockholm School of Economics. We would be very grateful if you could help us graduate.

We are inviting you to take our survey, which is fully anonymous and takes circa five (5) minutes to complete. By doing so, you will be part of a digital experiment. For every participant, we donate money to the Swedish Children's Cancer Fund (Barncancerfonden). Click the link to take the survey: `https://hhs.qualtrics.com/jfe/form/SV_abh03CmRI1GVl6m`.

Your participation is super helpful! A large sample is crucial to draw valid conclusions. The survey will be deactivated on the 7th of November. We will send you a reminder seven days from now. For any queries, please e-mail us at 23926@student.hhs.se.

Kindly,

Eugénie & Carl

–

Data Protection: Your e-mail addresses were provided to us via your school administration and/or your program director, for the explicit purpose of distributing this survey, with consent from the Data Protection Office. The survey is anonymous, and we will not be storing any contact information after completing this project. If you have any questions about the way we handle your data, send us an e-mail to 23926@student.hhs.se.

KTH, e-mail:

Dear KTH students,

Our names are Eugénie de Jong and Carl Widstrand. We are researching consumption choices in a retail setting, as part of a master's thesis project in economics here at Stockholm School of Economics. We would be very grateful if you could help us graduate.

We are inviting you to take our survey, which is fully anonymous and takes circa five (5) minutes to complete. By doing so, you will be part of a digital experiment. For every participant, we donate money to the Swedish Children's Cancer Fund (Barncancerfonden). Click the link to take the survey: `https://hhs.qualtrics.com/jfe/form/SV_abh03CmRI1GVl6m`.

Your participation is super helpful! A large sample is crucial to draw valid conclusions. The survey will be deactivated on the 7th of November. We will send you a reminder seven days from now. For any queries, please e-mail us at 23926@student.hhs.se.

Kindly,

Eugénie & Carl

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Data Protection: Your e-mail addresses were provided to us via your school administration and/or your program director, for the explicit purpose of distributing this survey, with consent from the Data Protection Office. The survey is anonymous, and we will not be storing any contact information after completing this project. If you have any questions about the way we handle your data, send us an e-mail to 23926@student.hhs.se.

SU, Facebook:

Dear SU students,

Our names are Eugénie de Jong and Carl Widstrand. We are researching consumption choices in a retail setting, as part of a master's thesis project, conducted at Stockholm School of Economics. We would be very grateful if you could help us graduate.

We are inviting you to take our survey, which is fully anonymous and takes circa five (5) minutes to complete. By doing so, you will be part of a digital experiment. For every participant, we donate money to the Swedish Children's Cancer Fund (Barncancerfonden). Click the link to take the survey: `https://hhs.qualtrics.com/jfe/form/SV_abh03CmRI1GVl6m`.

Your participation is super helpful! A large sample is crucial to draw valid conclusions.

Kindly,

Eugénie & Carl

SSE, Reminder Whatsapp/Facebook:

Hi all,

As you will have seen by now, we (Eugénie de Jong and Carl Widstrand) shared a link with you to our survey, since we are writing a thesis in economics on food consumption. We are super happy that so many of you have already participated. Thank you!

If you haven't done so, it would be really helpful if you could take five minutes to respond to the survey via this link: `https://hhs.qualtrics.com/jfe/form/SV_abh03CmRI1GVl6m`. We need as many responses as we can get.

Eugénie and Carl

Appendix C: Food Sustainability Classification

In nutrient terms, meat is primarily a source of protein (Livsmedelsverket, 2021). A person requires a daily protein intake of between 10% and 20% of total calories (kcal) Nordic Council of Ministers (2014). Obviously, different people have different nutritional needs, depending on factors such as gender and exercise. An average woman aged 31-64 years requires approximately 2,100 kcal per day, while a man of the same age needs circa 1.2 times that - 2,600 kcal. Livsmedelsverket (2016) has nonetheless proposed a standard portion size corresponding to 125 grams of meat or fish-based sources of proteins in general. (That is not to say that it recommends that people eat this amount for both lunch and dinner every day.) For example, for pork chops, this is equivalent to 25 grams of pure protein. Livsmedelsverket further provides a protein guide for vegans, which recommends a daily consumption of 150 grams of soybeans or other kinds of legumes to a woman. While this amount of food does not equal the same amount of proteins as 125 grams of meat, Livsmedelsverket points out that vegans also absorb proteins from other aspects of their diet, e.g. bread. Since a man needs roughly 1.2 times the amount of calories as a woman, we take the average between a woman's and a man's required intake to construct the "standard" meat-substitute intake: $(150 + (150 * 1.2))/2 = 165$.

We then need to identify which products can be considered sustainable and not. Florén et al. (2021) has suggested a four-tier "climate scale" for meals, which will be the basis for our classification of foods, according to the traffic-light scheme. It is said that, by 2050, the carbon footprint coming from our food must be reduced from current levels of approximately 5.2 kg of CO2e per day to 1.4 kg. RISE uses as its standard a proportion of lunch and dinner, the two biggest meals of the day, equal to roughly 35% of the daily nutrient intake respectively, which they translate into a footprint of 0.5 kg of CO2e per lunch and dinner. The scale has four levels as outlined below:

Table 5: Florén et al. (2021) climate scale

Level of sustainability	Carbon footprint (kg CO2e / meal)
Achieves long-term Sustainability	≤ 0.5
Halfway toward long-term sustainability	$0.6 - 0.9$
A good first step	$1.0 - 1.3$
Too minor a change from today	≥ 1.4

For the reasons already outlined above, our nudges will be a three-tier classification system. We therefore need to convert RISE's categorization from four levels to three. It makes sense to only use a green level when the consumption can be classified as long-term sustainable, i.e. at 0.5 or below; it similarly makes sense to use the red label when the consumption virtually achieves no change from today's unsustainable levels, i.e. at 1.4 and above. Thus, the two middle categories can be merged into a single yellow category, for necessary convenience.

As explained in the introduction, animal-based food consumption is responsible for 70% of the entire food-related carbon footprint (Konsumentverket, 2019; Röös, Karlsson, Witthöft, & Sundberg, 2015). We will therefore approximate the limit of what the different protein sources may contribute in terms of carbon footprint per meal to 70% of RISE's carbon footprint tiers, using 125 grams as the meal sizes of meat or fish and 150 grams as that of plant-based alternatives. If the respective sizes overshoot 70% of a threshold, it is moved up a level. For processed meat, e.g. bacon, we could not find separate figures for its carbon footprint, so we use the footprints for the kind of meat that goes into their production, pork in this case. Furthermore, we use the same footprints for the different vegetarian burger substitutes. Similarly, 70% of 0.5 equals 0.35, whereas the footprints for tuna and chicken are estimated at 0.33. To be able to answer our research question, which addresses reduced meat consumption, and fish can be considered a type of meat, we include tuna and chicken in the yellow category, to juxtapose it to the plant-based substitutes.

For our three-tier system, and the varieties of meat, fish and substitutes, the classification we obtain is presented in the table below:

Table 6: Carbon footprint classification

Food Variety	Carbon footprint (kg CO2e / 70% meal)
Green — max 0.35	
Quorn bits	0.20
Veggie balls	0.26
Veggie patties	0.27
Veggie mince, moldable	0.30
Veggie mince, regular	0.30
Yellow — 0.35-0.98	
Chicken	0.33
Tuna	0.33
Cod	0.44
Salmon	0.48
Pork	0.53
Red — exceeding 0.98	
Shrimp	1.86
Beef	4.36

Appendix D: The Survey

Below, we show our experimental design. This text was shown to all participants (except for the italic text). As explained in the main text, we showed pictures below the names and prices of all ingredients that were offered to participants. The pictures were the same for all participants, except for the pictures of meat, fish and plant-based substitutes, since the participants in the cognitive and affective nudge group saw a nudge on the pictures of these ingredients whereas the participants in the control group did not. For an example of the two nudges and their three versions, see Appendix E.

This survey is part of an experiment, conducted as part of a master's thesis project in economics at the Stockholm School of Economics. We are studying people's food consumption choices in a retail setting. The survey is completely anonymous, in compliance with GDPR, and the information collected is handled carefully and studied in the aggregate. Completing the survey should take circa five (5) minutes, and for every adequately submitted survey, we donate one (1) Swedish krona to the Swedish Childhood Cancer Fund (Barncancerfonden).
Thank you for taking part!

Carl Widstrand & Eugénie de Jong

For this study, we are relying on students in Stockholm as subjects. Before getting started, please answer whether you are a student currently enrolled at a university in Stockholm.

- Yes, I am currently a student studying at a university in Stockholm. (1)
- No, I am not currently a student studying at a university in Stockholm. (2)

Scenario: Imagine you are in a grocery store, about to buy ingredients for your dinner tonight, and you are walking through the store's different sections. Please select what dish you would prefer from the options below and proceed by selecting which ingredients you would buy in this scenario, from those presented to you on the following page. Assume that you need to buy all ingredients required to make the dish, except the most basic ones like salt, spices, etc.

All prices are relative (e.g. per kilogram) and are given in Swedish kronor (kr). Please be as realistic as you can, but keep in mind that the store has a limited selection of products to choose from!

Which dish would you like to have tonight and buy ingredients for?

- Hamburgers (1)
- Salad (2)
- Spaghetti Bolognese (3)
- Swedish Meatballs (4)
- Tacos (5)

Display This Question: If Which dish would you like to have tonight and buy ingredients for? = Hamburgers.
Which ingredients would you buy to make hamburgers tonight? Please select all such ingredients and no more.

- Tomatoes, 31.90 kr/kg (1)
- Lettuce, 30.90 kr/kg (2)
- Cucumber, 42.90 kr/kg (3)

- Onion, 11.50 kr/kg (4)
- Portabello mushrooms, 96.90 kr/kg (5)
- Pickles, 62.50 kr/kg (6)
- Brioche buns, 91.90 kr/kg (7)
- Cornmeal buns (gluten free), 73.50 kr/kg (8)
- Wheat buns, 69.90 kr/kg (9)
- Whole wheat buns, 64.90 kr/kg (10)
- Cheddar cheese slices, 195.90 kr/kg (11)
- Gouda cheese slices, 152.90 kr/kg (12)
- Minced meat, beef, 106.50 kr/kg (13)
- Minced meat, beef 50%, pork 50%, 83.90 kr/kg (31)
- Minced meat, pork, 64.50 kr/kg (14)
- Minced meat, chicken, 76.90 kr/kg (15)
- Plant-based mince, soybean, 76.50 kr/kg (16)
- Pre-made burger patty, beef, 101.90 kr/kg (17)
- Pre-made burger patty, chicken, 124.50 kr/kg (18)
- Pre-made burger patty, soybean, 157.90 kr/kg (21)
- Pre-made burger patty, spinach, 161.90 kr/kg (22)
- Pre-made chicken-style burger patty, peas, 148.50 kr/kg (23)
- Bacon, pork, 100.90 kr/kg (20)
- Fried cod fillet, 113.90 kr/kg (19)

- Ketchup, 25.50 kr/kg (24)
- Mayonnaise, 101.90 kr/kg (25)
- Mustard, 36.50 kr/kg (26)
- BBQ sauce, 89.90 kr/kg (27)
- Relish, 58.90 kr/kg (28)

Display This Question: If Which dish would you like to have tonight and buy ingredients for? = Salad.

Which ingredients would you buy to make salad tonight? Please select all such ingredients and no more.

- Asparagus, 159.90 kr/kg (1)
- Broccoli, 97.50 kr/kg (2)
- Bell pepper, 36.90 kr/kg (3)
- Cale, 99.90 kr/kg (4)
- Corn, 57.50 kr/kg (5)
- Arugula, 155.90 kr/kg (6)
- Carrots, 15.50 kr/kg (7)
- Avocado, 88.90 kr/kg (8)
- Olives, 96.90 kr/kg (9)
- Lime, 69.90 kr/kg (10)
- Onion, 11.50 kr/kg (11)
- Spinach, 134.50 kr/kg (12)

- Lettuce, 30.90 kr/kg (13)
- Cucumber, 42.90 kr/kg (14)
- Dried tomatoes, 207.50 kr/kg (15)
- Tomatoes, 31.90 kr/kg (16)
- Sugar snaps, 177.90 kr/kg (17)
- Feta cheese, 131.90 kr/kg (18)
- Halloumi, 136.50 kr/kg (19)
- Parmesan, 389.90 kr/kg (20)
- Grated cheese, 140.90 kr/kg (21)
- Goat cheese, 209.90 kr/kg (22)
- Mozzarella, 123.90 kr/kg (23)
- Blue cheese, 179.90 kr/kg (24)
- Eggs, 2.50 kr a piece (34)
- Bacon, pork, 100.90 kr/kg (27)
- Bacon, chicken, 155.90 kr/kg (28)
- Chicken fillet, 143.50 kr/kg (29)
- Falafel, 78.50 kr/kg (33)
- Tuna, 131.90 kr/kg (31)
- Shrimp, 262.90 kr/kg (32)
- Salmon, 171.90 kr/kg (48)
- Chickpeas, 50.90 kr/kg (30)

- Brown beans, 45.90 kr/kg (25)
- Black beans, 45.90 kr/kg (26)
- Pasta, 26.90 kr/kg (35)
- Bulgur, 26.90 kr/kg (36)
- Quinoa, 100.90 kr/kg (37)
- Black rice, 70.90 kr/kg (38)
- Croutons, 174.50 kr/kg (39)
- Cashews, 205.90 kr/kg (40)
- Almonds, 200.90 kr/kg (41)
- Walnuts, 169.90 kr/kg (42)
- Pine nuts, 629.90 kr/kg (43)
- Rhode Island dressing, 62.90 kr/kg (44)
- Caesar salad dressing, 62.90 kr/kg (45)
- Greek salad dressing, 62.90 kr/kg (46)
- Balsamic vinaigrette dressing, 144.90 kr/kg (47)

Display This Question: If Which dish would you like to have tonight and buy ingredients for? = Spaghetti Bolognese.
Which ingredients would you buy to make spaghetti bolognese tonight? Please select all such ingredients and no more.

- Basil, 19.50 kr a piece (1)
- Broccoli, 97.50 kr/kg (2)

- Carrots, 15.50 kr/kg (3)
- Celery, 57.90 kr/kg (4)
- Garlic, 89.90 kr/kg (5)
- Mushrooms, 54.90 kr/kg (6)
- Onion, 11.50 kr/kg (7)
- Tomatoes, 31.90 kr/kg (8)
- Zucchini, 35.90 kr/kg (9)
- Mozzarella, 123.90 kr/kg (10)
- Goat cheese, 209.90 kr/kg (11)
- Grated Gouda cheese, 140.90 kr/kg (12)
- Parmesan, 389.90 kr/kg (13)
- Minced meat, beef, 106.50 kr/kg (14)
- Minced meat, beef 50%, pork 50%, 83.90 kr/kg (28)
- Minced meat, pork, 64.50 kr/kg (15)
- Minced meat, chicken, 76.90 kr/kg (16)
- Plant-based mince, soybean, 64.50 kr/kg (17)
- Pancetta, 228.90 kr/kg (18)
- Spaghetti, 14.50 kr/kg (19)
- Fusilli, whole wheat, 26.90 kr/kg (20)
- Penne, 26.90 kr/kg (21)
- Penne (gluten free), 43.50 kr/kg (27)

- Tagliatelle, 39.90 kr/kg (22)
- Crushed tomatoes, 25.90 kr/kg (23)
- Passata, 28.50 kr/kg (24)
- Tomato sauce, 43.50 kr/kg (25)
- Tomato paste, 71.90 kr/kg (26)

Display This Question: If Which dish would you like to have tonight and buy ingredients for? = Swedish Meatballs.

Which ingredients would you buy to make Swedish meatballs tonight? Please select all such ingredients and no more.

- Bell pepper, 36.90 kr/kg (3)
- Broccoli, 97.50 kr/kg (4)
- Carrots, 15.50 kr/kg (2)
- Cauliflower, 24.50 kr/kg (5)
- Onion, 11.50 kr/kg (6)
- Peas, 28.50 kr/kg (1)
- Potatoes, 10.90 kr/kg (16)
- Pre-made mashed potatoes, 13.90 kr/kg (17)
- Beetroot, 41.50 kr/kg (21)
- Black currant, 81.90 kr/kg (20)
- Lingonberries, 58.90 kr/kg (18)
- Pickles, 62.50 kr/kg (19)

- Butter, 99.50 kr/kg (14)
- Milk, 10.50 liter/kg (15)
- Eggs, 2.50 kr a piece (13)
- Minced meat, beef, 106.50 kr/kg (7)
- Minced meat, beef 50%, pork 50%, 83.90 kr/kg (24)
- Minced meat, pork, 64.50 kr/kg (8)
- Minced meat, chicken, 76.90 kr/kg (9)
- Plant-based mince, soybean, 76.50 kr/kg (10)
- Pre-made meatballs, beef, 111.50 kr/kg (11)
- Pre-made veggie balls, soybean, 95.50 kr/kg (12)

Display This Question: If Which dish would you like to have tonight and buy ingredients for? = Tacos.

Which ingredients would you buy to make tacos tonight? Please select all such ingredients and no more.

- Cucumber, 42.90 kr/kg (1)
- Corn, 57.50 kr/kg (2)
- Tomatoes, 31.90 kr/kg (3)
- Coriander, 19.50 kr a piece (4)
- Bell pepper, 36.90 kr/kg (5)
- Avocado, 88.90 kr/kg (6)
- Lettuce, 30.90 kr/kg (7)

- Onion, 11.50 kr/kg (8)
- Garlic, 89.90 kr/kg (9)
- Lime, 69.90 kr/kg (10)
- Mango, 48.90 kr/kg (11)
- Jalapeño, 88.90 kr/kg (12)
- Tortillas, 49.90 kr/kg (13)
- Whole wheat tortillas, 48.90 kr/kg (14)
- Gluten-free tortillas, 138.90 kr/kg (15)
- Taco shells, 116.90 kr/kg (16)
- Tortilla chips, 69.90 kr/kg (17)
- Pre-made guacamole, 116.90 kr/kg (18)
- Cheese dip, 113.50 kr/kg (19)
- Taco salsa, mild, 53.90 kr/kg (20)
- Taco salsa, hot, 53.90 kr/kg (21)
- Fajita spice mix, 453.50 kr/kg (22)
- Fish taco spice mix, 453.50 kr/kg (23)
- Taco spice mix, hot, 412.50 kr/kg (24)
- Taco spice mix, mild, 412.50 kr/kg (37)
- Sour cream, 33.50 kr/kg (25)
- Sour cream light, 33.50 kr/kg (26)
- Grated cheese, 140.90 kr/kg (27)

- Black beans, 45.90 kr/kg (31)
- Brown beans, 45.90 kr/kg (32)
- Minced meat, beef, 106.50 kr/kg (28)
- Minced meat, beef 50%, pork 50%, 83.90 kr/kg (38)
- Minced meat, pork, 65.50 kr/kg (29)
- Minced meat, chicken, 76.90 kr/kg (30)
- Plant-based mince, soybeans, 64.50 kr/kg (34)
- Chicken fillet, 143.50 kr/kg (33)
- Salmon, 171.90 kr/kg (35)
- Cod, 126.50 kr/kg (36)

Well done! You are now done with shopping for tonight.

We are now going to ask you some general questions about you and your attitude towards food consumption.

What is your gender?

- Male (1)
- Female (2)
- Non-binary / third gender (3)
- Prefer not to say (4)

How old are you? Please submit years as integers (e.g. “25”).

Which Stockholm university are you currently attending?

- Karolinska Institutet (KI) (1)
- Royal Institute of Technology (KTH) (2)
- Stockholm School of Economics (SSE) (3)
- Stockholm University (SU) (4)
- Södertörn University (SH) (5)
- Other (6)

What kind of degree are you currently pursuing?

- Bachelor’s degree (1)
- Master’s degree (2)
- PhD or advanced graduate studies (3)
- Other (4)

What best describes your nationality?

- Swedish (1)
- EU/EEA (Non-Swedish) (2)
- Non-EU/-EEA (3)

What label best describes your diet?

- Vegan (1)
- Vegetarian (including milk-based products and/or eggs) (2)
- Pescatarian (including milk-based products, eggs, fish) (3)
- Flexitarian (including meat on an irregular basis) (4)
- Standard diet (including meat on a regular basis) (5)
- None of these labels (6)

Display This Question:
If What label best describes your diet? = Flexitarian (including meat on an irregular basis)
Or What label best describes your diet? = Pescatarian (including milk-based products, eggs, fish)
Or What label best describes your diet? = Standard diet (including meat on a regular basis)
Or What label best describes your diet? = None of these labels
Considering your daily meals over the course of a normal seven-day week (that is breakfast, lunch and dinner), approximately how many out of the 21 meals contain meat or fish? Please answer in integer numbers (e.g. “10”).

Which factors matter to you when choosing a diet to follow? Please choose all that apply.

- Convenience (1)
- Environment (2)
- Ethics (3)

- Habit (4)
- Health (5)
- Taste (6)
- Tradition (7)
- Variety (8)
- Prices (9)
- Other (10)

On a scale from one to seven, to what extent do you agree with the statement: “My purchase habits are affected by my concern for the environment”?

- 1. Strongly disagree (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Strongly agree (7)

On a scale from one to seven, to what extent do you agree with the statement: “I am willing to be inconvenienced in order to take actions that are more environmentally friendly”?

- 1. Strongly disagree (1)
- 2. (2)

- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Strongly agree (7)

On a scale from one to seven, to what extent do you agree with the statement: “There is not much that any one individual can do about the environment”?

- 1. Strongly disagree (1)
- 2. (2)
- 3. (3)
- 4. (4)
- 5. (5)
- 6. (6)
- 7. Strongly agree (7)

Would you be in favor of a law making it mandatory to label certain food products according to their climate impact?

- Definitely not (1)
- Probably not (2)
- Maybe/Don’t know (3)
- Probably yes (4)

- Definitely yes (5)

Would you be in favor of a ’carbon tax’ on food products, that would be proportional to their contribution to CO2 emissions?

- Definitely not (1)
- Probably not (2)
- Maybe/Don’t know (3)
- Probably yes (4)
- Definitely yes (5)

What was this survey about?

- Football (0)
- Choice of dinner and food products (1)
- Endangered animals (0)

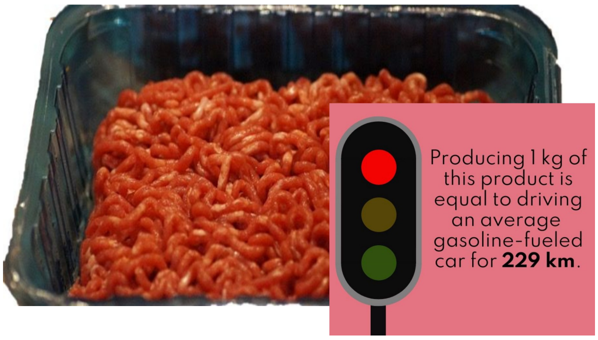
Thank you for taking part in this survey and for helping us out with our thesis project! If your answers are complete, we will now donate money to the Swedish Childhood Cancer Fund. All the information collected will be handled with care and will not be stored, once we are done with the project.

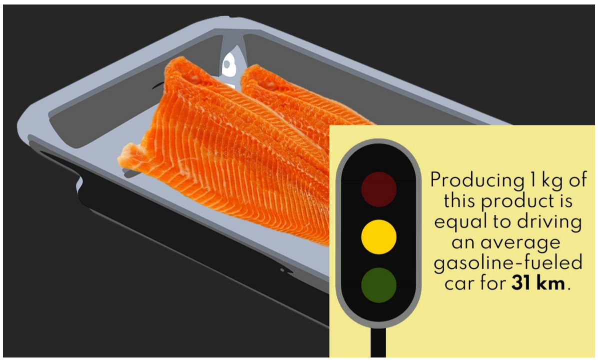
If you have any questions about the survey, please send us an e-mail to 23926@student.hhs.se.

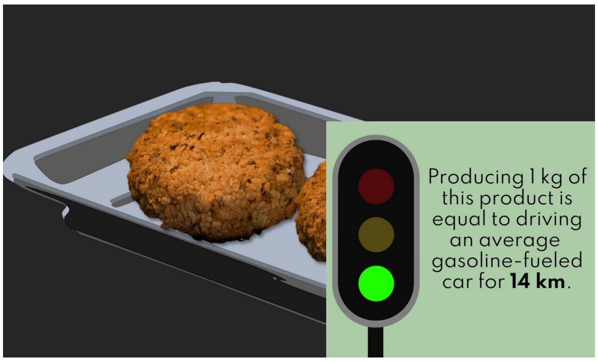
Appendix E: Nudge examples

Cognitive

Affective







Appendix F: Other Results

Main Analysis Including Wrong answers to the control Question

Table 7 shows regression results for our main model, based on the data that includes the observations from the participants that answered wrongly to the control question.

Table 7: Main regression analysis including wrong answers to the control question

	(1)	(2)	(3)
		Footprint	
Cognitive nudge treatment	-0.760	-1.239	-0.635
	(1.528)	(1.520)	(1.515)
Affective nudge treatment	-0.229	-0.221	0.013
	(1.547)	(1.545)	(1.528)
Diet factor: convenience		4.642***	3.875***
		(1.308)	(1.308)
Diet factor: variety		1.314	2.033
		(5.546)	(5.808)
Gender			
Female			-4.932***
			(1.263)
Non-binary			-6.850
			(7.156)
Prefer not to say			9.574
			(5.940)
Constant	17.28***	14.25***	16.717***
	(1.093)	(1.384)	(1.522)
N	631	631	631
R^2	0.000417	0.0189	0.0455
Type	OLS	OLS	OLS

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

Table 7 is mainly added for the reader to verify that deleting the observations from the participants that answered wrongly to the control question does not change much to the regression results, and, that it is, thus, justified to leave them out in the main analysis results, as shown in Table 4 in Section 5.2.

As in Table 4, under (1) the specification is shown without the diet factor control variables, and under (2) we find the main specification with the diet factor control variables. Under (3) the categorical variable *gender* is added, which, as explained in the main text, is added to verify that the regression results are not mainly driven by gender imbalances in the experiment groups. As mentioned in Section 5.2, Table 7 shows very similar results as Table 4, and does not change anything about the significance of the coefficients. Furthermore, when executing an F-test that checks whether the coefficients for the cognitive and affective nudge treatments are significantly different from each other, we get a p-value equal to 0.88 for the specification under (1) and a p-value equal to 0.68 for the specification under (2). These values are very similar to the values for the treatment coefficients from Table 4. They, therefore, also indicate that the treatment coefficients do not differ significantly from each other.

Exploratory Analysis with Interaction Effects

Mathematical Model & Variable Specification

As explained in Section 4.1.2, interaction effects are not the main interest in this thesis. However, it can still provide additional insights to our analysis. Hence, we add this model in this Appendix for the sake of transparency of our experiment results. Also, the model was not added to the pre-analysis plan, and, hence, everything that we observe with respect to this model should be considered exploratory. The mathematical model with interaction terms is as follows:

$$F_i = \alpha_0 + \beta_1 \cdot T1 + \beta_2 \cdot T2 + \beta_3 \cdot S + \beta_4 \cdot SB + \beta_5 \cdot SM + \beta_6 \cdot T +$$
$$\beta_7 \cdot T1 \cdot S + \beta_8 \cdot T2 \cdot S + \beta_9 \cdot T1 \cdot SB + \beta_{10} \cdot T2 \cdot SB + \beta_{11} \cdot T1 \cdot SM +$$
$$\beta_{12} \cdot T2 \cdot SM + \beta_{13} \cdot T1 \cdot T + \beta_{14} \cdot T2 \cdot T + \boldsymbol{\gamma} \cdot \mathbf{X_i} + \varepsilon_i$$

Like before, F_i stands for participant i's ecological footprint in terms of CO2e; α_0

represents the constant term; $T1$ stands for treatment 1 (cognitive nudge), $T2$ stands for treatment 2 (affective nudge) and β_1 and β_2 are the regression coefficients belonging to the treatment 1 and treatment 2 variables respectively; $\mathbf{X_i}$ is a vector of baseline controls (or fixed characteristics) applied to participant i, and $\boldsymbol{\gamma}$ represents the vector of coefficients that belongs to each of the baseline controls. The inclusion of controls follows the same procedure as has been explained in Section 4.1, and will therefore not be repeated here. We also added some new terms. In this regression analysis, S stands for salad, SB stands for spaghetti bolognese, SM for Swedish meatballs, T for tacos, and β_3 until β_6 are each of their respective regression coefficients; β_7 until β_{14} are the regression coefficients that belong to the different interaction terms.

The dependent variable F_i is coded exactly the same as in paragraph 4.1, and, hence, does not need further explanation.

As before, α_0 is a constant term, and thus has an invariant value. In this analysis, the value represents the average ecological footprint in terms of CO2e of someone who is in the control group, chooses hamburgers as their dish, and has value 0 for all control variables.

$T1$ and $T2$ respectively are still binary variables taking on value 1 if someone is in the cognitive nudge group and affective nudge group respectively. The variables S, SB, SM and T are also binary variables. S takes on value 1 if someone chooses salad as their dish for the experiment, and 0 otherwise. SB takes on value 1 if someone chooses spaghetti bolognese as their dish for the experiment, and 0 otherwise. SM takes on value 1 if someone chooses Swedish meatballs as their dish for the experiment, and 0 otherwise. T takes on value 1 if someone chooses tacos as their dish for the experiment, and 0 otherwise.

In this analysis, we have 14 beta-coefficients. The values for all these beta-coefficients relate to the constant term. This means that for a participant that chooses hamburgers as their dish, β_1 and β_2 represent the average change in footprint due to being exposed to the cognitive nudge and affective nudge respectively, as compared to when they are assigned to the control group. $\beta_3, \beta_4, \beta_5$ and β_6 represent the average change in footprint for a participant in the control group due to choosing salad, spaghetti bolognese, Swedish meatballs or tacos respectively, as compared to choosing hamburgers as their dish. The other *beta*-coefficients are somewhat less straightforward to interpret. Therefore, we will use examples to illustrate their interpretation. Firstly, for β_7 we can think about the following example: it is given that a participant chooses salad as their dish, $\beta_7 + \beta_1$ then represents the average difference in footprint for that participant between being exposed to the cognitive nudge and being in the control group. A similar logic holds for β_8: if a participant chooses salad as their dish, $\beta_8 + \beta_2$ represent the average difference in footprint for that participant between being exposed to the affective nudge and being in the control group. These type of examples also hold for the other coefficients. If a participants chooses spaghetti bolognese as their dish, $\beta_9 + \beta_1$ represents the average difference in footprint for that participant between being exposed to the cognitive nudge and being in the control group, and $\beta_{10} + \beta_2$ represents the average difference in footprint for that participant between being exposed to the affective nudge and being in the control group. Next, the average difference in footprint between a participant that chooses Swedish meatballs as their dish while being assigned to the cognitive nudge group and that same participant choosing tacos as their dish while being assigned to the control group is equal to $\beta_{11} + \beta_1$. The difference for a participant between choosing Swedish Meatballs while being assigned to the affective nudge group and choosing that while being assigned to the control group is equal to $\beta_{12} + \beta_2$. This logic also holds for someone who chooses tacos as their dish: the difference between choosing tacos while being assigned to the cognitive group as compared to being in the control group is equal to $\beta_{13} + \beta_1$ and the difference between choosing tacos while being assigned to the affective nudge group as compared to being in the control group is equal to $\beta_{14} + \beta_2$.

The first thing we will check, is whether average CO2e footprints differs significantly ($p < 0.05$) among the five dishes. We will only do this for the average CO2e footprint of each dish in the control group, since the choices from the participants in this group were not influenced by seeing the nudges. Therefore, these differences show the “natural” CO2e footprint differences between the different dishes. These significant differences can be inferred from the significance of the coefficients for each of the dishes in the table, and from assessing whether the coefficients for the dishes are statistically significantly different from each other. This can be inferred from doing multiple F-tests.

Next, we will check for each dish whether there is a statistically significant difference between being in the control group and the cognitive nudge group, between being in the control group and affective nudge group, and between being in the cognitive and affective nudge group, keeping all other factors fixed. Regarding the significant differences between being in the control group and in one of the treatment groups, we will perform F-tests that test *Cognitive nudge treatment + Cognitive nudge interaction term = 0* and F-test that test *Affective nudge treatment + Affective nudge interaction term = 0* for each dish. For detecting possible differences between being in the cognitive and affective nudge group, we will execute an F-test which checks *Affective nudge treatment – Cognitive nudge treatment = 0* for hamburgers, and F-tests which check *(Affective nudge treatment + Affective nudge interaction term) – (Cognitive nudge treatment + Cognitive nudge interaction term) = 0* for the other dishes.

We will also check whether the ability of the cognitive and affective nudge to reduce participants' CO2e footprint significantly differs between the different dishes, i.e. whether some dishes are more "nudgeable" than others. We will do this by examining if any of the cognitive nudge interaction terms are significantly different from zero and by executing F-tests which test whether any of those interaction terms are statistically significantly different from each other. We do the same for the affective nudge interaction terms. In case we find a statistically significant p-value for these F-tests, we can support the statement that the effectiveness of the nudge(s) differs for different dishes.

Regression Analysis Results

The results from the regression analysis with interaction effects are given in Table 8 below. We show the results from two analyses: one without any control variables, under (1), one with the two diet factor control variables, under (2) and (4), and one with the two diet factors and a categorical gender variable as control variables. The results under (1) (2) and (3) are based on the data that excludes the observations from the participants that answered wrongly to the control question ($N = 625$), whereas the results under (4) include those observations ($N = 631$). One can confirm by investigating the results under (1), (3) and (4) that not adding the diet factors as control variables [(1)], adding the gender variable as an extra control variable [(3)], and including the six participants who answered wrongly to the control question [(4)] does not change much to the results. In fact, it changes nothing to the conclusions that we can draw from the results, and, hence, it is justified to move on with using only the results under (2), where we have the same two control variables as in the main specification in the Results Section.

Table 8: Exploratory regression Analysis with Interaction Terms

	(1)	(2)	(3)	(4)
	Footprint			
Cognitive nudge treatment	-0.315	-0.206	0.035	-0.567
	(3.371)	(3.356)	(3.335)	(3.292)
Affective nudge treatment	0.410	0.712	0.793	0.485
	(3.219)	(3.235)	(3.212)	(3.212)
Salad	-21.66***	-20.74***	-20.245***	-20.80***
	(2.271)	(2.382)	(2.362)	(2.340)
Spaghetti bolognese	-5.947*	-5.638	-5.301	-5.863
	(2.979)	(3.029)	(3.018)	(3.001)
Swedish meatballs	-3.173	-2.734	-2.442	-2.965
	(3.431)	(3.483)	(3.477)	(3.458)
Tacos	-11.75***	-11.20***	-10.59***	-11.57***
	(2.962)	(2.967)	(2.978)	(2.902)
Cognitive nudge x salad	0.290	-0.384	-0.010	-0.193
	(3.551)	(3.654)	(3.631)	(3.589)
Affective nudge x salad	0.623	-0.163	0.283	-0.115
	(3.801)	(3.711)	(3.615)	(3.681)
Cognitive nudge x spaghetti bolognese	-2.625	-3.050	-3.110	-2.670

	(4.197)	(4.205)	(4.198)	(4.154)
Affective nudge x spaghetti bolognese	2.784	2.306	2.282	2.542
	(4.215)	(4.235)	(4.204)	(4.216)
Cognitive nudge x Swedish meatballs	10.94	10.01	10.10	10.42
	(5.971)	(5.991)	(6.040)	(5.956)
Affective nudge x Swedish meatballs	1.220	0.904	0.812	1.132
	(6.020)	(6.063)	(6.059)	(6.047)
Cognitive nudge x tacos	0.792	0.276	0.315	0.791
	(4.365)	(4.322)	(4.348)	(4.249)
Affective nudge x tacos	-2.413	-2.676	-2.604	-2.321
	(4.182)	(4.191)	(1.233)	(4.145)
Diet factor: convenience		2.931*	2.604*	2.762*
		(1.226)	(1.233)	(1.217)
Diet factor: variety		1.493	1.633	1.458
		(5.362)	(5.422)	(5.377)
Gender				
Female			-2.580*	
			(1.209)	
Non-binary			-1.691	
			(10.47)	
Prefer not to say			11.70**	
			(4.230)	
Constant	24.25***	21.96***	22.83***	22.30***
	(2.158)	(2.384)	(2.447)	(2.351)
N	625	625	625	631
R^2	0.199	0.206	0.2155	0.207
Type	OLS	OLS	OLS	OLS

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$

The first thing that we can infer from Table 8 is that the coefficient of “Salad” is highly statistically significantly different from zero ($p < 0.005$), and it seems to matter a lot for someone’s carbon footprint. After all, for someone who does not indicate that convenience and variety are important in choosing a diet, the average CO2e footprint when choosing hamburger as their dish is 22.30. If that same person were to choose a salad instead, their average CO2e footprint would be equal to $21.96 - 20.74 = 1.22$. This seems like a rather large difference. By executing multiple F-tests, we find that “Salad” is also highly statistically significantly different from all other dishes for participants in the control group ($p < 0.005$). So, on average participants in the control group that chose salad as their dish had a highly statistically significantly lower CO2e footprint than participants that chose any of the four other dishes. Participants in the control group who chose tacos on average had a statistically significantly higher CO2e footprint than participants who chose salads in the control group, but they had a statistically significantly lower footprint than participants who chose any of the other three dishes ($p < 0.005$). We can also infer from Table 8 that participants in the control group who chose spaghetti bolognese on average had a statistically significantly lower CO2e footprint than participants in the control group who chose hamburgers. Apart from this, there are no statistically significant differences between the different dishes in the control group, which follows from both Table 8 and F-tests. Based on all of these observations, we can support the statement that choosing certain dishes “naturally” creates a lower CO2e footprint than other dishes. However, since we did not find that the choice of dishes significantly differed between the experiment groups, we do not need to worry about this for the interpretation of the results in the main analysis. It merely shows that there is a natural difference in carbon footprints that comes from people choosing different dishes.

Next, we check for each dish whether there is a statistically significant difference between being in the control group and the cognitive nudge group and between being in the control group and affective nudge group, keeping all other factors fixed. The first thing we notice in Table 8 is that the cognitive nudge treatment and affective nudge treatment coefficients are not statistically significantly different from zero. This indicates that for participants who chose hamburgers as their dish, there is no statistically significant difference in CO2e footprint between being in the control group and the cognitive nudge group and between being in the control group and the affective nudge group, keeping all else equal. The F-tests show that the same holds for all other dishes (all $p > 0.05$), except for Swedish Meatballs. There we find $p = 0.048$ for the cognitive nudge effect. However, as we can observe from the table, the value of this effect is $-0.206 + 10.01 = 9.804$. And since this effect is statistically significantly different from zero, this indicates that for Swedish Meatballs, getting exposed to the cognitive nudge as compared to not getting exposed to a nudge on average significantly *increases* participants' CO2e footprint, keeping all other factors equal. These results together therefore provide *no evidence* for hypothesis 1, which states that the nudges on average significantly decrease consumers' carbon footprint.

Moreover, we use F-tests to check for each dish whether there is a statistically significant difference between being exposed to the cognitive nudge and the affective nudge, keeping all other factors equal. For each F-test we find insignificant p-values ($p > 0.05$), except for spaghetti bolognese. There we find that $p = 0.0063$, which indicates a highly statistically significant difference. From Table 8, we can infer that choosing spaghetti bolognese on average *decreases* CO2e footprint of someone who gets exposed to the cognitive nudge with $0.315 + 2.625 + 2.784 + 0.410 = 6.134$ *more* than someone who gets exposed to the affective nudge, keeping all other factors equal. This would indicate that for spaghetti bolognese the cognitive nudge would work better in decreasing carbon footprint than the affective nudge, which is the opposite of what hypothesis 2 states. All of this together shows that there is *no evidence* supporting hypothesis 2.

This leads us to analyzing whether the ability of the cognitive and affective nudge to reduce CO2e footprint differs statistically significantly between the different dishes. We first of all observe that none of the interaction terms are significantly different from zero. The F-tests that check whether the different cognitive nudge interaction terms are statistically significantly different from each other and from zero all have statistically insignificant p-values ($p > 0.05$), except for when we compare the coefficient of the cognitive nudge interaction term for Swedish meatballs with the one for spaghetti bolognese ($p = 0.0191$) and the one for salad ($p = 0.042$). The cognitive nudge interaction term for Swedish meatballs has a (large) positive value, and the cognitive nudge interaction terms for spaghetti bolognese and salad have slightly negative values, which means that compared to getting exposed to the cognitive nudge (as opposed to not getting exposed to any nudge) when having chosen spaghetti bolognese or salad, getting exposed to the cognitive nudge (as opposed to not getting exposed to any nudge) when having chosen Swedish meatballs increases participants' average carbon footprint statistically significantly, keeping all other factors equal. This suggests that participants on average tend to respond differently to the cognitive nudge when they have chosen salad or spaghetti bolognese as compared to when they have chosen Swedish meatballs. Nonetheless, since our main interest is finding out whether participants' average carbon footprint *decreases significantly more* for certain dishes due to seeing a nudge than for other dishes, this observation does not provide us with any support for that. Furthermore, all F-tests for the affective nudge interaction terms show insignificant p-values. All in all, this provides *no support* for the statement that the capacity of the nudges to *decrease* carbon footprint depends on the type of dish that someone chooses, i.e. it does not necessarily seem to be the case that some dishes in our experiment are more "nudgeable" than other dishes in our experiment.

Lastly, for each of the models, we observe that the R^2 is around 20%. This is an increase of more than 18 percentage points. However, we should still conclude that these models cannot explain more than 1/5 of the variation in participants' footprints. Hence, we can infer that the differences in CO2e footprint between participants in our experiment mostly got determined by other factors than whether or not a participant got exposed to one of the nudges and the dishes they chose.

Appendix G: Donation to Barncancerfonden

Below we show a screenshot of the confirmation e-mail from our donation to the Swedish Childhood Cancer Fund (Barncancerfonden).

Tack!

Vi är glada och tacksamma över att du stödjer Barncancerfondens verksamhet. Alla bidrag är betydande för vårt fortsatta arbete med forskning och stöd till drabbade familjer. Vi har mottagit följande uppgifter:

Ordernummer: 9437465
Betalningssätt: Swish
Givarnummer: 7238545
Namn: Eugénie de Jong
Adress: [redacted]
Din beställning: Gåva 631,00
Moms 0,00
Datum 2021-11-29

För dig som köpt en startplats till något av våra virtuella idrottsevent, använd nedan loppkod:

Run of Hope: [redacted]
Walk of Hope: [redacted]

Varmt tack.
Thorbjörn Larsson
Generalsekreterare

Vid eventuella frågor/kompletteringar kontakta vår givarservice på telefon 020-90 20 90, skicka ett mejl till info@barncancerfonden.se eller besök vårt supportforum.