The Limits of Nudging: Can Descriptive Social Norms be Used to Reduce Meat
Consumption? - It's Probably Not That Easy

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Abstract

A high level of meat consumption is associated with high emissions of greenhouse gases (GHG) and significantly contributes to anthropogenic climate change. One promising approach to reduce meat consumption without restrictions to freedom of choice might be the use of descriptive social norms as nudging interventions. We report two preregistered, randomized experiments ($N_1 = 450$ and $N_2 = 899$) in which we investigated whether written displays of true descriptive social norms about the rising popularity of vegetarian and vegan meals can be used to effectively nudge people towards more sustainable food choices, i.e. reduced meat consumption. Additionally, the main effect of subjects' environmental attitude and a possible interaction of the social norms intervention and environmental attitude were examined. Participants were asked to choose one of five meals in 29 (Exp. 1) and 28 (Exp. 2) trials, resulting in a total of 38,222 observations. Subjects with a higher environmental attitude were more likely to choose meat-free meals, $OR_1 = 3.50$, [2.84, 4.32]; $OR_2 = 2.79$, [2.40, 3.23]. The results of both experiments showed no significant effect of the social norms intervention on subjects' likelihood to select meat-free meals, $OR_1 = 0.73$, 95% CI [0.49, 1.09]; $OR_2 = 0.97$, [0.81, 1.16], and no interaction of the intervention with environmental attitude. An exploratory analysis suggested that subjects chose more meat-free meals if those made up a bigger portion of the offer. The results are discussed with regard to possible explanations, including a potentially high context-dependency of the efficacy of social norms interventions. The data, materials and preregistrations are available from <https://osf.io/ruyfs/>.

Keywords: Descriptive Social Norms, Nudging, Food Choices, Sustainable Consumption, Meat Consumption

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Introduction

In August 2018, the National Oceanic and Atmospheric Administration (NOAA) of the United States released their 28th annual report *State of the Climate*, summarizing developments of the global climate system (Blunden, Arndt, & Hartfield, 2018). According to the report, the atmospheric CO₂ concentration continues to rise (Dlugokencky et al., 2018), and not only was 2017 the warmest year not influenced by the climate phenomenon El Niño since the beginning of weather records in the late 19th century but the last four years were the four warmest years ever recorded (Sánchez-Lugo, Morice, Berrisford, & Argüez, 2018). On top of that, alpine glaciers have shrunk now for the 38th consecutive year (Pelto & WGMS Network, 2018). At the same time, the German farmer's association is expecting "the worst harvest of the century" due to a heavy drought (Stürzenhofecker and Zacharakis, 2018; see also Willinger, 2018), one of the weather extremes made more likely by climate change (Intergovernmental Panel on Climate Change, 2014, p. 69). Human impact on the earth's climate is so massive that a working group of the International Union of Geological Sciences proposed to formally recognize the *Anthropocene* as a new geological epoch (Zalasiewicz et al., 2017). These developments illustrate how pressing action against anthropogenic climate change has become. The most important part of such action is the effort to reduce greenhouse gas (GHG) emissions, the main drivers of anthropogenic climate change (Intergovernmental Panel on Climate Change, 2014, p. 4).

One sector of human economy that contributes significantly to GHG emissions is meat production. Agriculture in total is estimated to be responsible for about a quarter of anthropogenic GHG emissions (Intergovernmental Panel on Climate Change, 2014, p. 47), and a minimum of 66 percent of these emissions (in CO₂ equivalents) can be attributed to livestock production (Tubiello et al., 2014). A number of recent works have shown that it is possible to significantly reduce GHG emissions by reducing meat consumption. Scarborough et al. (2014) calculated the emissions caused by different diets for consumers in the UK, based on data from more than 55,000 subjects. They found that while an average vegetarian's diet causes the emission about 35% less GHG

emissions than an average meat-eaters diet, and the more meat a person consumes the more GHG emissions are produced. Bryngelsson, Wirsenius, Hedenus, and Sonesson (2016) estimated that for Sweden to meet the EU climate protection goals for 2050, it is necessary to reduce the consumption of beef and mutton by 50%. Additionally, according to a prediction by Springmann, Godfray, Rayner, and Scarborough (2016) it is possible to reduce GHG emissions associated with food production by 29-70% until 2050 compared to a reference scenario, if we move towards a more plant-based nutrition. Yet, worldwide meat consumption continues to grow; in fact it has grown by a factor of four to five between 1961 and 2014, as data from the United Nations Food and Agriculture Organization show (Ritchie & Roser, 2018).

During the campaign for the German federal elections 2013, the party *Bündnis 90/Die Grünen* (i.e. the green party) proposed the introduction of a *veggie day* (sale of vegetarian and vegan meals only on one day of the week) in public canteens in order to reduce meat consumption and increase awareness of the environmental, health, and animal welfare impacts of meat production (Bündnis 90/Die Grünen, 2013). The proposal was followed by a controversial debate (see, e.g., Caspari, 2013), with one representative survey reporting that 61% of Germans were opposed to the suggestion (Infratest Dimap, 2013). After the election, the party abandoned the notion of a veggie day (Bündnis 90/Die Grünen, 2014). This example serves to illustrate that the introduction of policies with the aim of a reduced meat consumption is a delicate matter, and public approval might not be easy to obtain.

One solution could lie in the application of *nudging* approaches, which are behavioral interventions that fully uphold people's freedom of choice. The concept of nudging was introduced by Thaler and Sunstein (2008) and has since received a lot of public attention, culminating in the award of the Nobel Memorial Prize in Economics to Richard Thaler (Nobel Media AB, 2017) for his contributions to behavioral economics.

In the following sections, we briefly review the concept of nudging in general and the use of social norms as nudges in particular, as well as a possible moderating role of environmental attitude, before introducing our research questions.

Theory

Nudging

Definition. The concept of nudging refers to a number of distinct behavioral interventions such as defaults, feedback, and social norms (Croson & Treich, 2014; Sunstein, 2014), many of which have already been known and studied before the term was introduced by Thaler and Sunstein in 2008. Nonetheless, it fulfills a useful function in summarizing interventions that rely on similar principles, especially since Hansen (2016) presented the following refined definition (p. 174):

A nudge is a function of (I) any attempt at influencing people’s judgment, choice or behavior in a predictable way, that is (1) made possible because of cognitive boundaries, biases, routines, and habits in individual and social decision-making posing barriers for people to perform rationally in their own self-declared interests, and which (2) works by making use of those boundaries, biases, routines, and habits as integral parts of such attempts.

Thus a nudge amongst other things works independently of:

- (i) forbidding or adding any rationally relevant choice options,
- (ii) changing incentives, whether regarded in terms of time, trouble, social sanctions, economic and so forth, or
- (iii) the provision of factual information and rational argumentation.

One of the most prominent nudging approaches is the use of default rules (Sunstein & Reisch, 2014), which consists in carefully choosing the outcome that takes effect if subjects make no active choice. Empirical work suggests that this approach is highly effective, e.g. in the effort to increase the rate of organ donors (Abadie & Gay, 2006) or to reduce the amount of paper wasted in simplex printing (Egebark & Ekström, 2013).

Nudging and Libertarian Paternalism. In order to further clarify the concept of nudging, it is helpful to briefly consider the differences between nudging and the political ideology of libertarian paternalism. Both are closely related and sometimes confused, but they can be separated from each other. The term libertarian paternalism

was introduced by Thaler and Sunstein (2003) and defined as “an approach that preserves freedom of choice but authorizes both private and public institutions to steer people in directions that will promote their welfare.” (p. 179). Hansen (2016) differentiates nudging from libertarian paternalism by explaining that (a) nudging interventions are not necessarily acts of libertarian paternalism, because they might also be used for other purposes than to serve the nudged individuals’ interests, and (b) the interventions employed by libertarian paternalists are not limited to nudging, as e.g. the provision of relevant factual information would qualify as an act of libertarian paternalism, but not as a nudge. One instrument of libertarian paternalism that is often confused with nudging is de-biasing. Croson and Treich (2014) for example refer to a study by Larrick and Soll (2008) as a nudging-study. The latter authors showed that the *miles per gallon* measure for the fuel efficiency of cars, which is widely used in the U.S.A., leads to significantly biased consumer judgments and that a change of the measure to *gallons per 100 miles* can improve those judgments. While this is an interesting and useful finding with a direct implication for policy, it does not fall under the definition of nudging given above, because the intervention does not *make use* of cognitive boundaries, biases, routines and habits as integral part of the attempt to influence behavior. Instead, the intervention works by *removing* a cognitive bias.

Nudging Food Choices. In the area of food choices, nudging is most often used in order to promote healthier choices. In a 2016 review, Wilson, Buckley, Buckley, and Bogomolova conclude that “[c]ombined salience and priming nudges showed consistent positive influence on healthier food and beverage choices.” (p. 47). The examined priming nudges included changes to visibility, accessibility and availability, while the salience nudges comprised different forms of labels (e.g., traffic light labels). Another review from the same year focused on the effect of changes to the product order (Bucher et al., 2016) and found that such changes can indeed influence the choices of consumers.

Although nudging has been widely applied both to improve food choices and to promote sustainability (see Croson and Treich, 2014; Lehner, Mont, and Heiskanen, 2016; Sunstein and Reisch, 2014), both lines of research have so far been brought together in

only one peer-reviewed paper: In a field experiment at two university restaurants, Kurz (2018) found an increase in the sales of vegetarian meals by six percentage points compared to a control restaurant after changes to the order of presentation and an increase in visibility for vegetarian meals. In another field experiment, reported as a working paper, Gravert and Kurz (2017) handed out differently phrased menus to customers of a restaurant. When the menu contained only a vegetarian and a fish meal and the sentence “An option containing meat is available on request.”, the share of meat dishes sold was 21%, while in the reverse condition 46% of all sold meals contained meat. In her master’s thesis, Hohle (2014) found that subjects’ choices were not significantly impacted by presenting vegetarian meals as “Meal of the Day” and changing their names to more attractive versions.

These very limited findings show that the efficacy of nudging approaches to stimulate sustainable food choices requires further investigation. In particular, the use of social norms, which Sunstein and Reisch (2014) esteem to be “[o]ne of the most effective nudges” (p. 586), has so far not been empirically examined for this purpose. This is the main focus of this work.

Social Norms

Descriptive and Injunctive Norms. In the literature, two main types of social norms are commonly distinguished, namely descriptive and injunctive social norms (Cialdini, Reno, & Kallgren, 1990; Cialdini et al., 2006; Deutsch & Gerard, 1955). Descriptive social norms contain information about common behavior (i.e. what people *actually do*). They supposedly work by providing decisional shortcuts to the identification of useful behavior and by making use of a motivation to maintain an accurate representation of the world (Cialdini & Goldstein, 2004). Because of this, people tend to internalize these norms and regard them as correct. Injunctive social norms on the other hand contain information about moral rules (i.e. what people *should do*). The effect of these norms on people’s choices probably relies on people’s motivation to maintain positive relationships with their peers (Cialdini & Goldstein, 2004). For this reason,

people might comply with injunctive norms without privately regarding them as correct.

Injunctive social norms don't necessarily qualify as nudges according to Hansen's (2016) definition, as they work at least partly by changing incentives through the implication of social sanctions. Nudges are supposed to be independent of such mechanisms. Descriptive social norms on the other hand work by utilizing a cognitive routine, namely the use of social information as a decisional shortcut. What's more, descriptive social norms don't forbid or add choice options, don't change incentives, and don't work through the provision of factual information and rational argumentation. Thus, descriptive social norms can be regarded as nudges.

Social Norms and Sustainable Behavior. The efficacy of drawing attention to descriptive social norms for promoting sustainable behavior has been successfully investigated in a number of empirical studies and for a variety of outcomes.

In a widely recognized study, Cialdini et al. (1990) found that observing implicit descriptive social norms can impact the amount of littering shown by people in public spaces, i.e. people littered more in a littered environment than in a clean environment. Effects have also been observed for explicitly communicated norms. In several similar studies, investigators used door hangers to communicate descriptive social norms to residents of single-family-homes. The norms contained information about the recycling behavior (Schultz, 1999) or the energy conservation behavior (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007) of people living in the same area and were found to be effective means for the promotion of sustainable practices (more recycling and less energy consumption), although Schultz et al. (2007) identified a boomerang effect for households with an already low consumption of energy. Those households tended to show an increase in energy usage following the intervention.

Goldstein, Cialdini, and Griskevicius (2008) prepared hotel rooms with signs showing written descriptive social norms like "75% of the guests who stayed in this room participated in our new resource savings program by using their towels more than once." Participants in these conditions reused their towels significantly more often than

participants in a control condition. A Bayesian meta-analysis on seven experiments examining this effect revealed a Bayes Factor of 36.89, indicating strong evidence for the efficacy of this kind of social norms intervention (Scheibehenne, Jamil, & Wagenmakers, 2016). In recent years, descriptive social norms have also been successfully used to make people choose more sustainable ways of transportation for their commutes (Kormos, Gifford, & Brown, 2015) and to foster more sustainable shopping behavior (Demarque, Charalambides, Hilton, & Waroquier, 2015).

Demarque et al. (2015) placed their subjects in an artificial online grocery store environment and presented them with written descriptive social norms at the beginning of their experiments. The norms contained true information about the behavior of previous participants in a pilot study. Interestingly, differing from their usual use, the descriptive social norms actually reflected minority behaviors, but were carefully phrased in order to encourage said behaviors with the use of verbal quantifiers like *more than* or *at least*. The authors found that subjects in the social norms condition bought significantly more ecological products and spent a significantly greater portion of their budgets on ecological products than subjects in a neutral control condition. A second, attentional control group, where the presented message read “For your information, some of the products on sale are ecological.”, did not significantly differ from the control group. This implies that the more sustainable choices of participants in the social norms group cannot be exclusively attributed to the fact that the intervention caused increased awareness of ecological products.

Social Norms and Food Choices. When food choices are concerned, descriptive social norms have mainly been used to influence the amount of food that subjects eat and to promote the selection of healthy meals. Social norms interventions appear to be effective in both areas, with studies suggesting that subjects can be led to choose healthy food (Burger et al., 2010; Robinson, Blissett, & Higgs, 2013) and to adjust their food intake according to communicated descriptive norms (Pliner & Mann, 2004; Robinson, Benwell, & Higgs, 2013). In a systematic review, Robinson, Thomas, Aveyard, and Higgs (2014) conclude that there is consistent evidence for the influence of

descriptive social norms on both mentioned outcome measures.

What has so far not been investigated is whether descriptive social norms can also be applied to make people choose more sustainable food, i.e. to make them choose meat-free meals instead of meat-containing meals more often, thereby reducing meat consumption. This might work through the informational function of descriptive social norms, implying that meatless meals are of good taste, quality, or nutritional value. It is not clear, however, whether this mechanism would be strong enough to make people deviate significantly from their usual food preferences.

The Role of Environmental Attitude

In light of the ecological impact of meat consumption it is plausible that people's food choices are not independent of their environmental attitude. A person with a high motivation to protect the environment (high environmental attitude) should be more inclined to refrain from meat consumption than a person with low or average motivation to protect the environment. Indeed, Byrka (2009) found that vegetarians had a higher environmental attitude, measured with the General Ecological Behavior Scale (Kaiser & Wilson, 2004), than non-vegetarians.

Beyond this association, it also seems possible that people's environmental attitude might interact with a social norms intervention. Consider the following hypothetical scenario: A person with a high environmental attitude and a very low consumption of meat is presented with a descriptive social norm about the popularity of vegetarian meals. Her goal of protecting the environment is satisfied, because meat consumption is declining or low enough already. She reacts by consuming more meat than before, because strict abstinence does not appear to be necessary anymore. In this scenario, a high environmental attitude leads to a reversed effect of the social norms intervention.

Kaiser, Arnold, and Otto (2014) argue that the effect of interventions that focus on the external conditions of behavior, like it is the case for nudging interventions, is independent of subject's attitudes. The authors base their case on Kaiser, Byrka, and Hartig's (2010) conception of behavior as an additive function of attitudes and behavioral

difficulty, building on the work of Donald T. Campbell (1963). In the case of social norms, one could indeed argue that a descriptive social norm reduces the difficulty of certain behaviors. By providing a decisional shortcut (Cialdini et al., 1990), they might be used as a heuristic that lowers the cognitive effort necessary to plan behavior, therefore making it easier to engage in the behavior in question. However, as the scenario above shows, the assumption that the effect of descriptive social norms is independent of people's environmental attitude is not trivial, which is why a second aim of this work is to test this assumption.

Overview of Hypotheses

Implementing steps to reduce meat consumption is a sensitive topic, as evidenced by the debate about the introduction of a veggie day in Germany. Descriptive norms might be more appropriate in this context than injunctive norms, as the former don't rely on moral imperatives and might therefore be less likely to provoke antagonistic reactions. Descriptive social norms have also been more widely applied to influence food choices than injunctive norms. Nonetheless, descriptive social norms have so far not been examined with regard to their potential to serve as nudges for a reduction in meat consumption. The present research aims to fill this gap in the literature. A second goal of this work was to test Kaiser et al.'s (2014) assumption that the effects of nudging and attitudes don't interact. For this purpose, we included a measure of environmental attitude and examined the relationship between that attitude and subjects' tendency to choose meat-free meals. We conducted two randomized, preregistered experiments, testing the following three general hypotheses:

- H 1** There is a positive relationship between the environmental attitude of participants and their tendency to choose meat-free meals: A more pronounced environmental attitude is associated with a higher likelihood to choose meat-free meals.
- H 2** Participants who see descriptive social norms about the popularity of meat-free meals are more likely to choose meat-free meals than participants in an attentional or neutral control condition.

H 3 There is no significant interaction between the presentation of descriptive social norms and participants' environmental attitude regarding the likelihood to choose meat-free meals.

In the first experiment, we compared a group of subjects who saw displays of descriptive social norms to an attentional control group. In the second experiment, we increased the sample size and added a neutral control group to test the robustness of the findings from Experiment 1.

Experiment 1

Methods

Determination of Sample Size. The target sample size of 450 subjects was based on an a priori power analysis conducted with the software G*Power (Faul, Erdfelder, Buchner, & Lang, 2009). The goal was to obtain a statistical power of at least .80 to detect a small effect size of $f^2 = 0.02$ at the standard .05 alpha error probability for hypotheses H 1 and H 2 in a hierarchical linear regression. For hypothesis H 3, we aimed to achieve a power of at least .90 at an alpha error probability of .10, also for a hierarchical linear regression. G*Power yielded a required sample size of 430, which was rounded up to 450. Thus, achieved power was .85 for H 1 and H 2 and .91 for H 3¹.

Participants. Data collection took place from February 27, 2018, till March 1, 2018. 779 people clicked on the link to the experiment; 477 completed it. They were recruited through posts in social media groups associated with the University of Göttingen, Germany, and could take part in a lottery at the end of the experiment, awarding a cash reward of €20 to five randomly selected participants.

Exclusion of subjects. Only the 477 complete datasets were entered into the analysis. Of those, 13 subjects were excluded because they claimed to have known the aim of the study beforehand. Zero subjects were excluded because they finished the experiment in less than five minutes, indicating arbitrary answers, and two subjects were excluded because they took longer than 60 minutes to finish the experiment, indicating a lack of attention. Of the remaining 462 subjects, we selected the first 225 complete datasets in each of the two conditions, arriving at a total of 450 subjects in this experiment.

Sample characteristics. The sample consisted mostly of university students (96.4 %), predominantly studying in Göttingen, Germany (99%), and a majority was

¹ Note that, due to a violation of the assumption of a normally distributed dependend variable, the data were actually analysed using hierarchical generalized mixed effects models (see below). Most likely, this lead to increased power, as the number of individual observations in the analysis went up to 13,050 (450 subjects answering 29 trials each).

female (68.0 %). Mean age was 24.04 years ($SD = 3.84$).

Environmental Attitude. Environmental attitude was measured using the General Ecological Behavior Scale (Kaiser & Wilson, 2004), which employs the dichotomous Rasch model as the measurement model. The scale consists of 50 items, asking about subjects' engagement in environmentally relevant behaviors. The estimated person parameter is utilized as a measure of attitude. Example items are "In the winter, I keep the heat on so that I do not have to wear a sweater.", "If I am offered a plastic bag in a store, I take it." and "I am a member of an environmental organization." 32 items were answered on a 5-point scale but recoded to a dichotomous format by collapsing the answers *never*, *seldom* and *occasionally* to a negative answer (indicating unreliable ecological engagement) and the answers *often* and *always* to a positive answer (indicating reliable ecological engagement). This approach is recommended by the authors, because they found answers in the polytomous format to be less reliable and more arbitrary (Kaiser & Wilson, 2000). The remaining 18 items were answered directly in a *yes/no* format. Nineteen of the 50 items were negatively formulated, those were reversed in coding. One item ("I follow a vegetarian diet.") was excluded in the present work due to overlap with the dependent variable. Subjects had the possibility to select *not applicable*, if an item did not apply to them. Those answers were coded as missing values. A total of 10.8 % of all observations were missing. Estimates of environmental attitude were obtained using conditional maximum likelihood estimation via the package eRm (Mair & Hatzinger, 2007) for the statistical programming language R (R Core Team, 2018). Andersens (1973) likelihood ratio test indicated good model fit, $\chi^2(48) = 42.24$, $p = .707$. Environmental attitude had a separation reliability (a rasch-specific measure similar to Cronbach's α) of $rel = .80$. A full list of the items is given in Table A.1 and Table A.2 of the Supplementary Materials 1 (link: <https://osf.io/4qtxk/>).

Dependent Variable. Participants were presented with 29 trials, each consisting of a presentation of five different meals. An example is shown in Figure 1. On each trial, they were asked to choose one of the presented options. Responses were recoded to 0 = meat-containing meal and 1 = meat-free meal. The exact question read:

“Which of the following meals would you choose if you were to have lunch in the university canteen on a day with this offer?” (translated from German). The composition of the trials was based directly on the menus of the university restaurants *Mensa am Turm* and *Zentralmensa* in Göttingen, Germany: Meals that were shown together in a trial were actually sold in the same combination in one of these restaurants. Presentation included the official title and subtitle of each meal as it appeared on the menu, a photo of the meal and the official information about allergens and food additives. The photos were taken on working days between January 10, 2018 and January 30, 2018 in both *Mensa am Turm* and *Zentralmensa*. Only main dishes without any of the also available side dishes were selected.

One trial contained one meat-free meal², 14 trials contained two meat-free meals, 12 trials contained three meat-free meals and two trials contained four meat-free meals. On 14 trials, Option 1 was a meat-free meal. A detailed overview, pictures of all complete trials, and all individual pictures are available from <https://osf.io/ruyfs/>. All participants had to pick one of the five presented options in each trial (forced choice). Meals containing fish were counted as meat-containing meals in accordance with the official classification of *Studentenwerk Göttingen*, the operator of the university restaurants.

Intervention. The intervention was introduced with text snippets, appearing in the top left corner of the trial display on every second trial, starting with Trial 1 (see Figure 1). Manipulated messages, containing either a descriptive social norm or attentional control messages were shown on Trials 1, 7, 13, 19 and 25. The remaining messages were distractors, e.g. “There are about 400 people employed at Studentenwerk Göttingen.” Following Demarque et al. (2015), we used verbal quantifiers like *more than* in the phrasing of some of the norms in order to encourage choosing vegetarian meals, even though this was a minority behavior (see also Geurts and Nouwen, 2007). In cooperation with Studentenwerk Göttingen, the messages were framed to sound like

² Due to a programming error, Trial 13 consisted of four meals that were sold on the same day and one meal that was sold on the day before. A meat-free meal was exchanged for a meat-containing meal. As a result, the trial consisted of only one meat-free meal and four meat-containing meals.

Figure 1. Example for one of the experimental trials. The text in the top left box was used to introduce the manipulation. On non-manipulated trials, the box was left blank. The text below the photos contains the title and subtitle of the meals as given in the official menus of the restaurants. No subtitle was given if none appeared in the menu.

statements being made by Studentenwerk Göttingen. Both the descriptive social norms and the attentional control messages were obtained from an analysis of the sales data of four university restaurants in Göttingen, Germany. The data were kindly provided by Studentenwerk Göttingen. Descriptive social norms messages contained information about the choices of other people. Attentional control messages contained only information about the offer. An example for a descriptive social norm message is “Between 2010 and 2017, the share of vegetarian and vegan meals in our sales rose from about 24% to more than 35%.”. An example for an attentional control message is “All side dishes in our canteens are either vegetarian or vegan.” See Table A.3 in Supplementary Materials 1 for a full list of the text snippets (link: <https://osf.io/4qtxk/>).

Design and Procedure. The experiment was programmed and conducted with the formr online survey framework (Arslan & Tata, 2018). Subjects were randomly assigned to either the social norms or the attentional control condition using the

Table 1

Descriptive data for Experiment 1.

Condition	<i>n</i>	Meat Consumption		Meat-Free Share (%)
		<i>Never</i> (<i>n</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Attentional Control	225	50	2.95 (1.40)	60.57 (32.33)
Social Norms	225	36	3.11 (1.28)	57.47 (29.25)
Total	450	86	3.03 (1.34)	59.02 (30.83)

Note. The column *Never* gives the number of people who responded that they never eat meat. The column *Meat-Free Share* gives the share of trials in which a vegetarian or vegan meal was chosen.

frameworks built-in random number generator. First, subjects answered all 29 choice trials. Next, they completed the GEB, followed by questions about their age, gender, student status, and a question asking whether they knew the aim of the study beforehand. Students were asked to indicate their place of study. Mixed among the GEB questions, subjects were asked how often they normally consume meat on a 5-point scale (1 = *never*, 2 = *seldom*, 3 = *occasionally*, 4 = *often*, 5 = *very often*).

Results and Discussion

Descriptive Data. Table 1 gives the descriptive data for Experiment 1. A Shapiro-Wilk-Test indicated that meat consumption habits were non-normally distributed, $W = 0.88$, $p < .001$. Therefore we tested for differences in meat consumption habits across groups using a χ^2 -test of homogeneity, which revealed no significant differences in responses between groups $\chi^2(4) = 6.34$, $p = .175$. An overview of the share of meat-free meals per trial is given in Figure 2. Observations from the figure include the following: (a) Descriptively, the share of meat-free meals is lower in the social norms group than in the attentional control group for many trials. This matches the descriptive comparison of the means (see Table 1). (b) Still, the confidence intervals largely overlap and mostly include both point estimates. (c) As the patterns in both groups are very similar, answers are likely to be quite specific to individual trials, i.e. to the offer.

Figure 2. Overview of the mean share of meat-free meals chosen per trial in Experiment 1. The colored ribbons give the 95% confidence intervals. Note that trials are arranged by share of meat-free meals to allow for easier comparison of the experimental conditions. Upwards ticks on the x-axis mark the manipulated trials.

Main Results. The share of meat-free meals chosen was significantly non-normally distributed, $W = 0.99$, $p < .001$, see also Figure A.1 in Supplementary Materials 1. This was due to 72 participants (16%) selecting non-meat meals only³. For this reason, the data were analyzed with hierarchical generalized linear mixed-effects models (GLMM) for binary outcomes, i.e. hierarchical logistic multilevel regression. This constitutes a deviation from the preregistered protocol (hierarchical linear regression on the mean share of meat-free meals chosen per subject), which became necessary because the assumption of a normally distributed dependent variable was not met. The statistical power of the analysis was likely improved by this change, as the number of observations entered into the analysis increased from 450 (number of subjects) to 13,050 (450 subjects, completing 29 trials each). The tendency to choose meat-free meals showed significant

³ Interestingly, this number is lower than the total number of participants responding that they *never* eat meat. This might be the result of interpersonal differences in whether subjects regarded fish as meat.

Figure 3. Relationship between subjects' environmental attitude and the share of meat-free meals in their choices in Experiment 1. Environmental attitude was z-scaled for easier interpretation. The points give the share of meat-free meals chosen by each subject. The red line represents the predicted probability that a subject with a certain environmental attitude will pick a meat-free meal, based on Model 1.

variance across participants, $SD = 2.15$, $\chi^2(1) = 4527.90$, $p < .001$. Responses to specific trials did not vary significantly when treated as nested within participants, $SD = 0.00$, $\chi^2(1) = 0.00$, $p = .993$, but they did when crossed random intercepts for trials and subjects were included, $SD = 0.85$, $\chi^2(1) = 1008.10$, $p < .001$. This suggests that, although trial-specific effects were present, there was little variation in choices within participants.

The emerging model with crossed random intercepts for subjects and trials was subsequently used as baseline for the hierarchical GLMM. On each step, one predictor was added. Results are displayed in Table 2. Environmental attitude showed a substantial effect, i.e. subjects with a high environmental attitude were much more likely to choose meat-free meals than subjects with low or average environmental attitude. Depending on the exact parameterization of the model, a subject with an environmental attitude that was one standard deviation above the mean had 3.50 to 4.09 times larger odds of choosing a meat-free meal in a given trial than a subject with average

environmental attitude (see Figure 3 for a visualization of this association). Neither the incorporation of condition (0 = attentional control, 1 = social norms) nor the interaction of condition and environmental attitude significantly improved the model. This suggests that participants in the social norms condition did not differ from participants in the attentional control condition in their tendency to choose meat-free meals and that this was the case regardless of participants' environmental attitude.

Robustness to alternative analyses. The results of the main analysis were checked for robustness. None of the conclusions changed, when subjects who responded that they never eat meat ($n = 86$) were excluded from the analysis. Additionally, the conclusions also remained the same when the originally preregistered hierarchical linear regression on the mean share of meat-free meals chosen by subjects was conducted in disregard of the violation of assumptions. See Section A.1 of the Supplementary Materials 2 for a detailed display of those results (link: <https://osf.io/atbdj/>).

Exploratory Analysis. Building on Model 3 from the main analysis, we conducted an exploratory analysis by adding the following predictors into another GLMM in a forced entry manner: The number of meat-free meals on offer in a trial, the type of display during trial (1 = no text, 2 = distractor, 3 = manipulated) and its interaction with experimental condition, the type of the first meal option (0 = meat-containing, 1 = meat-free), participants' gender (0 = male, 1 = female) and age.

Environmental attitude still significantly predicted subjects' choices in the experiment, $B = 1.30$, $z = 9.25$, $p < .001$, $OR = 3.65$, 95% CI [2.77, 4.80]. There was still no significant difference between the experimental conditions, $B = -0.31$, $z = -1.57$, $p = .116$, $OR = 0.73$ [0.50, 1.08] and no significant interaction between environmental attitude and experimental condition, $B = -0.28$, $z = -1.39$, $p = .163$, $OR = 0.76$ [0.51, 1.12].

Of the exploratory predictors, the number of meat-free options on offer showed a significant association with subjects' choices, $B = 1.14$, $z = 9.22$, $p < .001$, $OR = 3.11$ [2.44, 3.96], as did participants' gender, $B = 1.33$, $z = 6.44$, $p < .001$, $OR = 3.79$ [2.53, 5.70], and age, $B = -0.06$, $z = -2.29$, $p = .022$, $OR = 0.95$, [0.90, 0.99]. If more

meat-free meals were offered, subjects were more likely to choose such a meal. Women (mean share of meat-free meals chosen = 67.1%) and younger subjects were more likely to pick meat-free meals than men (mean share of meat-free meals chosen = 44.0%) and older subjects.

The type of text display did not significantly predict subjects' tendency to select meat-free meals, both when distractor messages, $B = 0.14$, $z = 0.76$, $p = .450$, $OR = 1.15$ [0.80, 1.65], and when manipulated messages, $B = 0.12$, $z = 0.54$, $p = .591$, $OR = 1.13$ [0.72, 1.78], were compared to trials with no display. Neither type of display interacted with experimental condition, $B = 0.06$, $z = 0.58$, $p = .561$, $OR = 1.06$ [0.87, 1.31] (Distractors x Condition), $B = 0.17$, $z = 1.26$, $p = .207$, $OR = 1.19$ [0.98, 1.56] (Manipulated x Condition). Moreover, there was no effect of the first option's meat-content, $B = -0.16$, $z = -0.86$, $p = .393$, $OR = 0.85$ [0.59, 1.23].

Discussion of Experiment 1. The results clearly support Hypothesis 1, as a higher environmental attitude was associated with higher odds of choosing meat-free meals.

Hypothesis 2 was not supported by this experiment. Contrary to the expectation, the display of descriptive social norms did not lead participants to choose meat-free meals more frequently. Some characteristics of the experiment may have hindered the intervention from being effective. For example, maybe participants did not pay attention to the information displayed in the text snippets, because there were too many of them (one on every second trial). Participants also might have disregarded the text snippets completely and instead only focused on the meal choices. Another possible explanation is that the control condition was too strong. This explanation seemed especially plausible in light of the fact that the overall mean share of meat-free meals was a lot higher in the experiment (59%) than in the actual sales data of the university restaurants provided by Studentenwerk Göttingen (36%): Both interventions might have caused subjects to choose more meat-free meals.

Hypothesis 3 was formally supported by this experiment, as no significant interaction between environmental attitude and the social norms intervention was found.

In the absence of an effect of the social norms intervention (H 2), however, the underlying assumption of independent effects of the social norms intervention and environmental attitude could not be tested.

Table 2

Fixed effect estimates and model comparison from hierarchical GLMM, Experiment 1.

	Fixed Effects			Model Comparison		
	<i>B</i>	<i>SE</i>	<i>OR</i> [95% CI]	χ^2_{diff}	<i>df</i>	<i>p</i>
Baseline						
(Intercept)	0.82***	0.20				
Model 1				126.56	1	< .001
(Intercept)	0.83***	0.19				
Env. Attitude	1.25***	0.11	3.50 [2.84, 4.32]			
Model 2				2.31	1	.129
(Intercept)	0.99***	0.22				
Env. Attitude	1.25***	0.11	3.51 [2.85, 4.32]			
Condition	−0.31	0.20	0.73 [0.49, 1.09]			
Model 3				2.32	1	.128
(Intercept)	1.00***	0.21				
Env. Attitude (A)	1.41***	0.15	4.09 [3.07, 5.45]			
Condition (B)	−0.33	0.20	0.72 [0.48, 1.07]			
A x B	−0.32	0.21	0.72 [0.48, 1.09]			

Note. $N = 450$. *OR* = Odds Ratio. *CI* = Confidence Interval. $\chi^2_{diff} = \chi^2$ -value for comparison to previous model. Dependent variable was a dummy variable giving subjects' food choices (0 = meat-containing, 1 = meat-free). Condition was coded 0 = attentional control, 1 = social norms. Environmental attitude was z-scaled with $M = 0$ and $SD = 1$ for more straightforward interpretation. The baseline model included crossed random intercepts for subjects and trials. Intraclass correlation (ICC) was .51 within subjects and .09 within trials, both values taken from Model 3. * $p < .05$. ** $p < .01$. *** $p < .001$

Experiment 2

To address the concerns from Experiment 1, we conducted a second experiment in which a neutral control condition was added and the number of displayed text snippets was reduced by removing all distractors. To check whether subjects' attention to the messages was mandatory for the presence of an effect, they were asked whether they read the messages at the end of the experiment. Additionally, the composition of trials was refined by balancing the number of meat-free meals offered per trial.

Methods

In Experiment 2, the methods were generally the same as in Experiment 1. In this section, we only give information specific to Experiment 2 and note differences to Experiment 1.

Determination of Sample Size. As the recruitment of subjects went well in Experiment 1, the target sample size was conservatively increased to 900 subjects (300 per group), leading to a total of 26,100 observations (900 subjects completing 28 trials each).

Participants. Data collection took place from May 14, 2018, till June 14, 2018. 2,739 people clicked on the link to the experiment; 1,187 completed it. Like in Experiment 1, they were recruited through posts (and, in this case, some ads) in social media groups associated with the University of Göttingen, Germany, and could take part in a lottery at the end of the experiment, awarding a cash reward of €20 to five randomly selected participants.

Exclusion of subjects. Only the 1,187 complete datasets were entered into the analysis. Of those, 66 subjects were excluded because they claimed to have known the aim of the study beforehand. Zero subjects were excluded because they finished the experiment in less than five minutes, indicating arbitrary answers, and 77 subjects were excluded because they took longer than 60 minutes to finish the experiment, indicating a lack of attention. A further 64 subjects were excluded, because they had already participated in Experiment 1. Of the remaining 980 subjects, we selected the first 300 complete datasets in each of the three conditions. One further participant had to be

Table 3

Descriptive data for Experiment 2.

Condition	<i>n</i>	Meat Consumption		Meat-Free Share (%)
		<i>Never</i> (<i>n</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Neutral Control	300	55	3.08 (1.34)	58.75 (30.51)
Attentional Control	299	63	2.99 (1.34)	62.34 (29.67)
Social Norms	300	63	3.11 (1.28)	61.46 (30.18)
Total	899	181	3.02 (1.33)	60.85 (30.12)

Note. The column *Never* gives the number of people who responded that they never eat meat. The column *Meat-Free Share* gives the share of trials in which a vegetarian or vegan meal was chosen.

excluded from the analysis, because he/she answered all questions of the GEB by choosing *not applicable*, making it impossible to fit the Rasch model. This case was not anticipated beforehand and therefore constitutes a justified deviation from the preregistration. Thus, the resulting sample size was 899.

Sample characteristics. Subjects were similar to those in Experiment 1: The sample consisted mostly of university students (96.0 %) studying in Göttingen, Germany (96.2 %), and a majority was female (70.1 %). Mean age was 23.54 years ($SD = 4.81$).

Environmental Attitude. Environmental attitude was measured with the GEB, as in Experiment 1. Andersens (1973) likelihood ratio test indicated good model fit, $\chi^2(96) = 92.72$, $p = .576$. A total of 10.2% of observations were missing. Environmental attitude had a separation reliability of $rel = .77$.

Dependent Variable. The measurement of subjects' tendency to choose meat-free meals was done similar to the measurement in Experiment 1, with some refinements. One trial was removed to allow for easier balancing, leaving the experiment with 28 trials. The trials alternatingly contained two or three meat-free meals that were, with one exception⁴, sold together on the same day in either of the university restaurants

⁴ Trial 22 contained four meals sold together and one meal sold on a different day in the same restaurant. This was necessary, because the trial would otherwise have contained four meat-free meals and we wanted

Mensa am Turm (MAT) or Zentralmensa (ZM) in Göttingen, Germany. They were also balanced with regard to the meat content of Option 1 (14 trials each started with a meat-containing and a meat-free meal), and the origin of the meals (14 trials each contained meals from MAT and ZM). A detailed overview, pictures of all complete trials, and all individual pictures are available from <https://osf.io/ruyfs/>. As in Experiment 1, all participants had to pick one of the five presented options in each trial (forced choice).

Intervention. The social norms and attentional control conditions remained largely the same. Compared to Experiment 1, one manipulated text and one attentional control text were added. In order to allow for greater attention to the manipulated text displays, no distractor messages were used in this experiment. Instead, some of the former distractors were used in the manipulated trials of the added neutral control group. Manipulated messages were shown on Trials 1, 6, 11, 16, 21, and 26. See Table A.3 in Supplementary Materials 1 for a full overview of all manipulated messages in both experiments (link: <https://osf.io/4qtxk/>).

Design and Procedure. Subjects were randomly assigned to one of three conditions: the social norms condition, the attentional control condition, and the neutral control condition. Otherwise, the procedure was parallel to Experiment 1. At the end of the experiment, an attention check was added (“Did you read the text snippets that were presented during the experiment?”).

Results

Descriptive Data. Table 3 gives the descriptive data for Experiment 2. Again, a Shapiro-Wilk-test indicated that meat consumption habits were non-normally distributed, $W = 0.89$, $p < .001$. There were no significant differences in meat consumption habits across groups, $\chi^2(8) = 4.41$, $p = .819$. An overview of the share of meat-free meals per trial is displayed in Figure 4. The results are similar to Experiment 1, most notably there is no clear difference between experimental conditions. Figure 5 gives a comparison of

to show only trials with at least two options of both types of meals. We chose a standard meal for the substitution that is offered multiple times in different combinations each month in both restaurants: pork schnitzel.

Figure 4. Overview of the mean share of meat-free meals chosen per trial in Experiment 2. The colored ribbons give the 95% confidence intervals. Note that trials are arranged by share of meat-free meals to allow for easier comparison of the experimental conditions. Upwards ticks on the x-axis mark the manipulated trials.

response patterns between experiments. The figure shows that subjects responded remarkably similar in both experiments.

Main Results. As in Experiment 1, the data were analyzed using hierarchical GLMM for binary outcomes. The results are displayed in Table 4. The steps were parallel to the analysis in Experiment 1. Because one group was added in Experiment 2, we specified planned contrasts, with Contrast 1 comparing both groups that had already been used in Experiment 1 to the new neutral control group and Contrast 2 comparing the social norms group to the attentional control group. The results confirm the results from Experiment 1: While there was a substantial effect of environmental attitude in all models, the addition of the experimental condition as a predictor in Model 2 and the interaction of experimental condition and environmental attitude in Model 3 did not significantly improve the model. This suggests that there were no significant differences between any of the experimental conditions and that subjects' environmental attitude did

Figure 5. Overview of the mean share of meat-free meals chosen by subjects in each trial in both experiments. The colored ribbons give the 95% confidence intervals. The facets split the data into the conditions. Upwards ticks on the x-axis mark the manipulated trials. Only the 26 trials with the same composition in both experiments are shown; Trials 10, 13 and 19 were excluded. Trial numbers are based on trial order in Experiment 1. The neutral control group from Experiment 2 is not shown, as there was no analogous neutral control group in Experiment 1 to compare it to.

not moderate the effect of any of the interventions. The non-significant planned contrasts in Model 2 and Model 3 are in line with this observation.

Robustness to alternative analyses. The results of the main analysis were again checked for robustness. None of the conclusions changed when subjects who responded that they never eat meat ($n = 181$) were excluded from the analysis. Additionally, the conclusions also remained the same when all subjects who responded not having read the text snippets ($n = 353$) were excluded or when this attention check (0 = did not read text snippets, 1 = did read text snippets) and its interaction with experimental condition were incorporated as a predictors into Model 3. See Section A.2 of the Supplementary Materials 2 for a detailed display of those results (link:

<https://osf.io/atbdj/>).

Discussion of Experiment 2

The results confirm the findings from Experiment 1: While subjects' environmental attitude had a substantial effect on their tendency to choose meat-free meals (H 1 was supported), the social norms intervention did not (H 2 was not supported). Interestingly, there was also no effect of directing attention to meat-free meals, as none of the groups differed with regard to the likelihood of subjects selecting meat-free meals. Hypothesis 3 was formally supported, since the results revealed no significant interaction of environmental attitude and the social norms intervention. Still, in the absence of an effect of the social norms intervention (H 2), the underlying assumption of independent effects of the social norms intervention and environmental attitude again could not be tested. As Figure 5 shows, response patterns were remarkably similar in both experiments, indicating a high reliability of the results. This reliable pattern strongly suggests that subjects did not pick meals arbitrarily.

Table 4

Fixed effect estimates and model comparison from hierarchical GLMM, Experiment 2.

	Fixed Effects			Model Comparison		
	<i>B</i>	<i>SE</i>	<i>OR</i> [95% CI]	χ^2_{diff}	<i>df</i>	<i>p</i>
Baseline						
(Intercept)	0.98***	0.14				
Model 1				171.17	1	< .001
(Intercept)	0.98***	0.14				
Env. Attitude	1.02***	0.08	2.79 [2.40, 3.23]			
Model 2				2.81	2	.245
(Intercept)	0.98***	0.14				
Env. Attitude	1.03***	0.08	2.79 [2.40, 3.24]			
Contrast 1	0.09	0.05	1.09 [0.98, 1.21]			
Contrast 2	−0.03	0.09	0.97 [0.81, 1.16]			
Model 3				1.91	2	.383
(Intercept)	0.98***	0.15				
Env. Attitude (A)	1.02***	0.08	2.76 [2.38, 3.20]			
Contrast 1	0.08	0.06	1.09 [0.98, 1.20]			
Contrast 2	−0.03	0.09	0.98 [0.82, 1.17]			
A x Contrast 1	−0.05	0.05	0.95 [0.85, 1.05]			
A x Contrast 2	0.10	0.09	1.10 [0.92, 1.32]			

Note. $N = 899$. *OR* = Odds Ratio. *CI* = Confidence Interval. $\chi^2_{diff} = \chi^2$ -value for comparison to previous model. Dependent variable was a dummy variable giving subjects' food choices (0 = meat-containing, 1 = meat-free). Contrast 1 compares the social norms and attentional control group to the neutral control group. Contrast 2 compares the social norms group to the attentional control group. Environmental attitude was z-scaled with $M = 0$ and $SD = 1$ for more straightforward interpretation. The baseline model included crossed random intercepts for subjects and trials. Intraclass correlation (ICC) was .54 within subjects and .05 within trials, both values taken from Model 3. * $p < .05$. ** $p < .01$. *** $p < .001$

General Discussion

Summary

In two preregistered, randomized experiments with large samples, we tested whether a high environmental attitude is associated with meat-reduced food selection (H 1) and whether simple written displays of true descriptive social norms can be used to effectively nudge people towards more sustainable food selection, i.e. reduced meat consumption (H 2). Additionally, we aimed to test the assumption that such an effect of descriptive social norms would be independent of subjects' environmental attitude (H 3).

The hypothesis of an association between environmental attitude and meat-reduced consumption (H 1) was strongly supported by the results of both experiments with substantial effect size estimates of $OR = 3.50$, 95% CI [2.84, 4.32] (Experiment 1, see Table 2) and $OR = 2.79$, [2.40, 3.23] (Experiment 2, see Table 4).

Hypothesis 2 was clearly not supported by the results of either experiment. The social norms intervention had no significant effect on subjects' tendency to choose meat-free meals, with effect size estimates of $OR = 0.73$, 95% CI [0.49, 1.09] in Experiment 1 and $OR = 0.97$, [0.81, 1.16] in Experiment 2 (both comparisons to an attentional control group, see Table 2 and Table 4). In fact, the confidence intervals imply a 97.5% chance that the effect of the intervention was smaller than $OR = 1.09$ (Experiment 1) or $OR = 1.16$ (Experiment 2).

Hypothesis 3 was supported, as neither experiment revealed a significant interaction between the intervention and participants' environmental attitude. However, since we did not find a significant effect of the social norms intervention (H 2), the underlying assumption that nudging measures and peoples' attitudes influence behavior independently could not be tested.

One remarkable exploratory finding is the strong association between the share of meat-free meals in the offer on a specific trial⁵ and the share of meat-free meals chosen in

⁵ Operationalized as number of meat-free meals on offer in the analysis. Because the total number of meals on offer was constant in both experiments, both measures are equivalent here.

that trial ($OR = 3.11$, $[2.44, 3.96]$, Experiment 1). When correlated with the mean share of meat-free meals per trial, the association was $r = .87$. A similar correlation was present in the actual sales data provided by Studentenwerk Göttingen, $r = .79^6$, suggesting that this correlation represents a substantial real effect.

Possible Explanations

Simple written displays of descriptive social norms seem to be insufficient to influence peoples' meal choices toward reduced meat consumption. Previous work on the effect of descriptive social norms on eating behavior might give some pointers to possible explanations.

Higgs (2015) conducted a review, identifying conditions that make adherence to social norms more likely. The influence of social norms is most pronounced when the consequences of food choices are uncertain (Laland, 2004), when the norm is clear and uniform (Leone, Pliner, & Peter Herman, 2007; Morgan, Rendell, Ehn, Hoppitt, & Laland, 2012), and when the norm is about psychologically salient in-group members that subjects identify with (Cruwys et al., 2012; Stok, Verkooijen, de Ridder, de Wit, & de Vet, 2014).

In the present experiments, the consequences of food choices were most likely clear to subjects, as they were probably familiar with the meals offered in the experiments from previous visits to the Zentralmensa and Mensa am Turm university restaurants. Additionally, the norms represented minority behaviors in some cases (e.g. "Between 2010 and 2017, the share of vegetarian and vegan meals in our sales rose from about 24% to more than 35%.") and it is not clear whether the represented group (customers of the university restaurants in Göttingen) was a sufficiently salient and strong in-group.

These conditions might have prevented the intervention from having a notable impact, although similar conditions were present in the experiments reported by Demarque et al. (2015). The main difference between the present and Demarque et al.'s work is the dependent variable and the frequency with which the norms were shown:

⁶ Correlation between the share of meat-free meals in the offer and the share of meat-free meals in sales. The data covered the years 2010-2017.

While we investigated the selection of main dishes served in university restaurants and presented different norms throughout the experiment, Demarque et al. focused on the selection of groceries in an online shopping environment and presented only one norm at the start of the experiment. In general however, both scenarios were quite similar, including a similar application of social norms via simple text displays and a positive framing of minority behaviors as norms.

One factor that may have been unfavorable for an effect of social norms in our experiments might be the social group that was represented in the norms, as mentioned above. In Demarque et al.'s experiments, the norms explicitly corresponded to participants who had participated in a pilot study, while the norms in our experiments generally referred to customers of the university restaurants in Göttingen. The former might act as a more salient and stronger in-group for experimental subjects than the latter, and therefore function as a more potent social norm. Yet, this reasoning cannot fully explain the differing results, because one norm that was added in Experiment 2 of the present research and shown on Trial 1 in fact involved previous participants as well. It read "In a previous study, participants chose a vegetarian or vegan meal in 59% of the trials." As mentioned above, Demarque et al. presented only one norm at the beginning of their experiments. If the salience of the represented group was the main reason why the intervention was effective in Demarque et al.'s experiments, Norm 1 in the present Experiment 2 should have been sufficient to induce a similar effect. The question of why a social norms intervention would show an effect in only one of those scenarios does not have a straightforward theoretical explanation and warrants further investigation.

Another factor that might play into the dynamics in question is, quite simply, taste. Pliner and Mann (2004) found that the palatability of offered food can cause an effect of social norms to disappear. This might have been the case in the reported experiments, since participants were able to judge the offered meals with regard to their palatability based on the pictures and descriptions in combination with their previous experiences from visits to the university restaurants.

In sum, there are a number of possible explanations for the absence of an effect of

the social norms intervention in the present research: The norms might have been too weak because the situation was clear, the norms reflected minority behaviors and the represented social group was not a close enough peer group for subjects. Additionally, subjects' personal taste might have overruled an influence of the presented norms.

Generalizability

External validity of the experimental design. The experiments were carefully constructed in order to reflect the real situation encountered by customers of the university restaurants in Göttingen as closely as possible without compromising internal validity. Trials were composed by almost exclusively combining meals that were in fact sold together in the same combination, and each meal was shown with the official title, information about additives and allergens, and, most notably, a picture. An indicator for the successful construction of realistic trials is the correlation between the number of meat-free meals on offer in a specific trial and the share of meat-free meals chosen in that trial, which was also present in comparable strength in the real sales data (see above). The similarity of response patterns in both experiments (see Figure 5) further supports the notion that subjects did indeed follow the instructions and select meals according to their real preferences instead of arbitrarily picking random options, especially considering the fact that trial order differed between experiments.

Still, notable differences to the real world remain. For instance, our experiment was programmed to be forced-choice, i.e. subjects had to pick one of the offered meals, which is of course not the case in reality. The trials further did not represent the full width of the options on offer in the actual university restaurants: Possibilities such as individually composed salads or every-day-offers like *Currywurst* (a sausage with curry sauce) were not included in the experiments. Further, the trials did not contain information about the price of the offered meals.

Sample. The examined sample was large in both experiments ($n = 450$ and $n = 899$) and consisted mostly of students (overall 96%), who also make up the overwhelming majority of customers of university restaurants. The age of participants in the

experiments ($M = 23.71$) was quite similar to the mean age of students at the University of Göttingen ($M = 25.30$). However, the majority subjects in both experiments was female (overall 69%), which is a much greater portion than at the University of Göttingen in general (52%). This difference is probably due to the voluntary nature of participation in the experiments and only poses a problem for the interpretation of the results if the examined effect works differently for men and women. There are no theoretical reasons to suspect such an interaction.

Share of meat-free meals. The overall share of meat-free meals was much higher in the reported experiments (overall $M = 60.2\%$) than in the actual sales data provided by Studentenwerk Göttingen ($M_{2017} = 35.7\%$). This might be partly due to the stronger representation of women in our studies, as they chose meat-free meals far more frequently than men ($M_f = 67.1\%$ vs. $M_m = 44.0\%$). However, even when taking this fact into consideration, the share of meat-free meals was rather high in the reported experiments. Another cause for this observation might be the aforementioned incomplete reflection of the real offer: Most every-day-offers in the university restaurants are meat-containing meals like Currywurst. Because these options were not available during the experiments, the share of meat-free meals possibly was overestimated in the experiments. Additionally, customers can choose to compose their own salads or select side dishes only in the university restaurants. As salads and side dishes are not included in the mean share of 35.7% mentioned above, this number is likely to underestimate the real share of meat-free meals consumed.

Ethical Aspects of Nudging Interventions

A common critique of nudging interventions is the claim that nudging is a form of manipulation (Bovens, 2009; Vallgård, 2012). Indeed, nudging techniques can be abused for deception and manipulation. One example for the abuse of social norms is the practice of *astroturfing*, which consists in “the creation of false impressions that a particular idea or opinion has widespread support” (Zhang, Carpenter, & Ko, 2013, p. 1). Astroturfing strategies include paying imposters to influence public debates for the

benefit of the initiators. Such tactics are used widely, e.g. in disinformation campaigns aimed at casting doubt on climate science (Cho, Martens, Kim, & Rodrigue, 2011) or at preventing anti-smoking regulations (Givel, 2007). In Germany, corporations have used astroturfing strategies, among other things, to advocate for nuclear power plants or the use of chemicals like PVC (Banse, 2008).

Thaler and Sunstein (2008, p. 10) argue that refraining completely from the use of nudges does not sufficiently address the ethical problems raised by a manipulative use of nudging, because it is impossible to fully avoid influencing people's choices. In light of the positive and negative potential of actively designing the *choice architecture*, it might in fact be unethical *not* to pay close attention to the conditions that influence people's choices. Instead of trying to avoid any influence, the authors argue, nudging should be used to serve people's welfare. To arrive at an ethical use of nudging interventions, the authors apply Rawls' (1971) *publicity principle* to nudging (Thaler & Sunstein, 2008, pp. 244-245). Simplified, the principle states that governments should enact only policies that they are willing to defend publicly. Adherence to this principle is also closely connected to the effort of employing nudges in a transparent way (see Hansen and Jespersen, 2013, for a more in-depth discussion). In the present research, we followed the publicity principle and aimed to avoid deception by using true statements as descriptive social norms. All participants had the opportunity to receive a summary of the projects' background, goals, and results, which was sent out on August 7, 2018.

Conclusion

Because the conditions were unfavorable for an influence of descriptive social norms in both experiments, the results should not be seen as evidence against social influence impacting food choices, but rather as showing the limits of the tested intervention. A simple, written display of descriptive social norms is probably not sufficient to promote meat-reduced consumption. Because of the large sample size and the consistent results in two preregistered experiments, the present work provides strong support for this conclusion. These findings demonstrate the limits of social norms interventions, which

probably need favorable conditions to be effective. Other approaches for reducing dietary greenhouse gas emissions need to be found.

A much more effective way to make people choose more sustainable meals, albeit not a nudge, might be to simply increase the share of such meals in the offer, as both data from our experiments and the analysis of real sales data show a remarkably strong effect of the share of meat-free meals in the offer on the share of meat-free meals chosen.

Open Practices

Both experiments were preregistered on the Open Science Framework (project link: <https://osf.io/ruyfs/>). The preregistrations include, among other things, determination of hypotheses, sample size, exclusion criteria, and method of data analysis prior to data collection. All primary data and materials needed to reproduce the analyses or replicate the experiments are available from the repository. Direct link to the data: <https://osf.io/gpt28/>. We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study⁷.

⁷ See Simmons, Nelson, and Simonsohn (2012): A 21 word solution.

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