Digital Nudging in Online Grocery Stores – Towards Ecologically Sustainable Nutrition

Completed Research Paper

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Abstract

A major driver of global environmental challenges is our current food system. More sustainable practices on the supply side depend on pressure from the demand side: Every individual can contribute to a greener food system by making sustainable food choices. Digital nudging represents a promising approach to foster desirable consumer behavior. Research in the growing online food context is scarce and lacks a comparative analysis of digital nudging elements and their effectiveness regarding different consumer groups. We transferred three nudging elements to the digital choice environment of an online grocery store and conducted a field experiment with 291 participants. Parametric, nonparametric, regression, and cluster analyses showed that default rules are effective for a broad consumer base and simplification for environmentally-conscious consumers to promote ecologically sustainable behavior, while social norms had no effect. The results inform research and practice regarding the potential of digital nudging to foster ecologically sustainable food choices.

Keywords: Digital nuding, green IS, ecological sustainability, food system, consumer behavior, green society, online grocery store

Introduction

Environmental deterioration has become one of the biggest concerns of our times (Plumer and Popovic, 2018). Its severe threat is acknowledged and battled in worldwide cooperation and can be observed, for example, in the sustainable development goals proposed by the United Nations (2015). Most of the environmental deterioration is human-induced, meaning that we ourselves are damaging our basis of existence (Dunlap et al. 2000; Schubert 2017; Schultz et al. 2005). Information Systems (IS) is seen as an important weapon to address this challenge (Melville 2010) due to its remarkable influence and ubiquitousness in all areas of our lives. IS researchers have been called upon to apply "the transformative power of IS to create an environmentally sustainable society" (Watson et al. 2010, p. 24). Prior research suggests focusing on IS design approaches that influence human behavior to protect the environment (Melville 2010). The use of digital nudging elements (DNEs) has proven to be an effective design approach for unconscious and automatic every-day decisions to influence individuals' behaviors in a positive way (Weinmann et al. 2016). Nudging aims to help making better choices by modifying the choice environment

without limiting the number of choices through laws, orders, or fiscal methods (Ferrari et al. 2019; Lehner et al. 2016; Thaler and Sunstein 2009). It has been demonstrated that nudging elements (NEs) have a remarkable potential to enable pro-environmental behavior (Schubert 2017) and to influence human behavior regarding food consumption decisions in particular (Lehner et al. 2016). DNEs can be implemented quicker, faster, and cheaper than in an offline, physical environment and can be personalized since online environments offer tools to track and analyze individuals' preferences (Weinmann et al. 2016).

Food is a main consumption area that has tremendous negative effects on the environment (Noleppa 2012). The production and transportation of food cause land depletion, the exhaustion of natural resources, and are responsible for about 26% of the global greenhouse gas (GHG) emissions (Poore and Nemecek 2018). It is not sufficient to rely on the proactivity of food producers to turn to more conscious and pro-environmental practices. The integration of ecological sustainability aspects into daily food consumption decisions by consumers is of importance as well (Ferrari et al. 2019). Pressure from the demand side must be significantly increased in order to accelerate changes towards ecologically sustainable production and transportation on the supply side (Mont et al. 2014). Consumers struggle when it comes to evaluating the environmental impacts of products (Hoek et al. 2017). But, common informational strategies like displaying numerical information about the product's GHG emissions have not proven to be successful (Spaargaren et al. 2013). Food decisions are mainly based on impulsivity (Mirsch et al. 2017) and given the fact that the consumers' point of contact with the food system is increasingly shifted to online areas, online food suppliers like delivery services or grocery stores as well as policymakers should consider implementing DNEs as a way to influence food choices in an ecologically sustainable manner (Weinmann et al. 2016). Grocery stores especially hold a large responsibility to the society including the support of an ecologically sustainable food system (Pulker et al. 2018). They have the power to stimulate environmentally friendly behavior of consumers and can, therefore, help fighting environmental deterioration (Hawkes 2008; Oosterveer et al. 2007).

Prior research on NEs in the food domain mainly focuses on coping with obesity and promoting healthy diets (Friis et al. 2017; Oullier et al. 2010; Schwartz 2007; Wansink 2004). Some research analyzes the effectiveness of single NEs focusing on the environmental dimension of food, including the NE default rules (Campbell-Arvai et al. 2014; Torma et al. 2018; Vandenbroele et al. 2018), changes to the physical environment (Vandenbroele et al. 2020; Wansink and Cheney 2005), simplification (also referred to priming or salience) (Bacon and Krpan 2018; Shearer et al. 2017), and social norms (Demarque et al. 2015; Kallbekken and Sælen 2013; Linder et al. 2018), however, focusing mainly on eating out or reducing food waste (Ferrari et al. 2019). These NEs furthermore have mostly been applied in an offline, physical context. A separate consideration of DNEs in the online food domain promoting ecologically sustainable shopping behavior is necessary since consumers behave differently online, which is why Weinmann et al. (2016) and Mirsch et al. (2017) called for research about the effect of different DNEs in online environments. To our knowledge, only Demarque et al. (2015) analyzed one of the four named NEs, social norms, as a DNE in an online grocery store to promote ecologically sustainable behavior, without comparing it to other DNEs. Additionally, digital functionalities like tracking the browsing behavior of consumers allow individualizing the DNEs presented to the consumers based on individual characteristics (Benartzi and Lehrer 2017; Weinmann et al. 2016). We still lack understanding of how effective DNEs are regarding different target groups to consider and implement individualized digital nudging (Mirsch et al. 2017). As a consequence, we aim to answer the following research questions:

(1) Which of the DNEs default rules, simplification, and social norms are effective in online food shopping contexts regarding the promotion of ecologically sustainable food choices?
(2) Do the DNEs differ in their influence on different consumer groups?

To answer our research questions, we conducted a field experiment including an online grocery shopping task in which we implemented the DNEs in different treatment groups. We analyzed and compared the effectiveness of the different DNEs on ecologically sustainable food choices using parametric and nonparametric statistics and regression analyses. Additionally, we used cluster analysis to determine consumer groups and again employed parametric and nonparametric statistics to examine in which ways the effects of the DNEs differed.

This paper proceeds as follows: We first present the theoretical background compiled from various literature streams such as IS and behavioral science. Subsequently, the methodology and the results are presented. We conclude with a summary, implications, limitations, and proposals for future research.

Theoretical Background

In the following, we present the definition and influencing factors of food sustainability and elaborate on the origin and rising relevance of online grocery stores. Next, we introduce the theoretical background from behavioral science and the concept of nudging. We summarize prior research made in offline and digital nudging (DN) focusing on sustainable food consumption.

The Need for Ecologically Sustainable Food Consumption

The current global food system is in many respects far from sustainable in the sense that it ensures nutrition for everyone without compromising economic, social, and environmental bases for future generations (HLPE 2014). It causes negative impacts on the environment including GHG emissions as well as land, water, and energy exploitation. This leads to a loss in biodiversity, ozone depletion, terrestrial acidification, and contaminated groundwater (Meybeck and Gitz 2017; Tukker et al. 2011). A growing food demand caused by an increasing world population is leading to an expansion in food production. However, the limited amount of available resources stays constant which emphasizes the need to reorient the current practices towards a more sustainable food system (Ferrari et al. 2019).

Regarding the sustainability of a single product, the environmental impacts of it depend on how and where its components have been produced (Meybeck and Gitz 2017). Regional production, for example, causes lower pollutant emissions and consumes less energy and raw materials due to shorter transport distances, and fewer requirements for storing, cooling, and packing (Koerber and Kretschmer 2000; Specht et al. 2016). Whereas organic farming is based on the balance of soil, animals, and plants (Koerber and Kretschmer 2000) and is seen in the European organic label, which considers animal welfare, environmental pollution, biological diversity, and renewable energy, chemical, and synthetic inputs (The Council of the European Union 2007). Restrictions of chemical fertilizers and pesticides in organic farming reduce nitrate pollution in water and groundwater. Through organic fertilization and the carefully coordinated cultivation of changing plants, the fertility of the soil is maintained, thus reducing soil erosion and promoting biodiversity. Additionally, organic farming produces less GHG emissions and consumes up to 40% less energy (Koerber and Kretschmer 2000). Generally speaking, organically produced and regional products are in sum more sustainable than conventional food products and should be primarily consumed on the demand side to transform the supply-side system towards a more sustainable one (Koerber and Kretschmer 2000; Schlich and Fleissner 2005). These decisions about food consumption are increasingly made online.

Rising Relevance of Online Food Shopping as Choice Environment for Nudging

With the emergence of the internet, electronic commerce (e-commerce) started to grow in the 1990s (Wigand 1997). E-commerce describes "the process of buying and selling products or services using electronic data transmission via the Internet" (Grandon and Pearson 2004, p. 197) and includes, but is not limited to, products and services in the segments of fashion, electronics, furniture, and groceries (Striapunina 2020). Especially through improved payment systems and mobile applications, e-commerce developed quickly, starting in 2005 (Rokicki 2018). Grocery purchases made online increased since 2006, when only 1% of German consumers bought groceries online, whereas in 2017, already 21% did so (Centraal Bureau voor de Statistiek 2019). The developments in Asia, where more than 88% of Chinese and 87% of Thais plan to purchase groceries online in the next 12 months (PWC 2018), leave no doubt about online grocery shopping becoming an important pillar of the food retail sector in the future (Centraal Bureau voor de Statistiek 2019). Major advantages of e-commerce, especially related to grocery purchases made online, include time-savings due to avoid travel to a traditional store or standing in queues, but also higher convenience because of flexibility due to 24h availability and accessibility from different places (Moagar-Poladian et al. 2017; Morganosky and Cude 2000). Especially in times of uncertainty like the COVID-19 pandemic in 2020, online grocery shopping has become a useful and safe alternative to physical shopping (Gassmann 2020).

Two different kinds of online grocery stores can be distinguished: virtual supermarkets that only exist online and traditional grocery stores that offer an additional online shop (Morganosky and Cude 2000). Next to online grocery stores, online food delivery services have emerged, representing restaurants themselves who offer a delivery service, such as Pizza Hut, or intermediaries between multiple consumers

and restaurants, like delivery.com (Yeo et al. 2017). Online delivery has increased tremendously starting in 2011 and accounted for 36% of all food orders in 2016 (Hirschberg et al. 2016). Lastly, online platforms also offer subscriptions of meal boxes, like Hello Fresh, which have become popular in the last years (Wunsch 2019). Online grocery stores, delivery services, and subscription services all represent choice environments in which consumers decide between different food products. These choice environments can be modified by the use of DNE.

Digital Nudging towards More Ecologically Sustainable Food Choices

Behavioral Science and the Concept of Nudging

Nudging describes ways to influence choices by modifying the environment in which choices are presented and framed (Münscher et al. 2016). NEs aim to help individuals make better choices, elicit certain behaviors, and improve life without limiting the freedom of choice or manipulating incentives (Thaler and Sunstein 2009). NEs should remain transparent and open as they have no manipulative or prohibitive nature (Sunstein 2014). The concept of nudging is based on the dual process theory of behavioral economics, which suggests that human decision making occurs in an intuitive system 1 or a reason-based system 2 (Stanovich and West 2000). System 1 is responsible for rather effortless, intuitive, emotional, automatic, and fast decisions, whereas in system 2, slower, controlled, rule-governed, and more effortful decisions develop (Kahneman 2003). Kahneman (2011) showed that every-day decisions like deciding whether to take the elevator or the stairs could be attributed to system 1, whereas important decisions about one's life occur in system 2. System 1 protects the deliberate system 2 to prevent cognitive overload and turns familiar tasks into automatic routines. For non-automatic routines, information is quickly sorted through and shortcuts are taken which makes every-day intuitive decisions prone to heuristics and cognitive biases like a rule of thumb or gut feelings (Kahneman 2011; Tversky and Kahneman 1974). Combined with time pressure or limited cognitive capacity, this leads to faster, but also potentially undesirable decisions (Campbell-Arvai et al. 2014). This is the starting point for nudging. NEs can positively influence the decision-making process for the individual and the society in general by making use of counteracts of these heuristics and cognitive biases caused by psychological effects that might lead to mistakes in decision-making processes (Thaler and Sunstein 2009).

The Use of Nudging in Food Contexts to Promote Ecologically Sustainable Choices

Food behavior is highly habitual, making traditional educational approaches to enhance knowledge insufficient when it comes to changing the behavior (van't Riet et al. 2011). Hence, food choices can mainly be attributed to system 1 as automatic, emotional and intentional decisions with lower amounts of cognitive effort (Kahneman 2011). This makes food choices prone to nudging. Research provides evidence that nudging is effective in influencing individuals' food behaviors (Schwartz 2007; Vandenbroele et al. 2020; Wansink 2004). Lehner et al. (2016) and Ferrari et al. (2019) reviewed a wide range of research focusing on the effect of NEs to leverage healthier and ecologically sustainable food choices. Lehner et al. (2016) found four NEs to be effective in promoting sustainable behavior concerning energy use, food, and personal transport. These are default rules, changes to the physical environment, simplification and framing of information, and the use of social norms. Ferrari et al. (2019) found similar NEs to be effective regarding consumers' environmentally-friendly behavior in physical areas like restaurants, canteens, hotels, and supermarkets.

The NE default rules describes a setting in which the preferred option is pre-selected and will be maintained if the person does nothing (Thaler and Sunstein 2009). It is based on the need for maintaining the status quo (Kahneman 2011), and the drive to procrastinate due to the dislike and time consumption of making active decisions (Sunstein 2014). Regarding default rules in food contexts, Campbell-Arvai et al. (2014) found evidence that default meat-free options promote the choice of vegetarian meals when eating out and Kallbekken and Sælen (2013), as well as Vandenbroele et al. (2018), demonstrated that reduced plate size leads to less food waste.

The NE simplification represents the transportation of condensed information about a complex construct and comes along with framing of information to activate certain values (Sunstein 2014; Thaler and Sunstein 2009). Framing means that the different choice options are presented in ways that intentionally evoke certain associations of the decision-maker (Thaler and Sunstein 2009). Information can, for example, be

simplified and framed through descriptive labels, or by visualizing consequences (Lehner et al. 2016; Mirsch et al. 2017). Prior research in food contexts focused on redesigning menus in restaurants to promote environmentally-friendly choices (Bacon and Krpan 2018; Kurz 2018). Also, Van Gilder Cooke (2012) used GHG emission labels for burgers and increased sales of lower-carbon-footprint burgers. Linder et al. (2018) proofed the effectiveness of visual cues and information flyers to reduce food waste.

Lastly, social norms are "an individual's beliefs about the typical and condoned behavior in a given situation" (Kormos et al. 2015, p. 480). The NE social norms utilizes the effect of social pressure and social conformity (Aldrovandi et al. 2015) by giving information about appropriate behavior within a group (Kormos et al. 2015). Injunctive and descriptive norms exist (Cialdini et al. 1990). Injunctive norms describe a generally desired behavior, for example leaving a tip in a restaurant, and proved to be effective in contexts like alcohol use (LaBrie et al. 2010) or gambling (Neighbors et al. 2007). Descriptive norms instrumentalize the behavior of other individuals (Cialdini et al. 1990) by conveying, for example, the following information: "70% bought at least one ecological product" (Demarque et al. 2015, p. 169). Especially in ambiguous or uncertain situations, descriptive norms function well as a heuristic, because they provide the decision-maker with information about socially-accepted behavior (Higgs 2015). Melnyk et al. (2010) found in their meta-analysis that descriptive norms are effective in influencing the consumers' behavior in general, and Robinson et al. (2014) confirmed their results regarding eating behavior, also by conducting a meta-analysis. Other research showed an improved ecologically sustainable behavior by the use of descriptive norms, for example by promoting less towel use in hotels (Goldstein et al. 2008) or supporting recycling (Nigbur et al. 2010). In terms of promoting ecologically sustainable behavior related to food, Linder et al. (2018) Kameke and Fischer (2018) used descriptive norms to reduce food waste and Demarque et al. (2015) promoted ecologically sustainable products in an online grocery store. In the following, we, therefore, refer to descriptive norms when talking about the DNE social norms.

Digital Nudging for Ecologically Sustainable Food Choices in Online Choice Environments

Making desirable ecologically sustainable daily food choices is hard. Additionally, people tend to be overwhelmed by information overload simply resulting in inaction (Mont et al. 2014). Especially online, people tend to fail to process all relevant data needed to make informed decisions, leading to automated and hurried choices (Benartzi and Lehrer 2017). The three discussed NEs default rules, simplification, and social norms all have the potential to be transferred to online choice environments and support the decision processes of consumers. We exclude changes to the physical environment for obvious reasons of non-applicability. Default rules and simplification are not evaluated in online food shopping contexts yet. Research regarding DNEs in online food shopping contexts to promote ecologically sustainable food choices is to our knowledge limited to the work of Demarque et al. (2015) which focusses on the design possibilities of social norms. Consequently, no comparison of the effects of these DNEs exists so far. Due to the rise of online grocery shopping, further research on the effectiveness of different DNEs is needed, especially with the potential of individualizing the usage of DNEs in online choice environments (Mirsch et al. 2017; Weinmann et al. 2016).

Research Process

The development of DNE in online decision environments can be structured along a five-step process consisting of the steps (1) define, (2) diagnose, (3) select, (4) implement and (5) measure according to Weinmann et al. (2016). To answer our research questions, we focus on steps 4 and 5. We perform an online field experiment to demonstrate a cause-and-effect relationship between the independent variable (here: implementation of the DNEs) and the dependent variable (here: ecologically sustainable food shopping behavior (Gravetter and Forzano 2016). We, therefore, design and implement the three DNEs default rules, simplification, and social norms in an online grocery store. Subsequently, we evaluate their effectiveness considering control variables that might influence the online grocery shopping behavior of individuals.

Design and Implementation of the Digital Nudging Elements

The three DNEs were embedded in the decision environment of an online grocery store (see Figure **1**). While implementing the field experiment, the priority was to provide a situation as close to real life and as easy to use as possible (Gravetter and Forzano 2016). The online grocery store was implemented as a single-page

website structured into the columns shopping list, products, and shopping cart. The shopping list indicated which and how many products were to purchase by the participants. The product area contained a scrollable list of different products with three items per row and occupied the largest and most prominent middle column. The entry for each item consisted of a picture of the product, its name and weight or volume, its price per unit, its scaled price per kilogram or liter, and a button to add the item to the shopping cart. The information and depiction of the product data thus match the standards found in real-life online grocery stores of familiar German retail chains. All product data, including product pictures and prices, are based on real-life examples found in the online grocery stores of those chains. The shopping cart column comprised the name and weight or volume, the adaptable quantity, and the price per unit of each added product.

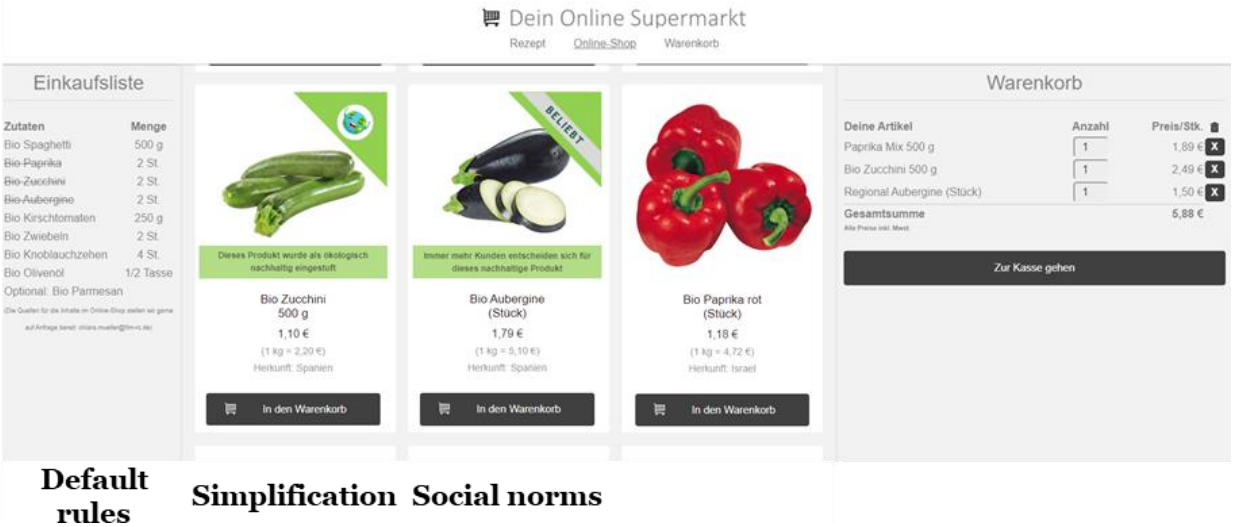

Figure 1. Online Grocery Store Design with the Areas Shopping List (Left), Products (Middle), and Shopping Cart (Right)

We implemented the three DNEs as follows. Default rules as a way to provide consumers who are not willing, aware, or able to make decisions with pre-selected options, was realized in the shopping list: we added the marker "Bio" (German for "organic") in front of each item that the participants were asked to purchase (see left column in Figure **1**). Since products of organic origin are in general more sustainable (Koerber and Kretschmer 2000; Schlich and Fleissner 2005), participants were thus nudged to choose products in a more environmentally-friendly fashion. Simplification is meant to comprise complex information in a significantly shorter description or framed depiction. We aim at fostering ecologically sustainable food purchasing behavior, therefore we implemented simplification as an icon of a smiling world and provided the additional short statement "This product was classified as ecologically sustainable" when participants hovered over the picture of the product in question (see icon on red pepper in Figure **1**). Lastly, the DNE social norms was implemented as a banner reading "popular" and the statement "More and more customers choose this sustainable product" was displayed when hovering over the product in question (see eggplant in Figure **1**). The intention was to make the participants aware of the behavior of the masses to stimulate socially-conforming sustainable food shopping behavior. Figure **1** illustrates the online grocery store's design and examples of the three DNEs. For illustrative purposes, all DNEs are displayed at once in Figure **1** which differs from the implementation in the field experiment. For the procedure in the field experiment, please see the following section.

Design and Implementation of the Field Experiment

To acquire the necessary data to answer our research questions, we created a field experiment that combined a shopping task in the online grocery store described above with an online survey. The field experiment was conducted in German. Prior to the execution of the field experiment, four people took part in a pretest and their feedback regarding, e.g., understandability of the included texts and usability of the online grocery store, was adopted. Subsequently, we administered a participation invitation via several

social media channels and email. After clicking on the included link, an introduction informed the participants about the setting of the field experiment as well as our data protection policy which needed to be accepted before continuing. To keep the experiment as realistic and comprehensible as possible, we proceeded as follows. Participants were asked to imagine a scenario in which they planned to cook a meal the next evening following a specific recipe and needed to order the ingredients online. Additionally, we provided the following incentive: we announced that each participant could dispose freely of a fixed amount of thirty euros. By participating in a voluntary price draw, they got the chance to win a) the content of the shopping cart after completion of the shopping task and b) the remaining difference to the total of thirty euros as cash transferal. The aim of presenting the opportunity to win the products as well as the remaining amount of cash was to guarantee a shopping behavior as close to the real preferences of food quality and monetary benefits as possible.

In the next step, participants were transferred to our online grocery store environment. The first page contained an overview of the planned recipe including a picture, a list of nine ingredients, and the cooking instructions. To allow for a maximum number of participants to be able to relate to the scenario and not to exclude individuals with diverse nutritional preferences, we chose an inherently vegan dish with eight required plant-based and one optional vegetarian ingredient (parmesan cheese). The second page displayed the online grocery store as exemplarily presented in Figure **1**. For each of the nine ingredients, there were three products to choose differing in the level of ecological sustainability. The participants were randomly assigned to one of four groups: (1) a control group which shopped without any DNEs, (2) a group with the DNE default rules implemented in the shopping list, (3) one that shopped in an environment that had the DNE simplification, and (4) one with the DNE social norms implemented for the most sustainable product of each ingredient. In the following, we term the groups C (control group), DR (group with DNE default rules), S (group with DNE simplification), and SN (group with DNE social norms), respectively. All participants could only choose one of the three products for each ingredient, and could freely decide on the quantity. They were able to proceed to checkout only after one product of each of the required eight ingredients had been added to the shopping cart.

After checkout, participants were transferred to a concluding survey regarding their food choice and consumption behavior as well as demographic characteristics. The standard single-item Food Choice Questionnaire (FCQ) developed by Onwezen et al. (2019) based on Steptoe et al. (1995) contains twelve questions regarding the motives underlying an individual's typical daily selection of food such as healthiness, price, and ethical concerns. Measurement occurs on a seven-point Likert scale ranging from 1 indicating no importance at all and 7 indicating great importance of the twelve included attributes of food. Following Onwezen et al. (2014, 2019), we created a Self-reported Consumption (SRC) questionnaire which queries the frequency of consumption of food from the categories vegetables, fruit, dairy, fish, and meat in the last month on a seven-point Likert scale ranging from 1 indicating "not this month" to 7 indicating "6-7 times a week". Given the fact that nudging is a subtle way of directing decisions in more favorable directions, it is unlikely that it is the only influence explaining the online grocery shopping behavior of individuals. It most likely depends on individual factors like price sensitivity, general attitude towards sustainable food, and typical food consumption behavior as well, all of which and more are covered by the FCQ and SRC. Thus, we included both questionnaires in our field experiment and as control variables in the following analyses. An overview of the items can be found in Table 1. Both questionnaires were translated into German. Thereby, two German native speakers translated the English items into German in parallel. They afterward resolved discrepancies and agreed on the most suitable translation. Lastly, a non-involved English native speaker translated the German items back into English, thus doublechecking for correctness. Lastly, we included socio-demographic questions based on our own development as well as the German census of 2011 (Statistische Ämter des Bundes und der Länder 2015). 291 participants completed the field experiment and answered both included control questions correctly. 44.0% of participants were female, 55.5% male. 0.5% identified as diverse. The age of the participants ranged from 15 to 77 with a mean of 29.[1]

The field experiment described above was resumed after five months to take the effect of salience nudging into account. The NE salience means that "[n]ovel, personally relevant or vivid examples and explanations

[1] Unfortunately, due to a technical error on the part of the service provider of the employed survey software, the socio-demographic information of 102 participants was only partially recorded so that these numbers are based on the data of 189 participants. All further analyses are based on all 291 participants.

are used to increase attention to [a] particular choice" and is often a part of or blurs with other NEs (Blumenthal-Barby and Burroughs 2012; Wilson et al. 2016). Specifically, in our work, the mere graphical emphasis of the sustainable product options itself as shown in Figure **1** can be interpreted as a salience DNE. Therefore, the question arose whether possible effects of the three focused DNEs can be attributed to increased participant attention alone (salience) or their sustainability-related content as well (S, SN, and, to a limited extent, DR). We consequently reran the field experiment with a fifth group SL (group with DNE salience) where we merely highlighted the most sustainable product options to catch the participants' attention but removed any thematical relation to sustainability. The DNE salience was implemented as an emoji licking its lips to symbolize great taste and the statement "This product is a pleasure" was displayed when hovering over the product in question. We collected 78 additional data sets in this second run. As this data was collected at a different point in time and covered a slightly different population (48% of participants were female, 52% male. The age of the participants ranged from 19 to 76 with a mean of 41.), we only marginally include the SL group in our analyses described below and discuss the implications for our results and further research.

Data Analysis

Our paper's focus is on the effectiveness of the three presented DNEs on ecologically sustainable food choices in online grocery stores. To answer our research questions, first a measure for ecologically sustainable food choice behavior needs to be defined. To this end, we assign sustainability ratings to each of the three products for the eight required ingredients. The ratings are based on extensive online research for each product considering, among others, seasonality, organic farming, GHG emissions, and distance travelled to point of sale. Each of the three options of the eight ingredients either obtains a rating of 2 (most environmentally sustainable choice), 1 (second best), or 0 (last). We aggregate the ratings of all eight chosen product options in a measure termed Sustainability Score (SC) for each participant. The SC thus reflects the individual's extent of environmentally sustainable choices made in our field experiment. Its possible value range is 0 to 16.

To answer our first research question which DNEs are how effective in promoting sustainable food shopping behavior in online grocery stores, we first conduct parametric ANOVA as well as nonparametric Kruskal-Wallis tests comparing the SCs of the different treatment groups. Although the treatment groups each consist of more than 30 participants and thus assuming normally distributed data following the Central Limit Theorem is warranted, in the further analyses described below we have to rely on nonparametric tests. We apply both types of tests for all analyses for reasons of consistency and transparency. We proceed to perform a more sophisticated multiple regression analysis with SC as the dependent variable which additionally allows for controlling for the participants' FCQ and SRC.

Regarding the second research question whether the effectiveness of the three DNEs differs between consumer groups, we first partition our participants into subsamples employing two-stage cluster analysis and using FCQ and SRC as input characteristics. Following recommendations from research, we combined hierarchical and partitioning (k-means) techniques which should lead to more accurate clustering compared to the results of the individual approaches alone (Balijepally et al. 2011; Milligan and Cooper 1987; Punj and Stewart 1983). We conducted the hierarchical clustering with Ward's minimum variance method and squared Euclidian distances. The Ward's minimum variance algorithm is shown to have superior performance compared to other algorithms (Milligan and Cooper 1987). Its results are then used as input for partitioning to pre-specify the number of clusters and the starting points for the k-means algorithm. We subsequently compare the FCQ and SRC values between clusters and the SCs between treatments for each identified cluster, again using parametric ANOVA and pairwise post-hoc t-tests as well as nonparametric Kruskal-Wallis and pairwise post-hoc Mann-Whitney-U tests.

Results

The mean and median SCs as well as their standard deviations and interquartile ranges of the control group (C) and the default rules (DR), simplification (S), and social norms (SN) groups differ only slightly. This applies to a comparison to each other as well as the total sample. Shapiro-Wilk tests reject the null hypothesis that the SCs are normally distributed for the treatment groups C, S, and SN. A Bartlett test does not reject the null hypothesis that the SC variance is the same in all treatment groups. Considering the Central Limit Theorem, we apply an ANOVA between the four groups as well as a Kruskal-Wallis test. Both

do not reject the null-hypotheses that the SC means or medians of the four groups are the same, rendering pairwise post-hoc tests unnecessary and indicating that there was no effect of the DNEs in promoting sustainable food shopping behavior in online grocery stores. Table 1 presents the descriptive statistics of the sample and the four treatment groups and the significance levels of the applied tests' p-values. Non-significant test results were excluded for reasons of readability.

		Total	C	DR	S	SN	Shapiro-Wilk normality	Bartlett variance	ANOVA	Kruskal-Wallis	Pairw. t-tests	Pairw. Mann-Whitney-U
	N	291	73	74	68	76						
SC	Mean	9.35	9.29	9.55	9.53	9.04	C .					
	Standard deviation	2.92	2.71	3.16	2.97	2.86	S *					
	Median	10	9	10	10	10	SN .					
	Interquartile range	4	4	3	4	4						

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 1. Descriptive SC Statistics of the Treatment Groups and Significance Levels of Parametric and Nonparametric Tests for Differences between Treatment Groups

The mean SC of the additional salience (SL) group is 8.38 with a standard deviation of 2.68, a median of 8.5, and an interquartile range of 4. Taking the SL group into account, both the ANOVA and the Kruskal-Wallis test indicate differences between the groups at a 10% significance level. Pairwise t-tests indicate differences between SL and C, DR, and S at a 5 % significance level. Pairwise Mann-Whitney-U tests indicate differences between SL and C and SN at a 10% and DR and S at a 5% significance level. We thus observe hints at a negative effect of the DNE salience on the SV as compared to most of the other groups.

Variable	**Description**	**Estimate**	**p-value**	
Intercept		6.05	0.000	***
Group DR	Default rules	0.80	0.094	.
Group S	Simplification	0.71	0.136	
Group SN	Social norms	0.07	0.876	
FCQ1	Healthy	0.00	0.998	
FCQ2	Enables mood monitoring	0.00	0.969	
FCQ3	Convenient	-0.07	0.568	
FCQ4	Provides pleasurable sensations	0.06	0.669	
FCQ5	Natural	0.17	0.379	
FCQ6	Affordable	-0.33	0.005	**
FCQ7	Helps control weight	-0.06	0.483	
FCQ8	Familiar	0.06	0.574	
FCQ9	Environmentally friendly	0.25	0.195	
FCQ10	Animal friendly	0.03	0.857	
FCQ11	Fairly traded	0.27	0.193	
SRC1	Vegetables	0.25	0.120	
SRC2	Fruit	-0.12	0.330	
SRC3	Dairy	0.02	0.785	
SRC4	Fish	0.05	0.736	
SRC5	Meat	-0.18	0.101	

*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 2. Estimates and p-Values of Linear Regression

Next, we perform a multiple linear regression analysis with SC as the dependent variable. The allocation to the treatment groups and the set of FCQ and SRC items were included as independent variables. This allows us to consider a multitude of important explanatory factors as control variables which, alongside the DNEs, might have influenced the sustainable food shopping behavior of our field experiment's participants. The VIFs of all 16 items were lower than 2.84, thus indicating that multicollinearity was not to be dealt with. Controlling for both the participants' FCQ and SRC, the DNE default rules had a minor significant positive effect in promoting sustainable food shopping behavior. We find a significantly negative effect of the participant's priority that food be affordable (s. Table 2).

To address our second research question, we perform a two-step cluster analysis with the FCQ and SRC items as input variables. We first apply the hierarchical Ward's minimum variance method with squared Euclidian distances. An elbow plot, the gap statistic as well as ten out of thirty calculated indices recommend three as the optimal number of clusters. We therefore proceed to partition our sample into three groups using k-means clustering. To verify the validity of the division of participants into three groups, we a) thoroughly discussed the three-cluster solution and its interpretation within the research team and compared it to solutions with different numbers of clusters. We b) tested the groups for differences between each other regarding their SCs and all FCQ and SRC items using ANOVA and Kruskal-Wallis tests and, if indicated by their results, pairwise post-hoc t-tests and Mann-Whitney-U tests. The full set of SC, FCQ, and SRC values for each cluster as well as the test results can be found in the online appendix[2]. Based on these analyses, we conclude that a three-cluster solution is the most suitable one and that each cluster represents a unique consumer group which can be specified as follows.

		Total	C	DR	S	SN	Shapiro-Wilk normality	Bartlett variance	ANOVA	Kruskal-Wallis	Pairw. t-tests	Pairw. Mann-Whitney-U
C1	N	95	32	18	21	24						
SC	Mean	10.30	10.00	10.11	11.52	9.75						
	Standard deviation	2.60	2.89	2.70	1.97	2.42			.	.	C-S *	C-S *
	Median	10	10	10	11	10						
	Interquartile range	3	4	2	3	3						
C2	N	90	16	31	23	20						
SC	Mean	8.36	8.50	9.90	8.13	7.65						
	Standard deviation	2.84	1.75	3.04	3.01	3.03	S *					
	Median	8	8	9	8	7						
	Interquartile range	3	1	4	4	3						
C3	N	106	25	25	24	32						
SC	Mean	9.34	8.88	9.96	9.13	9.38						
	Standard deviation	3.00	2.83	3.57	2.80	2.84						
	Median	10	9	10	10	10						
	Interquartile range	4	3	4	4	3						

Cluster codes: C1 - environmentally-conscious, C2 - environmentally-unconscious, C3 - pragmatic
*p-value significance codes: *** for < 0.001, ** for < 0.01, * for < 0.05, + for < 0.1*

Table 3. Descriptive SC Statistics of the Treatment Groups within Clusters and Results of Parametric and Nonparametric Tests for Differences between Treatment Groups

Cluster 1 - environmentally-conscious participants. These individuals are driven by pro-environmental motives. They score highest in food choice motives regarding naturalness, environmental and animal friendliness, and fair trade (mean cluster scores > 6.01 on seven-point Likert scale). They consume plant-

[2] http://bitly.ws/9zrq

based products most (vegetables and fruit > 6.03) and non-vegetarian animal products least (fish and meat < 1.86) frequently. Environmentally-conscious participants exhibit the highest mean SC of 10.30.

Cluster 2 - environmentally-unconscious participants. These participants exhibit the lowest scores regarding the above-mentioned food choice motives (< 4.85) and consume the least plant-based products (< 5.26) compared to the other clusters. Their mean SC is the lowest (8.36).

Cluster 3 - pragmatic participants. Pragmatic participants occupy the middle of the score spectrum of the different clusters regarding the above-mentioned food choice motives (> 5.97) and simultaneously place the highest value on convenience, price, and familiarity (> 4.49). Their mean SC is 9.34.

A Shapiro-Wilk test rejects the null hypothesis that the SCs are normally distributed for the treatment group S in the environmentally-unconscious cluster. Bartlett tests do not reject the null hypothesis that the SC variance is the same in all treatment groups. Considering the rather small numbers of participants in the different treatment groups within each cluster, we apply a Kruskal-Wallis test between the four groups as well as an ANOVA. Both reject the null-hypotheses that the SC medians or means of the different treatment groups are the same within the environmentally-conscious cluster. Pairwise post-hoc tests specify that there was a significant difference between the control group and the group with the DNE simplification. Regarding our second research question, we find that the DNE simplification has a significant positive effect on sustainable food shopping behavior in the cluster of environmentally-conscious participants. Table 3 presents the descriptive statistics of the clusters and the comprised four treatment groups and the significance levels of the applied tests' p-values. Non-significant test results were excluded for reasons of readability.

Discussion and Conclusion

Digital technologies are promising tools to address societal problems, including those related to sustainability (Watson et al. 2010). The world's current food system has tremendous detrimental effects on the environment. Changing the ways in which we produce and transport food is a major factor in shaping a sustainable global future. The demand side has the power to accelerate these changes on the supply side by demanding more ecologically sustainable food (Mont et al. 2014). Due to the rising interaction with technologies, the potential of improving individuals' behavior to address societal problems has risen (Melville 2010). Demand-side food choices are increasingly made online in the context of online grocery stores, delivery services, and food or grocery subscription services. Besides the elimination and restriction of choices through laws or fiscal methods, nudging is a promising tool to influence the individual's behavior in an ecologically sustainable manner (Ferrari et al. 2019; Lehner et al. 2016; Schubert 2017).

In this study, we tested the effectiveness of the three DNEs default rules, simplification, and social norms to promote ecologically sustainable food choices by conducting an online field experiment with 291 participants. We compared the impact of the different DNEs with each other (RQ1) as well as regarding different consumer groups (RQ2).

We found that the DNE default rules was effective (with a moderate effect size and statistical significance) in an online food context to promote ecologically sustainable food products controlling for their food choice motives and their typical food consumption behavior. For many consumers, daily food choices are likely to occur as automatic and intuitive decision-making processes in system 1 (Kahneman 2011). Some participants might have subconsciously wanted to maintain the status quo of product selection which was indicated in the shopping list by adding the marker "Bio" in front of each item. Others might have automatically gone with the selection of products nudged in the shopping list because they dislike making decisions or wanted to save time (Sunstein 2014). The aspect of time-saving as a major advantage of e-commerce (Moagar-Poladian et al. 2017) in the dynamic digital age might have positively interacted with and fostered the effectiveness of the DNE default rules.

The DNE simplification had a significant positive effect on the sustainable shopping behavior of the subgroup of environmentally-conscious participants. These individuals place a high value on naturalness, environmental and animal friendliness, and fair trade. They also consume significantly more plant-based products as compared to the members of the other two identified clusters. Still, the environmentally-conscious participants might generally have difficulties in determining the correct choice regarding ecological sustainability (Spaargaren et al. 2013). The simple summary of the required information as well

as a positive framing in the form of a smiling world icon might thus have been highly appreciated, leading the participants to more informed, ecologically sustainable product choices.

Unexpectedly and contradictory to prior research by Demarque et al. (2015), the DNE social norms showed no influence on the sustainable shopping behavior of our field experiment's participants. Providing them with information about the trend that more and more customers bought sustainable products and flagging the products as popular did not have any effect. This might be due to the low level of uncertainty regarding the choices in our experiment. Higgs (2015) found that the usage of social norms is especially effective in situations with high uncertainty in which following the crowd is perceived as a safe option. The presented products were standard ingredients with which most participants can be expected to be familiar. The DNE social norms might work better for nudging ecologically sustainable new products which are not yet known to a broad customer base.

Lastly, we included the fourth DNE salience in our considerations in order to sort out whether possible observed effects of our three focused DNEs should be attributed to mere attention catching or their thematic relation to sustainability. Based on the limited analyses that we could perform which we will address in the limitations and further research section, we found that solely emphasizing sustainable product options based on a topic which is unrelated to sustainability had an adverse effect on sustainable shopping behavior. The graphical emphasis might have drawn the attention of our field experiments participants, but the thematic focus on taste most likely irritated them or even made them feel manipulated, resulting in the selection of other, less sustainable products. We conclude that based on our results, nudging sustainable choices requires more than flashy ways to draw attention and needs a relation of its content to sustainability.

Theoretical Contribution

Our work contributes to the existing literature regarding nudging, digital nudging, and the promotion of ecologically sustainable choices in online food contexts in three ways. (1) Complementing the research by Demarque et al. (2015) about the DNE social norms, we transferred two additional major NEs from the physical to the digital world. Default rules and simplification have been evaluated in physical contexts by Lehner et al. (2016) and Ferrari et al. (2019), but to the best of our knowledge have not yet been applied online regarding the promotion of ecologically sustainable food choices. The concrete design and implementation examples of the DNEs in the field experiment might inform further research in this area. (2) While prior research focused mainly on the implementation and configuration of single (D)NEs, we gathered empirical data about the effectiveness of all three DNEs default rules, simplification, and social norms in a field experiment with 291 participants. This enabled us to compare different DNEs and shed new light on possible differences in their impacts. Regarding the whole sample, we found minor significance for default rules to have succeeded in promoting ecologically sustainable shopping behavior in the context of an online grocery store while simplification and social norms showed no effect. Default rules are thus a suitable one-size-fits-all solution for fostering sustainable food shopping. (3) By considering individual food choice motives (FCQ) and consumption patterns (SRC) and employing clustering techniques, we identified three typical consumer types in our field experiment: environmentally-conscious, environmentally-unconscious, and pragmatic consumers. This enabled us to examine the effectiveness of the different DNEs in different consumer groups. While there were no effects observable in the environmentally-unconscious and the pragmatic clusters, simplification proved to be effective in the environmentally-conscious cluster. This highlights the potential of using online individual consumer data to provide individualized choice environments based on personal characteristics and preferences. Simplification, although not effective regarding the complete consumer base, might be a powerful tool to promote sustainable food shopping behavior in the target group of environmentally-conscious consumers. The same might apply to other DNEs and other consumer groups identified using different individual characteristics and behavior patterns.

Practical Implications

Online grocery stores, delivery services, and food or grocery subscription services are on the rise. They are gaining ever more relevance regarding our food consumption and increasingly have the power to influence our food choices towards more ecologically sustainable ones. In our study, the DNE default rules proved to be an effective instrument regarding a broad customer base. Regarding online grocery stores that offer buckets for specific meals or weekly grocery shopping, the DNE could be implemented by pre-selecting only ecologically sustainable products which then can easily be added directly to the shopping cart. Online

grocery stores and grocery subscription services could focus on ecologically sustainable products when presenting the ingredients of recipes similar to the implementation in our field experiment. Subscription services could also pre-select ecologically friendly options and require customers to actively decide against them in case they prefer other products. Depending on the data available to online grocery stores, delivery services, and food or grocery subscription services, they might also target environmentally-conscious customers with the DNE simplification which proved to be effective for this specific consumer group in our field study. By providing condensed information about the sustainability of products, dishes, or other offers using labels, icons, or other means of displaying the relevant information, they might provide environmentally-conscious customers with just the nudge they need to transfer their good intentions into concrete choices. If successful, food suppliers might announce rising sales of ecologically sustainable products as part of their marketing campaigns. This can lead to competitive advantages because the environmental awareness of customers has risen and will continue to rise, hence sustainability has become a real business issue for food retailers (Claro et al. 2013).

As a result, consumers could profit from time savings due to reduced decision-making efforts when shopping for groceries as well as health benefits that ecologically sustainable products might bring along. Moreover, the implementation of DNEs supports consumers who wish to follow their societal responsibility to counteract environmental deterioration by choosing products with higher ecological sustainability.

However, we found that the customers' price sensitivity has a negative influence on their SCs. The higher the participants of our field study valued that food is affordable, the less sustainable products they purchased. This is due to the fact that generally, sustainable products are more expensive than conventional products. This relationship needs to be dissolved in order to ensure a global sustainable future. We, therefore, call on legislators and regulators to start or enforce the conversation about how sustainable products can become comparatively cheaper in the future, e.g., through tax instruments or subsidies.

Limitations and Further Research

Like all research, this paper is limited regarding several aspects that require further work and development. First, the consideration of DNEs is limited to the three most common ones in the consumption domain. Further, DNEs like feedback or reminders should prospectively be examined and tested in online field experiments. This includes the analysis of and comparison with other NEs such as salience based on data acquired from the same population and the same point in time. Second, the design of the individual DNEs should be analyzed and refined in the future, especially for social norms, which did not show any significant influence on sustainable food shopping behavior in our filed experiment. Similar to Demarque et al. (2015), different levels from weak to strong forms of social norms could be evaluated. The considerations of products with higher consumer uncertainty (Higgs 2015) like new, more sustainable substitutes for traditional food should also be taken into account regarding social norms. As a positive side effect, the findings of Demarque et al. (2015), who focused on students, could be enriched as students might be more sensitive to social norms compared to other age and social groups. Third, even though we provided an incentive to guarantee a shopping behavior as close to real-life behavior as possible by balancing food sustainability and price, the analysis of real observations from online grocery stores that implemented DNEs would yield important insight about the applicability and effectiveness of the DNEs as well as possible intention-behavior gaps. Fourth, our limited sample size resulted in a limited statistical power. Future research might consider a field experiment in collaboration with food delivery services or supermarkets to, on the one hand, observe real-life shopping behavior, and, on the other hand, increase the sample size. Additionally, different and more specific consumer groups can be identified by collecting more individual characteristics and behavioral data. Lastly, we determined the sustainable product options in our field experiment by mainly relying on information about organic or non-organic origins. Different studies about the ecological sustainability of organic vs. conventional food exist, and science does not yet agree (Clark and Tilman 2017). However, our results can be adapted to any new findings regardless of the specific definition of ecologically sustainable products.

Overall, we have linked the need for global sustainability with the promising IS tool of digital nudging in the highly relevant online food context. We call on research to further transfer NEs from physical to digital contexts and consider further individualization of DNEs to promote ecologically sustainable food choices.

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