

Nudging Organic Food Purchases in Supermarkets

Three Pragmatic Field Experiments based on Social Norms, Feedback, and Position

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1 Introduction

When they envision a grocery shopping trip, many people think of a relaxed Saturday morning with time to plan a meal to cook for friends or family. They see themselves strolling down the grocery aisles with a shopping basket in their hands, armed with a vague idea of dinner plans and a rough understanding of the products missing in their refrigerator. After surveying fruits, vegetables, and other available products, they settle on a plan, buy the required ingredients, and return home.

After studying the issue of environmentally relevant purchase decisions for some time, what strikes me most about this perspective is that it portrays consumers as rational actors, in full control of their own decisions, evaluating the available options without bias, and making decisions on their own. This perspective frames consumers as being in control.

What I have come to notice during my work on this dissertation is that this view is not so much wrong as it is incomplete. What about the times when they visit the supermarket just to get some milk and, on the way to the milk shelf, select several extra products? What about the times when they stop by the supermarket on their way home, mentally exhausted after a long day of work, and simply choose the first product roughly matching their hunger that comes into view? Did they actually buy the French wine because it was a good fit for the meal? Or was it because the French music playing in the background that reminded them of a summer vacation? How much of the decision to purchase a product was based on the actual product and how much was based on the presentation? Was an environmentally friendly product bought because of its environmental benefits or because it was placed at eye level?

Rarely, if ever, I consider a world where supermarkets or other self-serve stores are not an ever-present phenomenon. As Tevere Macfadyen observed as early as 1985 (para. 7): “Because supermarkets seem so basic, so intrinsically unremarkable, it’s difficult for most of us to comprehend the true impact of their invention.”

Before the advent of self-serve supermarkets about 100 years ago, shopping for groceries was an entirely different experience. Customers drafted shopping lists that they handed to a store clerk, who selected the products for them, or sometimes they telephoned their orders from afar (Vileisis, 2008, p. 160). Purchases were recorded by the clerk and did not have to be paid for directly, a relic from times when farm workers’ pay varied seasonally.

When the first self-serve Piggly Wiggly store opened in 1916 in Tennessee and droves of people showed up, it started a revolution that continues until today (Vileisis, 2008, p. 160). Ever since, supermarkets have become a global phenomenon and have revolutionized the way people produce, process, market, and consume groceries. Increasing car ownership, a rising middle class, more space to store groceries at home, and home refrigeration have facilitated the rise of the supermarket around the world (Child et al., 2015; Vileisis, 2008). Supermarkets have expanded quickly even in developing countries (Reardon et al., 2012).

The introduction of supermarkets has had a profound effect on the environmental impacts of food production. Before the advent of supermarkets, consumers were much more knowledgeable about the production of the groceries and were able to factor this into their purchase or production decisions. People grew vegetables in the garden or could observe whether the neighboring farmer used excessive amounts of pesticides that killed the village bees. They also knew whether a neighbor's chicken was kept without cruelty. In stores, the share of locally or regionally produced products was much higher than that seen today. Now, consumers are encouraged to know little more than the brand and the price of a product they consume, a development actively encouraged by mass advertising and mass production of food that coincided with the rise of supermarkets (Vileisis, 2008, pp. 160–205). Even when consumers know the country where a cow was bred, they do not know whether it was fed with soy grown on recently deforested plantations.

History is full of cases where this growing gap between consumers and food production has threatened consumers as well as the environment. To support the new forms of agriculture for mass production, new pesticides were employed, often without consumers' knowledge and with tacit approval or active cover-ups by food and health authorities. For instance, poisonous lead arsenate was heavily used as an insecticide in the United States and Europe during the first half of the 20th century. Its residues on apples and pears poisoned many consumers. But health authorities, fearing political repercussions and economic hazards, opted to keep quiet and cover up known health and environmental problems rather than inform consumers (Vileisis, 2008, pp. 172–178). Heavy use of lead arsenate not only posed a risk for health through residues on fruit, but it also contaminated soils with levels of lead arsenate that cause issues decades after their use (Peryea, 1997) and still are a health concern for homes built in former fruit orchards (Wisconsin Department of Agriculture Trade and Consumer Protection, 2012). Since consumers were actively encouraged by modern advertisers to learn little more than the brand name and the price, many of these cases escaped their consideration (Vileisis, 2008, p. 170).

The supermarket expansion also made consumers more susceptible to previously irrelevant characteristics of the store and the products. For instance, “The product’s package acquired an added responsibility, having not only to supply protection in transit to the store but also to project a unique and identifiable image on the shelf” (Macfadyen, 1985). However, other features of the stores also grew in importance. Shelf and aisle layout, lighting, brand, and sorting became key factors for consumption decisions (Gröppel-Klein, 2012). Spontaneous purchases that were not on consumers’ shopping lists – often inspired by in-store product displays – now account for more than half of supermarket purchases (Inman et al., 2009, p. 23).

In this context of the global expansion of supermarkets and the growing gap between food producers and food consumers, the organic movement has attempted to reconnect consumers with the environmental impacts of food production. It has done so by offering food products with certified production and processing conditions, limiting the use of pesticides and fertilizers, and improving breeding conditions for animals. However, while its share has been growing, organic food production still accounts for only 1.4 % of agricultural land globally (Willer & Lernoud, 2019, p. 25). While many consumers report their intention to purchase such organic foods—in Germany more than 50% say they want to buy organic groceries—the German share of purchased organic foods remains at 5.1 % (Bund Ökologische Lebensmittelwirtschaft, 2019, p. 21; Bundesanstalt für Landwirtschaft und Ernährung, 2019, p. 8).

This dissertation connects these two themes—the influence of store characteristics on purchase decisions and the attempts of the organic movement to lessen the environmental burdens of food production. The underlying idea is that perhaps the in-store factors that have led to the growing gap between food producers and food consumers explain some of the disconnect between green purchase intentions and actual green purchases. Perhaps, the same tools that led to the widening chasm between consumers and production conditions can be used to lessen the environmental impacts.

Organic food purchases are just one example of many choices where the decision context plays a role in influencing selections toward or away from a pro-environmental outcome. Would train tickets be purchased more if they were always offered as a first choice where alternatives are available? Would vegetarianism increase if the first and last item on any menu was vegetarian? Would more renewable energy be purchased if the default filter on any price comparison site would be for renewable contracts only, and one had to explicitly click to see non-renewable tariffs? It seems that any environmentally relevant decision is at least partly influenced by such situational characteristics.

“Nudging,” a term coined by Thaler and Sunstein to describe gently guiding people toward a choice without forcing them or changing incentives (R. Thaler & Sunstein, 2008), leverages these situational characteristics to improve decisions. Over the past decade, nudging has become a popular policy lever that avoids changing incentives through taxes or fines and stays clear of outright bans that forbid certain choices. While the original nudging ideas were largely related to health, wealth, and happiness, nudging also has many applications in the field of pro-environmental behavior.

Nudging organic food purchases by changing situational characteristics may be an especially attractive proposition and thus is the hypothesis of this dissertation. Since nudging interventions do not force a certain choice, they could be more palatable to consumers than outright bans of certain products. Implementing nudging techniques can be simple and inexpensive. For example, supermarkets regularly rearrange their products, and changing their layout may carry no extra cost at all if it is done as part of these regular changes. The food sector, with its already widely available organic products, may be an interesting precursor for other consumption areas such as mobility or clothing. Lessons from the food sector might serve as a blueprint to help these other sectors enhance their sustainability. Additionally, the environmental impacts of food consumption are quite large – some estimate that they account for one-fifth to one-third of the household environmental footprint (Scholl et al., 2017, p. 53). Thus, even small improvements may make important sustainability contributions, given the large scale of the behavior. The global expansion of supermarkets underlines the need for making food purchasing in supermarkets more sustainable. Lastly, nudging from conventional to organic products may be an especially relevant technique for food consumption, since not consuming at all is not an option for this consumption area. Therefore, other sustainability strategies, such as sufficiency, may be less relevant for the food consumption field.

1.1 Research Objective, Background, and Scope

Three major scientific developments, each crowned with one or more Nobel prizes in the past two decades, form the basic building blocks of this dissertation.

First, research on climate change and the corresponding global sustainability crises form the backdrop and the motivation for the work in this dissertation. As highlighted by the work of the Intergovernmental Panel for Climate Change (IPCC), climate change is accelerating, and no adequate policy measures to stop it have been taken to this point. The IPCC earned the 2007 Nobel Prize for its work in disseminating climate change knowledge. Several observations underline the need for urgent action. The years 2015 to 2019 were the five warmest years on record globally (National Aeronautics and Space Administration, 2020). In 2019, arctic sea ice was at its second lowest extent since the beginning of the satellite records (National Snow and Ice Data Center, 2020). The climate crisis goes

hand in hand with other sustainability crises of planetary scale (Rockström et al., 2009). Biodiversity loss, fundamental alterations to nutrient cycles, and increasing land use for human purposes also threaten the planetary ecosystem. A recent IPCC report on climate change and land has highlighted the interconnectedness of the food production system with climate (Intergovernmental Panel on Climate Change, 2019).

Second, the behavioral science advances, culminating in a Nobel Prize for Daniel Kahneman in 2002 and a Nobel Prize for Richard Thaler in 2017, are also a major building block of this dissertation. Kahneman's work, which demonstrates systematic deviations from rationality in human decision-making, led the way in facilitating a behavioral science revolution that integrates psychological insight in the field of economics and others. In their research, Kahneman and Tversky found that seemingly irrelevant factors can have a major influence on decisions. For example, people weigh losses more than gains, prefer the status quo over changes, and judge probabilities inconsistently. Thaler's research builds on these findings and popularized the term "nudging" for behavioral science-based interventions that gently push deciders in a certain direction while maintaining their freedom of choice. The contribution of the behavioral science revolution has been to be much more considerate toward the many factors that influence behavior and to build on these insights in policy-making and elsewhere.

Third, the careful experimental approach employed by Kremer, Duflo, and Banerjee, which earned them the 2019 Nobel Prize for their work in the field of development economics, is the methodical blueprint for this dissertation. Their approach relies on testing interventions in realistic, randomized, and controlled field experiments to draw causal inferences. While they employ this approach to the task of alleviating global poverty, their method of randomized controlled trials can and has been transferred to other fields.

While each of these building blocks has received significant attention in the scientific literature and beyond, they have rarely been combined to leverage the strength of each. This dissertation does just that: It merges these three building blocks. It draws on the first block, climate change and the corresponding sustainability problems, as the scientific and practical research problem; on the second block, the behavioral science advances, for a novel approach to addressing the problem; and on the third block, randomized and controlled field trials, for an experimental method for testing the effectiveness of the interventions.

Broadly, the research objective of this dissertation is to study the suitability of such new behavioral techniques to solve the sustainability crisis by employing causal inference methods. Since climate change and the corresponding sustainability crisis span too many topics to be analyzed within the

finite space of one dissertation, this dissertation limits itself to one aspect, **the influence of nudging on organic food purchases in supermarkets**. The specificity of this question allows for considering the details of the supermarket environment that are sometimes ignored in broad-brush reviews.

This approach excludes some realms that may be worth considering in further research or have been studied elsewhere. First and foremost, it only considers food consumption and excludes other fields such as sustainable fashion or housing. Of the three consumption phases – acquisition, usage, and disposal – it considers only the acquisition. For instance, this research does not consider issues such as food waste or closing nutrient cycles based on disposals, which are important sustainability levers. Consistent with the nudging approach, only non-price factors are considered in this research, even though price is undoubtedly an important criterion for consumer choice. Additionally, this dissertation focuses on in-store decisions and does not consider the decision for or against shopping at a certain supermarket. Another significant factor—the packaging, labeling, and design of individual products—is also excluded from the scope of this dissertation, which instead focuses on the direct influence of the supermarket environment on consumers. Out-of-store factors such as environmental education are also not considered. Lastly, this dissertation looks only at supermarkets that already offer a choice between conventional and organic products. Organic-only or conventional-only markets are not analyzed.

1.2 Structure

In evaluating the potential for nudging to encourage sustainable food purchases, this dissertation examines five questions:

- What sustainability challenges is the global food system facing?
- Can changes in the decision environment (nudging) help address the sustainability challenges of the food system? If so, how?
- What nudging strategies were found to be effective by prior research and what are their theoretical underpinnings and empirical results?
- Are these nudging strategies effective when implemented in a realistic setting in supermarkets?
- What are future avenues of research for the sustainability of the food system?

In line with these questions, this dissertation is organized into six chapters presented in Figure 1.



Figure 1: Chapter structure

This chapter, the introduction, introduces the research objective, presents the structure, and embeds this dissertation within the wider scientific developments and theory. This chapter also highlights practical, methodical, and theoretical contributions made in this dissertation.

The second chapter explores the sustainability challenges of the global food system. The contributions of food production to global sustainability problems are examined, drawing on the concept of planetary ecosystem boundaries. Environmental impacts by food category, the advantages and limitations of organic farming, and the German food system are surveyed in detail. Particular attention is given to food and feedstuff trade as well as consumption patterns as important sustainability characteristics of the German food system. The chapter also emphasizes the interconnectedness and complexity of the global food system as a factor that eliminates “silver bullet” solutions to the presented sustainability problems.

The third chapter evaluates the potential of nudging to increase the sustainability of food purchasing. The basic decision-making flaws and biases that are the foundation of nudging are introduced first.

Then, several common ethical arguments against nudging are contrasted with frequent rebuttals. In a last step, the chapter provides a survey of existing nudging techniques and their applicability to sustainable behavior in general and to sustainable purchasing in particular. This chapter emphasizes the diversity of nudging techniques and related ethical and practical arguments and selects three techniques for further review.

The fourth chapter provides an in-depth review of the theory and empirical evidence for three nudging techniques: social norms, feedback, and placement. After the central theoretical frameworks for each technique are presented, previous applications in the field of pro-environmental behavior and, where available, pro-environmental purchasing are analyzed. A closer look is also taken at the factors that amplify or diminish each technique's effectiveness in specific settings.

The fifth chapter, the central analysis chapter of this dissertation, derives specific research hypotheses for each technique and tests them in three large-scale field experiments in more than 100 supermarkets and with more than 21,000 consumers in Northern Germany. The chapter reports genuinely new quantitative results in three studies that tested actual purchase behavior with real consumers. Study 1 tested the effectiveness of social norm and feedback messages, Study 2 tested the effectiveness of a sorting intervention, and Study 3 tested the effectiveness of a vertical positioning intervention. All three interventions were targeted at increasing the organic share of products sold in the respective markets and categories.

The sixth and last chapter synthesizes the results from the field experiments and the literature review, provides a critical perspective on the current state of the field, and develops a future research agenda.

1.3 Conceptual research design

When undertaking a large research project such as this dissertation, one must reflect on the nature and pitfalls of knowledge generation in science. How is new knowledge generated? How is knowledge different from opinions or preferences? What is the role of science, scientists, and the scientific method in this process? Philosophy of science has debated these questions at length and some themes have emerged, though the debates are by no means settled (e.g., Döring & Bortz, 2016, pp. 31–80; Ernst, 2017; Hartmann, 2017). Various philosophical traditions have kept these debates more specific to certain countries and continents compared to other globally debated scientific issues (Ciaffa, 1998, p. 13).

On the question of how new knowledge is generated, this dissertation embraces the epistemological position of critical rationalism (Albert, 2000; Popper, 1998). That is, theories need to be falsifiable to be of value and can never be proven to be correct based on inductive reasoning. Theories are only

preliminarily accepted until evidence to the contrary emerges. Only falsification, through deductive reasoning, can prove a theory incorrect. For instance, the theory that no Swiss cow is pink can be preliminarily accepted after a survey of Swiss cows that supports such a finding. To falsify the theory, a single pink Swiss cow would suffice.

Climate change and the related sustainability crises have sparked normative arguments about what ought to be done and considered as practical solutions to these crises. As the German sociologist and economist Max Weber argued more than 100 years ago, such infusion of values into science can be problematic, for instance, if they tarnish the accuracy of the conducted science. Weber suggested to keep science entirely free of such values, the so-called “Wertfreiheitspostulat” (Weber, 1922). Later iterations of this view have conceded that an entirely value-free science may not be possible (Raffée, 1974). For example, normative considerations may indirectly influence science through the topics scientists choose to analyze or the way that subjects of research make decisions. Critical rationalism allows for indirect normative influence of this kind but argues that it is not desirable for value judgments to influence the scientific work directly (Raffée, 1974).

A multitude of authors have criticized critical rationalism from many angles. Kuhn argued, based on a historical perspective, that science does not progress linearly but that it develops in major leaps that he calls scientific revolutions (Kuhn, 1968). Funtowicz & Ravetz (2003) proposed infusing science with value judgments due to the urgency of the sustainability crisis and the necessity to take decisive action without conclusive evidence. It has also been questioned how ethical considerations enter science under critical rationalism (Küpper, 2011, p. 7). Recently, arguments about the limits of human cognitive abilities have given new credence to a view that emphasizes the fallibility of human cognitions in making decisions and, therefore, in generating knowledge (Kahneman, 2011, also see Chapter 3.1 of this dissertation). However, while being frequently compelling in the counterarguments they propose, these critics have often failed to propose viable alternatives that would gain widespread recognition, and the debates have continued. It is beyond the scope of this dissertation to settle these ongoing philosophical debates. Recognizing these limits, and to keep science separate from politics and other more value-infused fields of human endeavor, this dissertation aims to avoid hidden value-infused statements to the degree possible.

Other than the epistemological position, this dissertation has a place on several other relevant dimensions of the scientific discourse. For instance, most science falls somewhere along a spectrum from theory-focused to practice-focused research. This dissertation is practice-focused in the sense that it researches practical solutions to the practical problems of the global sustainability crises and is not focused on generating knowledge for knowledge’s sake. This dissertation takes a practical

approach to solving the sustainability crisis of the food system. The proposition of this dissertation is that practically testing interventions in a realistic setting provides the best evidence for the effectiveness of sustainability measures.

The replication crisis in the social sciences highlighted that the studies underlying many previously accepted theories could not be replicated. For example, Shrout and Rodgers (2018, p. 489) report that only slightly more than a third of findings sampled from top-tier journals in psychology could be replicated in an effort by the open science collaboration. These findings provide evidence that replicating prior studies multiple times, publishing statistically nonsignificant results, and taking other measures can be as important as developing new theories. In this spirit, this dissertation replicates experiments for several theories that have previously been empirically tested in other fields.

To adequately address the problem of consumer choice and food system sustainability, this dissertation must be interdisciplinary in nature. Accordingly, its insights rest on the shoulders of not just one but several disciplines: sustainability science, economics, marketing, and psychology. Sustainability science provides the backdrop for the environmental problem that this dissertation seeks to address. Marketing, and especially its subfield of consumer research, provides a look at how purchase decisions are made and how they interact with store characteristics, but often with little focus on sustainability aspects. Psychology, often in the form of environmental psychology, contributes a perspective on how human decisions are made and how they interact with intentions or attitudes regarding pro-environmental behavior. Economics, often in the form of behavioral economics, offer some analysis on the behavioral antecedents of pro-environmental behavior.

Methodically, Chapters 2, 3, and 4 assemble, critically reflect, and synthesize the literature in the respective fields. Chapter 5 develops and empirically tests genuinely new results regarding the effectiveness of three nudging techniques for increasing organic food purchases. In terms of the disciplines, Chapter 2 is rooted in the sustainability sciences and the related agriculturally focused fields. Chapter 3 rests on previous work in the behavioral sciences with a strong focus on foundations from psychology and behavioral economics. Philosophy is consulted in evaluating ethical arguments around nudging. Chapter 4 relies mostly on marketing and psychology as well as other behavioral sciences. Chapter 5 enriches the debate from Chapter 4 with genuinely new quantitative research that is modeled on the methods of the behavioral sciences.

The challenge this dissertation faces is to integrate this multitude of disciplines with various terminologies, theories, and methodical idiosyncrasies. To avoid confusion, Chapters 3, 4, and 5 carefully define and elaborate the terminology, theories, and methods to place the research from the different fields on a common baseline.

2 Sustainability Challenges of the Global Food System

Food purchases in supermarkets are the salient end point of an intertwined food production system that spans the planet and threatens planetary ecosystems. While some global connections are transparent to consumers, for example, when purchasing fruit from the other side of the globe, others are much less visible. Cattle marketed as regionally bred may have been fed with soy grown thousands of kilometers away on land cleared from tropical forests. Equally, environmental consequences of food production, such as climate change or eutrophication, may become visible far from the point of purchase or production. The understanding of the interactions of these complex and global human systems with ecosystems of even greater complexity and scale is still quite limited.

The scale and structure of the global food system make it “the largest cause of environmental change” on the planet (Willett et al., 2019, p. 15). The food system covers 37% of the Earth’s land surface (Food and Agriculture Organization of the United Nations, 2016), emits between one-quarter and one-third of global greenhouse gases (Food and Agriculture Organization of the United Nations, 2013, 2014; Intergovernmental Panel on Climate Change, 2014b), withdraws 70% of freshwater (Molden, 2013, p. 5), and influences planetary systems such as biodiversity, nitrogen cycles, or phosphate cycles (Rockström et al., 2009).

Consequently, a global perspective on the mechanisms and interdependencies of the global environmental system and the global food system is needed to assess its sustainability challenges and develop potential solutions.

2.1 Sustainability

Sustainability is a broad concept that warrants further exploration in a discussion of sustainability challenges. The term traces back to the Brundtland report on “Our Common Future,” published in 1987, which defined sustainable development “as meeting the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs” (Brundtland, 1987, p. 292).

Notably, this definition is not purely focused on the environmental aspect of sustainability but places human needs and aspirations front and center (Steg et al., 2013, p. 108). The roots of sustainability trace back to centuries-old German writings on forestry. However, only with the 1992 Rio Earth summit with its Declaration on Environment and Development did the term gather widespread

recognition. More than two decades later, the sustainable development goals, adopted by all UN member states in 2015, are the latest testament to the importance of sustainability in the current development agenda.

Sustainable behavior is commonly understood as having three pillars of equal importance: environmental sustainability, social sustainability, and economic sustainability, as highlighted in the Johannesburg Declaration on Sustainable Development in 2002 (United Nations, 2002). What is less clear is whether a loss in one pillar can be compensated by a gain in another one. The concept of strong sustainability, a position with more support among natural scientists, suggests that the three pillars are not substitutable and that certain “minimum amounts of [social, environmental, and economic] capital” should be maintained (Ayres et al., 2001, p. 160). Weak sustainability, a position attracting more support by economists, assumes that the different types of capital can be added up and, thus, a loss in one type can be made up by a gain in another one. Another point of contention is the question whether sustainable behavior requires the intention to act sustainably, if it suffices for behavior to result in increased sustainability, or if both are required (Geiger et al., 2018; Stern, 2000). Possibly, both aspects are separately valuable. An impact-oriented perspective could be helpful for identifying important levers while an intent-based perspective could help in understanding and changing behaviors (Stern, 2000, p. 408).

Social sustainability, though often omitted in sustainability discussions in the literature and excluded from further consideration in this dissertation, deserves more attention. Unclear worker immigration status, low wages, exposure to toxic substances, and generally exploitative working conditions are just some of the predicaments suffered by modern farm workers (Oxfam, 2004; Psarikidou & Szerszynski, 2012; Shreck et al., 2006). The length and lack of transparency of supply chains of the global food production system means that these conditions are rarely detectable for consumers.

The inclusion or exclusion of social sustainability differentiates sustainable behavior from related concepts such as pro-environmental behavior (e.g., Kollmuss & Agyeman, 2002), environmentally significant behavior (e.g., Stern, 2000), and ecological behavior (e.g., Kaiser, 1998), which are all more focused on the environmental aspect of sustainability and take various stances on whether sustainable behavior must be intentional.

2.2 Planetary Boundaries of Food Production

The global food system is environmentally unsustainable in its current form. This lack of sustainability is frequently described with the concept of planetary boundaries, an attempt to define the safe operating limits of global environmental systems. Essential global systems already exceed or are close

to exceeding boundaries of essential planetary systems, and projections foresee even greater excesses (Rockström et al., 2009; Willett et al., 2019). In their seminal review, which warrants recounting and forms the foundation for the following paragraphs, Willett et al. (2019) identify six planetary systems impacted by global food production:

1. climate
2. biodiversity
3. land use
4. freshwater use
5. nitrogen cycle
6. phosphorus cycle

Global food production drives environmental change for each of these systems, and a closer look at each is helpful in identifying avenues toward making the food system more sustainable.

First and foremost, greenhouse gases released into the atmosphere by food production accelerate global climate change. The potent greenhouse gases—carbon dioxide, methane, and nitrous oxide—are emitted at various stages of food production. Methane from ruminant livestock and nitrous oxides emitted from fertilizer use are of special concern, since they are much more potent as a greenhouse gas than the more frequently discussed carbon dioxide. Their global warming potentials are 84 times (methane) and 264 times (nitrous oxides) that of carbon dioxide over 20 years (Intergovernmental Panel on Climate Change, 2014a, p. 87). A change in land use (such as the conversion of forests into farmland) or the transportation of food over long distances also release greenhouse gases into the atmosphere.

Second, biodiversity loss is both a result and a driver of food-related global environmental change. “Terrestrial and aquatic habitat loss, habitat fragmentation, climate change, chemical pollution, invasive species, and unsustainable harvest of wild species” (Willett et al., 2019, p. 22) are the main drivers of biodiversity loss. Still, biodiversity loss can also impede biomass production. While the effects are non-linear and much uncertainty remains, research indicates that species loss can impact biomass production as much as climate warming (Hooper et al., 2012, p. 105).

Third, land-use change, driven by an expanding area used for food production in the tropics, is one of the largest contributors to carbon in the atmosphere (Harris et al., 2012, p. 1573). However, land-use change has other detrimental effects on the environment as well. Fragmentation and conversion of habitats to agricultural land threatens biodiversity, especially when it occurs in the species-rich tropics (Willett et al., 2019, p. 22).

Fourth, even though only one-sixth of global agricultural land is irrigated, this land is responsible for 70% of global freshwater withdrawals (Molden, 2013, p. 5). Almost half of global crop production (44%) comes from irrigated land, which indicates the importance of irrigation in feeding the global population (Committee on World Food Security, 2015, p. 11). Yet, excessive freshwater withdrawals can destroy aquatic and terrestrial ecosystems downstream if the quantity or quality of water fall below a minimum threshold (Arthington et al., 2018). Agricultural water withdrawals can be particularly damaging, since much of the water is withdrawn for consumptive uses; in other words, the water evaporates from the watered plants and is not fed back into freshwater streams.

Fifth, nitrogen is an essential nutrient for plant growth and is the limiting factor to plant growth in most ecosystems (Erisman et al., 2013; Sutton et al., 2013, p. viii). However, if all nitrogen cannot be absorbed during growth, runoffs and emissions can cause significant environmental harm. Since the invention of the Haber-Bosch process at the beginning of the 20th century, large amounts of atmospheric nitrogen have been converted to reactive nitrogen in fertilizers. Excessive application of this reactive nitrogen disrupts natural flows, causes eutrophication in aquatic ecosystems, acidifies soils and water, and emits nitrous oxide, a potent greenhouse gas, as well as releasing atmospheric particulate matter (Erisman et al., 2013; Sutton et al., 2013; Willett et al., 2019, p. 19).

Sixth, phosphorus is also an essential nutrient for plant growth that causes environmental harm, such as eutrophication, when applied in excess. In contrast to nitrogen, phosphorus is mined from non-renewable sources. Global stocks are projected to run out within the next 50-100 years (Cordell et al., 2009, p. 292). Historical data indicates “that large-scale ocean anoxic events occur when critical thresholds of phosphorus inflow to the oceans are crossed” (Rockström et al., 2009, p. 474).

Staying within the boundaries of these planetary systems is the main environmental sustainability challenge of the global food system. For each of these six subsystems, global boundaries have been proposed by Willett et al. (2019). Currently, the authors estimate that global boundaries are exceeded for greenhouse gas emissions, biodiversity loss, nitrogen application, and phosphorus application. They project that, under a business-as-usual scenario, global boundaries of all six subsystems will be exceeded in 2050.

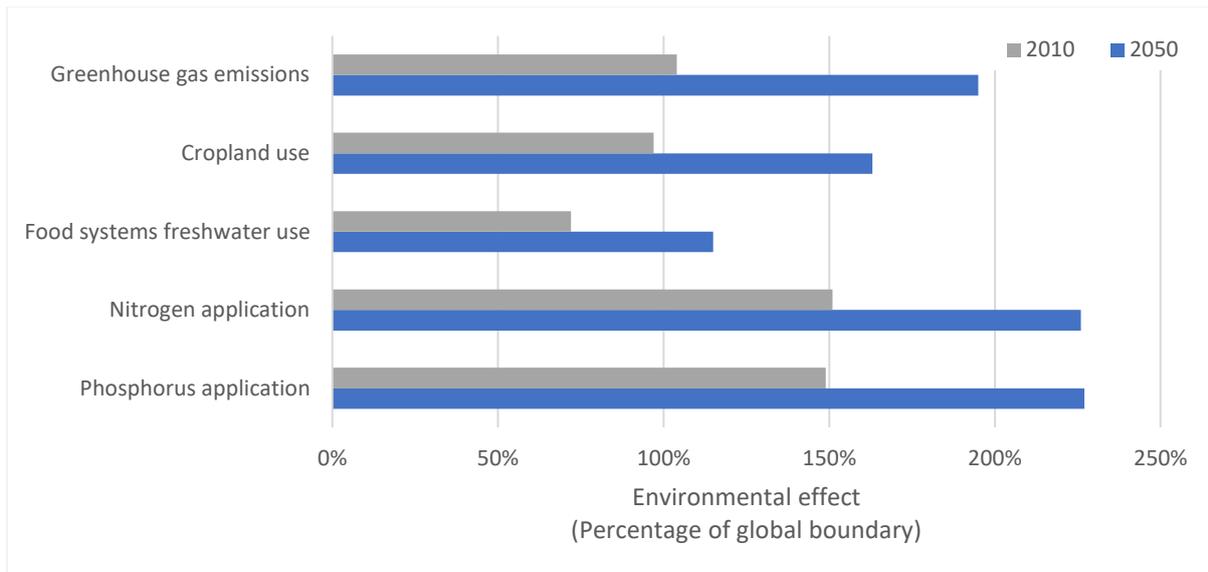


Figure 2: Planetary boundaries (biodiversity missing in source as well, based on data from Willett et al., 2019, p. 26)

Without major change, global systems are projected to overshoot planetary boundaries by a wide margin (Rockström et al., 2009; Willett et al., 2019).

But what are the mechanisms driving this transgression of planetary boundaries? Ehrlich and Holdren (1972) understood in the early 1970s that projections of rising environmental impacts can be formulated as the product of three factors: population, affluence, and technology. They developed a simple formula to describe the relationship:

$$\text{Environmental Impact} = \text{Population} * \text{Affluence} * \text{Technology}$$

While this is obviously a simplistic model, it is still useful in highlighting trends that hold today. In the shared socioeconomic pathway model 2, which forms the base for the projections in Figure 2, population increases by one-third and Gross Domestic Product (GDP) per capita increases by 150% in purchasing power terms between 2010 and 2050 (Riahi et al., 2017). These trends explain a significant share of the rising environmental impact in the business-as-usual scenario predicted for 2050 by Willett et al. and can only partly be offset by improvements in technology.

The population and GDP trends outlined in this scenario could be an overly optimistic estimate. The United Nations population division predicts a global population of 10.9 billion in 2100 (United Nations, 2019), an almost 20% increase over the 2050 prediction above. Thus, stresses on the environment could well be even higher.

Since population increases will be difficult to avoid, and increasing affluence is desirable politically, especially in less developed countries, technology is the main lever to address the global sustainability

challenge. The term “technology” can be somewhat misleading, however, since it evokes associations of technical solutions and neglects more human factors that impact the environmental intensity of a lifestyle. Therefore, it might be better to understand technology as the impact intensity per person and affluence. Economic systems, social practices, dietary preferences, or cultural norms around food can be subsumed under this term. The dietary composition is one important determinant of this impact intensity and is thus further explored in the next subchapter.

2.3 Environmental Impacts by Food Category

Foods vary in their environmental footprint per serving. Even though environmental impacts are not always consistent across impact categories—such as water use, land use, or greenhouse gas emissions—a hierarchy among different food categories can be established (Clune et al., 2017, p. 766). Plant-based foods such as grains or vegetables have the lowest environmental impacts, dairy products have medium impact, and meat products, especially from ruminants, have the largest environmental footprint (Clark & Tilman, 2017, p. 1; Clune et al., 2017, p. 766). Figure 3 illustrates these differences relative to the environmental impacts per calorie of maize. For instance, the land use per calorie of ruminant meat is 472 times larger than the land use per calorie of maize.

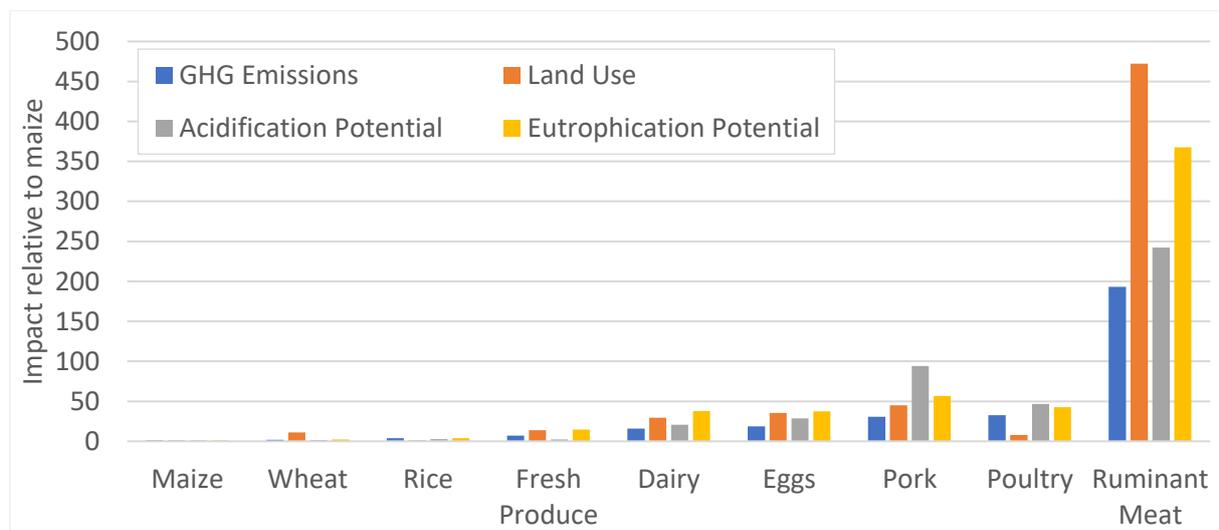


Figure 3: Selected environmental impacts by food category(own chart based on data from Clark and Tilman (2017), environmental impact per calorie displayed relative to maize)

As Figure 3 illustrates, the spread in environmental impacts among categories is large. Ruminant meat, for example, has an overall environmental impacts 100 times larger than plant-based food (Clark & Tilman, 2017, p. 1). These differences in environmental footprint from food to food mean it is possible to significantly reduce the environmental footprint by shifting from a meat-heavy to a vegetarian or vegan diet. Aleksandrowicz, Green, Joy, Smith, and Haines (2016, p. 1) estimate that with a dietary

shift, reductions of up to 70-80% of greenhouse gas emissions are possible. They also find that reductions in footprint were generally proportional to reductions in the consumption of animal-based foods.

Reductions in animal-based foods can offer health benefits as well (Nelson et al., 2016, p. 1005). Red meat and processed red meat have recently been classified as probably carcinogenic and carcinogenic, respectively, by the World Health Organization (2018, p. 492). Diets without any meat can be a healthy and environmentally friendly option. A health study with a large North American cohort found vegetarian diets to be associated with lower mortality from all causes (Orlich et al., 2013, p. 1230).

However, are diets that meet planetary boundaries and health requirements a possibility? Many experts believe the answer is yes. Willett et al. (2019, p. 2) found that shifting to healthy low-meat and low-dairy diets can prevent about 11 million deaths per year and that these diets can be produced in a sustainable food system that meets planetary boundaries. They caution, however, that such a system would require an aggressive health and sustainability transformation of the food production system as well as a significant shift in diets. To be successful, a concerted change of diets, purchase behavior, and policies, among other measures, would be necessary. The margin for error is low. The large footprint of animal products means that even small increases in meat or dairy consumption would make such a food system exceed planetary boundaries.

2.4 Organic Farming

Organic farming is another technology that is widely perceived as a potential solution to the sustainability crisis of the global food system. Since the purchase of organic food is studied in this dissertation's field experiments (see Chapter 5), a more detailed discussion of its potential and drawbacks is provided in this subchapter.

The intention of organic farming is to create a sustainable food production system that considers human, environmental, and economic aspects and “maximise[s] reliance on farm-derived renewable resources” (Padel & Lampkin, 1994, p. 5). The historical foundations of organic farming were developed by Rudolf Steiner in the 1920s (Lockeretz, 2007, p. 19). His courses on biodynamic agriculture gained a following in anthroposophic circles in Germany, though his writings were not published until much later. In the following years, others independently developed organic farming approaches in Switzerland, Britain, the United States, and Japan (Lockeretz, 2007, pp. 24–27; Reganold & Wachter, 2016, p. 1).

Over the past 20 years, the land under organic management has more than quintupled—from 0.3% of total agricultural land in 1999 to 1.4% in 2017 (Willer & Lernoud, 2019, p. 25)—but in overall terms

the share is still small. This growth has been the most pronounced in Europe and Oceania (especially in Australia) (Willer & Lernoud, 2019, p. 25). In terms of consumption, the largest markets for organically produced products are the United States (€40 billion) and Germany (€10 billion) (Willer & Lernoud, 2019, p. 27). Denmark (13.3%), Sweden (9.1%), and Switzerland (9%) have the highest organic consumption shares (Willer & Lernoud, 2019, p. 27). Despite being the second largest market, Germany's share is much lower, at about 5.1% (Bund Ökologische Lebensmittelwirtschaft, 2019, p. 21). A wide gap exists between consumer self-perception of organic food and actual purchase behavior: 58% of consumers report always or often buying organic food in Germany (Bundesanstalt für Landwirtschaft und Ernährung, 2019, p. 8).

The diverse historical roots of organic agriculture have resulted in a multitude of certification schemes and bodies. Today, 283 certification organizations exist (Reganold & Wachter, 2016, p. 1; Willer & Lernoud, 2015). This diversity has meant that organic standards vary somewhat from country to country. This dissertation refers to the European Union definition of organic products when not otherwise noted. The EU standard severely limits the use of artificial fertilizers, herbicides, pesticides, and antibiotics and prohibits the use of ionizing radiation, genetically modified organisms, and hormones (European Union, 2007, 2008). Maintaining crop fertility by rotating crops, cultivating nitrogen-fixing plants, and avoiding the use of mineral nitrogen fertilizers are also an essential part of organic food production practices in the EU (European Union, 2007, 2008). It is also important to keep in mind that not all foods that are organically grown are also certified as such, especially in the Global South.

Organic farming aims to enable closed local nutrient loops and to keep soil carbon content high (Baumgarten et al., 2018, p. 17). Manure and dung from livestock breeding are reused to fertilize crops. The use of synthetic pesticides and herbicides is replaced by mechanically removing weeds and using natural predators. Cover cropping and other practices increase soil fertility and humus, thereby keeping organic matter in the soil.

As a consequence, organic farms are estimated to have 7% higher soil organic matter, 31% lower nitrogen leaching, 31% lower nitrous oxide emissions, 1% lower phosphorus losses, and 30% higher biodiversity (Tuomisto et al., 2012, pp. 312–316). Organic farming may also use water more efficiently, use less fossil fuel, improve soil quality, be more drought-resistant, and be more resistant to other threats, making it more stable in yields (Azadi et al., 2011).

Despite these reported positive impacts of organic farming, its overall benefits are contested. A number of reviews come to contradictory conclusions on the benefits regarding greenhouse gases,

land use, nitrogen cycling, and biodiversity (e.g., Clark & Tilman, 2017; Hole et al., 2005; Meemken & Qaim, 2018; Mondelaers, Aertsens, & Van Huylenbroeck, 2009; Tuomisto et al., 2012).

This debate about the environmental benefits of organic farming hinges on one central question: whether and, if so, by how much, yields for organic farming are lower than for conventional production methods. If yields are one-third lower for organic production (as estimated by Seufert et al., 2012, p. 229), 50% more land would be needed to grow the same output in the absence of other measures. Since farmland is scarce, this would lead to more carbon- and biodiversity-rich land converted to farmland and counteract the biodiversity and carbon benefits that organic agriculture might have in the areas where it is applied.

Even with many studies and reviews in this field, a conclusive answer to the question of yield differences is still missing. Estimates for the overall yield gap range between -19% and -25% (de Ponti et al., 2012; Ponisio et al., 2015; Seufert et al., 2012). Tuomisto et al. (2012, p. 314) report 84% higher land use for organic farming “due to lower crop yields, lower yielding animals and land area requirement[s] for fertility building crops”. However, Seufert et al. (2012, pp. 229–230) report no yield gaps for fruits, legumes, perennials, and for crops grown under best management practices. Others, however, could not replicate these findings (Ponisio et al., 2015, p. 2). Ponisio et al. (2015, p. 1) find that agricultural diversification techniques such as multi-cropping and crop rotations reduce the yield gap to less than 10%. Thus, overall, a picture of uncertainty on the yield gap and related environmental impacts emerges (Seufert & Ramankutty, 2017).

Despite the uncertainty about this yield gap, organic farming systems may “better balance multiple sustainability goals than their conventional counterparts,” especially when currently uncounted negative externalities of conventional farming are considered (Reganold & Wachter, 2016, p. 3; Treu & Sanders, 2019). Additionally, the comparison between highly optimized conventional farming methods and organic farming systems still in their infancy may be less useful than it seems at first glance (Ponisio et al., 2015, p. 5). Varieties currently used in organic farming have been bred for high yields with the high inputs of conventional agriculture and not for use in organic agriculture (Lammerts van Bueren et al., 2011, p. 193), and research on organic systems has received less funding than conventional systems (Vanloqueren & Baret, 2009). Thus, a better perspective on organic farming may be to view it as a prototype (Bellon & Penvern, 2014) that has the potential to make global farming sustainable but must be improved. It seems plausible that a more developed organic farming system could deliver on its sustainability ambitions.

In summary, organic agriculture can contribute to making the food system more sustainable by decreasing the environmental impact per agricultural area. However, as this analysis also indicated,

organic food production is not a panacea and it must be complemented by other measures such as lowering meat consumption and decreasing food waste to meet planetary boundaries.

2.5 German Food System

The outlined sustainability and health challenges are global, but solutions will have to be tailored to the local context. This dissertation studies Germany as an example of a developed country with high meat and dairy consumption, significant food imports and exports, and substantial organic food production as well as consumption. The German food system contributes significantly to exceeding global boundaries for greenhouse gas emissions, land use, biodiversity, nitrogen cycles and phosphorus cycles, and these contributions will have to decrease significantly to meet global and national sustainability ambitions.

The German food system can be viewed both through production and consumption lenses, and these views differ substantially, since Germany is both a significant importer and exporter of food and its predecessors. This subchapter explores the production side first, examines the trading relationships in a second step, and places the consumption side into focus in its last part.

2.5.1 Agricultural Production and Its Impact on Planetary Boundaries

More than half of Germany's land is used for agricultural production, most of it for growing grains (Baumgarten et al., 2018, p. 84). But agricultural production by growing food from plants is neither the only nor the most significant contributor to planetary boundaries of German food production. High meat and dairy production as well as a rapidly increasing area for biofuel production also contribute a substantial share. A total of 7.5% of German agricultural land is used for organic production, still far less than the 20% goal set by the German government (Bundesministerium für Ernährung und Landwirtschaft, 2017) but not low by international standards. This diverse system of agricultural production strains planetary boundaries across almost all relevant categories. Of the planetary ecosystem boundaries, only freshwater use is not a major concern for German agriculture since supply is quite abundant. Greenhouse gas emissions, biodiversity, land use, nitrogen cycles, and phosphorus cycles are all impacted substantially and are explored in more detail in the following paragraphs.

While direct agricultural greenhouse gas emissions (excluding transport, fertilizer production, storage, etc.) account for only 7% of German overall emissions (Baumgarten et al., 2018, p. 34), they will still have to decrease by 65-80% to meet 2050 European Union emission targets (Bryngelsson et al., 2016, p. 152). Nitrous oxides from soils are the largest emission driver (41%), followed by methane emissions from enteric fermentation by ruminants (37%), and manure management emissions (22%) (Rösemann

et al., 2017, p. 7). Meat and dairy production, through emissions from enteric fermentation and manure management, are responsible for 59% of German agricultural emissions.

Some have questioned whether these emission estimates encompass all relevant agricultural emission categories (e.g., Baumgarten et al., 2018; Hirschfeld, Weiß, Preidl, & Korbun, 2008). Specifically, the production of conventional fertilizers is quite carbon-intensive and is omitted from estimates. Additionally, current emission estimates do not consider the emissions resulting from feedstock production in other countries. Moreover, emissions from land use and land use change are not reported as agricultural emissions. A more extensive definition of agricultural definition may double the share of emissions attributable to agriculture.

The German government tracks biodiversity based on an index of indicator bird species. The populations of these bird species illustrate the health of the ecosystems on which the respective species rely. This index, based on populations of 51 bird species, indicates a significant decline over the past 50 years and is on a trajectory to miss goals established for 2030 (Statistisches Bundesamt, 2018b, p. 106). Land use change, drainage, and the use of pesticides are agricultural causes for this decline (Baumgarten et al., 2018, p. 42).

While still more than half of German land is used for agriculture, land use has declined by 2.4% since 2000. But these declines have largely been offset by increases in settlement and transport area (Baumgarten et al., 2018, p. 52) and, consequently, have not aided environmental goals. Crops grown for biofuel have also placed significant pressure on land use and now account for 14% of agricultural land (Fachagentur Nachwachsende Rohstoffe, 2019, p. 3).

Freshwater use has not been an issue of concern in Germany to date. Currently, an estimated 13.3% of available freshwater is used in agriculture (Baumgarten et al., 2018, p. 27). A share of up to 20% is viewed as being consistent with good environmental practices.

The nitrogen cycle of German agriculture is also increasingly out of balance, resulting in eutrophication and acidification on land and in lakes, rivers, and the sea. This is caused by an oversupply of reactive nitrogen fertilizers in agriculture that cannot be absorbed by plant growth and, as a result, reach waterways, the atmosphere, and non-agricultural land. Reactive nitrogen in the European ecosystem, the main component of fertilizers, has tripled, according to some estimates (Baumgarten et al., 2018, p. 58). As a result, the nitrogen surplus on agricultural land is on a trajectory to miss the goal established for 2030 as well (Statistisches Bundesamt, 2018b, p. 12). Germany has also faced action by the European Court of Justice and European Commission on this issue (Bundesministerium für Ernährung und Landwirtschaft, 2019).

A similar story applies to the phosphorus cycle in Germany. Currently, only 37% of measuring stations report phosphorus levels consistent with positive environmental conditions (Statistisches Bundesamt, 2018b, p. 42).

The environmental impacts of food production are not created in a vacuum. Policy, both on the German and the European level, plays a key role in setting regulatory boundaries and creating financial incentives and disincentives for certain behaviors. On the European level, the common agricultural policy is an important instrument that disburses more than one-third of the overall budget of the European Union to farmers. While some environmental elements have been introduced in past reforms, a sizable portion of the money is still distributed without stringent sustainability rules attached. National policy is also important. For instance, the German fertilizer regulation (“Düngemittelverordnung”) is a key regulation for steering the use of fertilizers on German farms. Consumption taxes also play a role. Reduced value-added taxes for meat and dairy products in Germany incentivize the consumption of these carbon-intensive foods.

German agriculture contributes significantly to exceeding planetary boundaries. However, this view is lacking an increasingly important component: imports and exports.

2.5.2 Food and Feedstuff Trade

German agricultural production figures do not capture the environmental footprint of imported foods and feedstuff but do include those of exports produced within Germany.

Overall, Germany is a net importer of food and feedstuff—its imports are larger than the exports (Baumgarten et al., 2018, p. 19). Both imports and exports have risen steadily over the past two decades. More than two-thirds of food and feedstuff are imported from European Union members and more than three-quarters are exported to them. Oilseeds, mostly in the form of soy for meat production, are an important exception to this pattern. They are mostly imported from North and South America. Meat and meat products constitute the most important export category, and the share of German meat that is exported has risen quickly from 14% in 1995 to 48% in 2014 (Baumgarten et al., 2018, p. 22).

Germany’s food and feedstuff imports require an area of 19.1 million hectares in other countries, an area significantly larger than the 14 million hectares that Germany uses for food production (Statistisches Bundesamt, 2019b, p. 8, also see Figure 4).

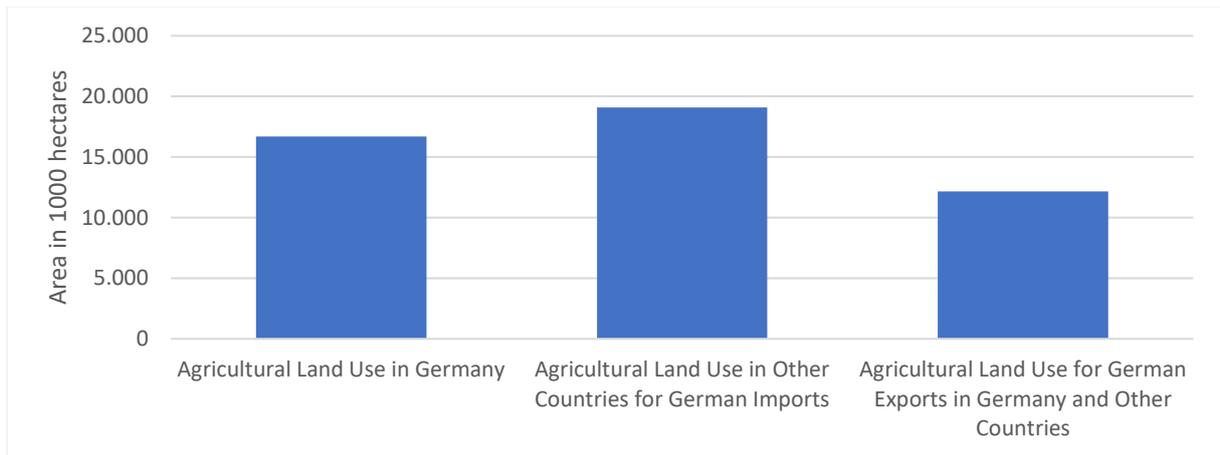


Figure 4: Land use for German production, imports, and exports(own figure, data sourced from Statistisches Bundesamt, 2019b)

As Figure 4 highlights, Germany is a significant net importer of land in other countries (Baumgarten et al., 2018, pp. 24–25). The imports cover almost 7 million hectares more land in other countries than is accounted for by the exports. This virtual import of land can be viewed as a proxy for German contribution to the environmental impact at the locations where these imports are produced. Planetary boundaries at these locations—for instance, freshwater use—that are not a large issue in Germany can be a more significant problem.

In the same fashion as for land, Germany imports water and genetically modified crops (Baumgarten et al., 2018, pp. 25–26). Most of these imported genetically modified crops (often soy from North and South America) are feedstuff for meat and dairy production. Interestingly, under current regulation, the meat and dairy products emanating from this feedstuff do not need to be labeled as having used genetically modified crops.

2.5.3 German Food Consumption

German food consumption is characterized by high meat and dairy consumption, which is responsible for the majority of environmental impacts. Germans consume an average of 44 kg of meat, 93 kg of dairy, and 85 kg of vegetables per year (the author's own calculations based on Max Rubner-Institut, 2008, pp. 32–44). Meat products alone are responsible for approximately 39% of greenhouse gas emissions and 51% of land use (this and following figures are the author's own calculations based on Treu et al., 2017). Dairy products cause 21% of emissions and 17% of land use (also see Figure 5).

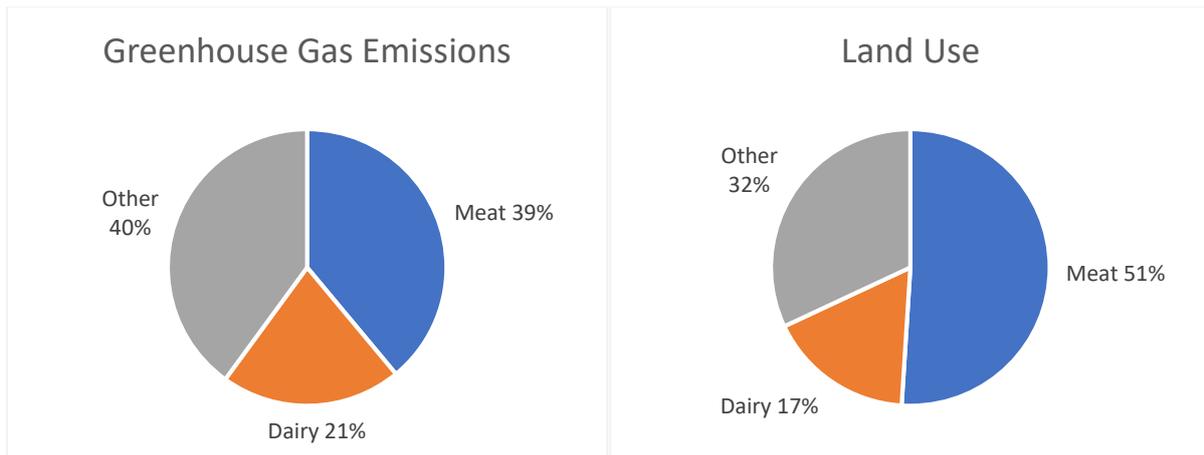


Figure 5: German emission and land use shares caused by meat and dairy consumption (the author's own calculations based on Treu et al., 2017)

Current dietary patterns in Germany do not meet health guidelines, and changes in diet could be beneficial both for health and the environment. German men consume twice the amount of meat suggested by German dietary guidelines (Heuer et al., 2015, p. 1606). Dairy consumption is also exceptionally high by international standards (Willett et al., 2019). Consequently, a healthier lower-meat, lower-dairy diet would not simply complement more sustainable food consumption globally but would have a positive effect in a high-meat, high-dairy country such as Germany as well.

German households spend relatively little on food—10.7% of their expenditures—compared to their international peers (United States Department of Agriculture, 2020). The French spend almost 25% more on food than their German neighbors.

German consumers perceive organic food as a potential solution to sustainability challenges. However, the carbon and land use footprints of German organic consumers are similar to those of conventional consumers (Treu et al., 2017, p. 127). The analysis by Treu et al. indicates that emission and land use benefits of lower meat consumption are offset by the impacts of increased dairy consumption (Treu et al., 2017, p. 127). The underlying study, however, did not assess other environmental impacts, such as biodiversity or freshwater use, and organic food consumption may fare better in these realms.

A discussion of food consumption would not be complete without the consideration of food waste. Almost a third of food products in Germany are wasted (Baumgarten et al., 2018, p. 148). Most of this food waste (61%) comes from private households. Two-thirds of overall food waste could be avoided with substantial environmental benefits. Overall production could be reduced by 20% if this were implemented.

In summary, both German food production and consumption face significant sustainability challenges. High meat and dairy production, significant soy imports and meat exports with related environmental burdens, as well as high resource-intensive meat and dairy consumption all cause significant environmental impacts on the national and global ecosystems.

2.6 Need for Transformation and Policy Options

As the previous analysis indicates, a rapid and large-scale transformation of the global and the German food systems is needed to avoid grave environmental consequences and to remain within planetary boundaries.

This transformation must encompass a wide range of changes from regulatory, consumer, producer, and other relevant actors. The transformation will require measures ranging from changing diets and reducing environmental harm from conventional agricultural production systems to developing organic agriculture as an environmentally friendly alternative.

To date, the global regulatory approach to food system sustainability has often been but not exclusively focused on two policy instruments: banning clearly environmentally damaging practices and providing information and education to consumers to make more informed choices. Banning practices, however, is often politically costly, especially in the time of populist politics. For example, the German Green Party's suggestion to introduce a vegetarian day in public canteens caused a significant backlash and was perceived as a "paternalistic interference in the public's freedom to eat meat" (Vasagar, 2013). The recent introduction of more stringent fertilizer rules has triggered large-scale protests by farmers in the Netherlands and Germany (e.g., NDR, 2020). The other regulatory approach, information provision, is rarely effective in changing behavior (e.g., Klöckner, 2015, p. 177). Therefore, other regulatory options will need to be leveraged as well to support the transformation.

Several other policy options exist. The Nuffield policy ladder (Nuffield Council on Bioethics, 2007, p. 42) illustrates several other options besides bans and the provision of information that could be employed to aid a large-scale sustainability transformation (see Table 1).

Eliminate choice
Restrict choice
Guide choices through disincentives
Guide choices through incentives
Guide choice by changing default policy
Enable choice
Provide information
Do nothing

Table 1: Nuffield policy ladder(Nuffield Council on Bioethics, 2007, p. 42)

The policy ladder highlights the diversity of options available to policymakers in support of a sustainability transition. Nudging is one example of a new policy instrument that is closely related to changing default policies, enabling choice, and providing information. This tool is explored in the next chapter.

3 Nudging Sustainable Food Purchasing

Keeping the global food system within the environmental boundaries of the planet requires large-scale behavior change. Nudging—roughly defined as gently guiding people toward a choice without forcing them and without changing incentives—is an increasingly popular policy lever to aid behavior change that could contribute such a required sustainability transformation. The promise of nudging is to be effective in changing behavior without limiting freedom of choice in the way that more intrusive measures such as taxes or bans do.

3.1 Decision-Making Flaws

3.1.1 Cognitive Biases

Nudging rests on five decades of research in psychology and other behavioral sciences that investigate flaws in human decision-making. The heuristics and biases program was pioneered by Amos Tversky and Daniel Kahneman in the early 1970s. Their seminal 1974 paper on judgment under uncertainty (Tversky & Kahneman, 1974) is often credited as the foundational document of this line of research; it is worth presenting in some detail in the following paragraphs.

The premise of the heuristics and biases research program was that human decision-making frequently employs heuristics, or simple rules of thumb. These are generally useful in mastering the many decisions that humans face but fail in some circumstances. In other words, Tversky and Kahneman contend that there is a tradeoff between mental effort and accuracy. For example, they report that people estimate the distance of an object by factoring in its blurriness, and this generally produces accurate results. In foggy weather, however, this rule of thumb fails and causes people to overestimate distances. Tversky and Kahneman propose and document that human decision-making, and especially judgments of probability, often work in a similar fashion.

One of the first examples of such a judgment flaw was the so-called representativity bias (Kahneman & Tversky, 1972). In judging the probability of a person's belonging to a group, people make inferences based on the representativity of a person for a group while ignoring other meaningful information such as base rate probabilities. For instance, when a hypothetical person named Linda is described as 31 years old, outspoken, single, and a philosophy major, more people will think Linda is a "bank teller and active in the feminist movement" than will think she is a "bank teller" (R. Thaler & Sunstein, 2008, pp. 26–27). This is in obvious contradiction to the statistical fact that the probability of the two things

being true is obviously lower than the probability of her being a “bank teller” who may or may not be active in such a movement.

Another bias, loss aversion, is the basis for many interventions. Loss aversion, sometimes formulated as its theoretical pendant prospect theory, describes the tendency to weigh losses more than gains. For example, a loss of \$10 reduces satisfaction by more than the corresponding gain of \$10 would increase satisfaction. This effect can be quite relevant in a sustainable purchasing setting. If a surcharge is placed on plastic bags or takeaway cups, it frames the additional costs as a loss, which, according to prospect theory, carries more weight. In the alternative scenario, where a discount is given for bringing your own cup or not using a plastic bag, the same cost is perceived as a gain and, thus, carries less weight. Accordingly, even seemingly small framing decisions may substantially influence choice.

Related to loss aversion is the status quo bias or the tendency to remain with the current state (Kahneman et al., 1991; Samuelson & Zeckhauser, 1988). People prefer options if they are designated as the status quo or the default compared to the same option when it is not labeled as such. Loss aversion supports this tendency, since any potential gains from switching away from the status quo carry less weight than the potential losses from doing so. This bias has important implications for the design of many everyday decisions. Options framed as the default or the status quo are significantly more likely to be chosen due to this framing. A powerful example of this bias comes from the field of organ donorship. Organ donations tend to be substantially higher if the default is to donate organs than when it is not (Johnson & Goldstein, 2003). In the environmental domain, this bias can also be important. If the traditional, environmentally unfriendly option is presented as a default, it may be chosen more often. And if the new, environmentally friendly option is presented as a deviation from the default, it may be chosen less often.

Judgment flaws are more likely to develop in domains where people lack timely and unbiased feedback regarding the result of their actions. For instance, 94% of teachers rated themselves as better than the average teacher at a U.S. university (Price, 2006). This overestimation of one’s own skills extends to other domains such a driving, risk of contracting a disease, or even one’s own friendliness. The lack of timely and unbiased feedback on the environmental implications of our purchase behavior may cause a similar bias. Over the past centuries, supply chains have stretched longer and longer, thereby reducing the feedback required to develop an accurate sense of one’s own actions and their consequences.

Meaningless information also influences human decisions. Research by Daniel Gilbert (2002) indicated that meaningless information can reduce our ability to draw correct inferences. For example, when

participants in an experiment watched a video that was visually degraded, they were less able to correct misconceptions held about people appearing in the video even when these were still clearly discernable.

A finding concerning to science is that people tend to detect patterns in random data even when there are none. In the aptly titled book “How We Know What Isn’t So: The Fallibility of Human Reason in Everyday Life” (1991), Thomas Gilovich describes a tendency to misinterpret random data as systematic. People then cement their beliefs by generating a causal theory to support the initial misinterpretation after the fact.

Several other biases have been documented in research. The planning fallacy describes the tendency to be too optimistic regarding the time it takes to finish a project (e.g., Roger, Dale, & Michael, 1994). The anchoring heuristic describes how people tend to start numerical estimation tasks with an anchor number and then adjust that anchor insufficiently to arrive at an estimate (e.g., Epley & Gilovich, 2006). Even seemingly irrelevant numbers, such as writing down one’s own phone number before an estimation task, can influence this process. The framing bias illustrates how the framing of information influences people’s thoughts even when the informational content is the same (e.g., Tversky & Kahneman, 1981). People respond differently to the message that 80% survived a disease than to the message that 20% died.

In short, an impressive list of judgment flaws has been assembled over the past decades, and, in many circumstances, these judgment flaws lead people to make less-than-optimal decisions. One main insight from the cognitive biases research is that context matters. People are not immune to changes in context—whether a choice is framed as a loss or a gain matters, whether it is presented as maintaining the status quo makes a difference, and even seemingly meaningless information may distract from making well-considered decisions.

Analyzing these judgment flaws is not simply a theoretical exercise; they have major real-world consequences. They make many people worse off than they could be. Grüne-Yanoff and Hertwig (2016) note that their implications range from people failing to save enough for retirement, to consumers frequently making unhealthy food choices, to the development of a large gap between the intention to protect the environment and the behavior to do so. These consequences provide the motivation to study ways of eliminating these biases to improve decisions or to harness their power where they cannot be eliminated.

3.1.2 Dual-Process Theory

Dual-process theory provides the backdrop for much of the cognitive bias research. The theory proposes that people employ two modes of thinking when making decisions—one automatic, fast, and effortless (often called system 1), and one reflective, slow, and effortful (often called system 2).

System 1 – Automatic System	System 2 – Reflective System
Uncontrolled	Controlled
Effortless	Effortful
Associative	Deductive
Fast	Slow
Unconscious	Self-aware
Skilled	Rule-following

Table 2: Cognitive Systems (labels modified, based on R. Thaler & Sunstein, 2008, p. 20)

Most of the time, to save scarce mental resources, people employ system 1. Exemplary tasks of system 1 are reading emotions on another person's face, braking in traffic, or calculating $2 + 2$. Additionally, people have little sense of voluntary control for system 1 tasks. For example, when reading $2 + 2$, one cannot help oneself but think of the answer.

In contrast, system 2 is dedicated to more reflective tasks, such as computing the product of 17 and 37, parking a car in a small space, or evaluating the logic of an argument. These tasks require attention, and people are unable to complete them without it. For instance, an audience will have trouble computing the product of 17 and 37 while listening to a speaker. When behaviors become habitual, they can move from system 2 to system 1. When learning to drive, one must think about breaking and then perform a controlled action to do so. But as the behavior is repeated it becomes effortless and fast; it moves to system 1.

Dual-process theory suggests that there exists a fundamental tradeoff between mental effort and accuracy between these two systems. While system 1 is fast and effortless, it also frequently produces inaccurate results. System 2 produces more accurate results, but these results require significantly more mental effort. While system 1 thinking is an effective strategy to master the multitude of decisions people are faced with every day, these decision rules have systematic flaws that let us predictably err in many settings. These flaws introduce errors, often based on cognitive biases, in many of the decisions made based on system 1 thinking.

3.1.3 Choice Environment, Decision Environment, and Choice Architecture

The terms “choice environment,” “decision environment,” or “choice architecture” are often used interchangeably to describe the context that influences decision-making. What these terms have in common is that they describe the “context in which people make decisions” (R. Thaler & Sunstein, 2008, p. 3); these contexts often intentionally or unintentionally trigger cognitive biases. These biases steer people toward decisions “detrimental to their own welfare or to public welfare” (Grüne-Yanoff & Hertwig, 2016, p. 150), which they would not take “if they had paid full attention and possessed complete information, unlimited cognitive abilities, and complete self-control” (R. Thaler & Sunstein, 2008, p. 5).

The term choice architecture, preferred by Thaler and Sunstein, highlights the active role of people in designing choice situations. The existence of an architecture implies that there is an architect, a person who makes design decisions in creating choice architectures for particular decisions, often by “focusing the attention of users in a particular direction” (R. Thaler & Sunstein, 2008, p. 3). Many people are choice architects, even if they may not describe themselves as such. Designing the layout of supermarket shelves, ordering items on a restaurant menu, choosing the background color of a website, or selecting the words used to tell a patient about the treatment options for a disease—these are all tasks of choice architects, and they influence how people make decisions in that context. What these situations have in common is that “small and apparently insignificant details can have major impacts on people’s behavior” (R. Thaler & Sunstein, 2008, p. 3).

In the same way that buildings without architecture are inconceivable, having some form of choice architecture is often unavoidable. In a supermarket setting, some product will always be the first product seen when one enters the market; on a menu, one item will always be the first; on a website, the background requires some color; and it is impossible to tell a patient about a disease without using words or other forms of communication. This means “there is no such thing as a ‘neutral’ design” (R. Thaler & Sunstein, 2008, p. 3) that does not influence decisions.

A choice architecture may aim to guide people to make well-reflected decisions using system 2 thinking rather than system 1. For example, a choice architect may provide information, require wait times, or require people to supply reasons for a specific choice. This can be a helpful route, especially for decisions with high stakes that are made infrequently. However, the multitude of decisions that people must make every day means that full system 2 evaluations of each and every decision would overwhelm our cognitive resources.

To summarize, our decisions are often influenced by seemingly irrelevant context features, and the decision environment has a major influence on our choices. This is an important insight, since entire

disciplines and policy fields are built on the assumption that choices are made rationally and reflect intrinsic preferences. These mental flaws suggest the existence of major exceptions to these ideas and that these exceptions must be taken into account when designing sensible environmental policy.

3.2 Nudging

The term “nudging” was coined by Richard Thaler and Cass Sunstein in their discipline-inspiring book “Nudge—Improving Decisions About Health, Wealth, and Happiness” (R. Thaler & Sunstein, 2008). In the book, they define nudging as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives” (R. Thaler & Sunstein, 2008, p. 6).

3.2.1 The Rapid Rise of Nudging

Over the past decade, the number of publications labeled as nudging has grown quickly and this trend continues to date (see Figure 6).

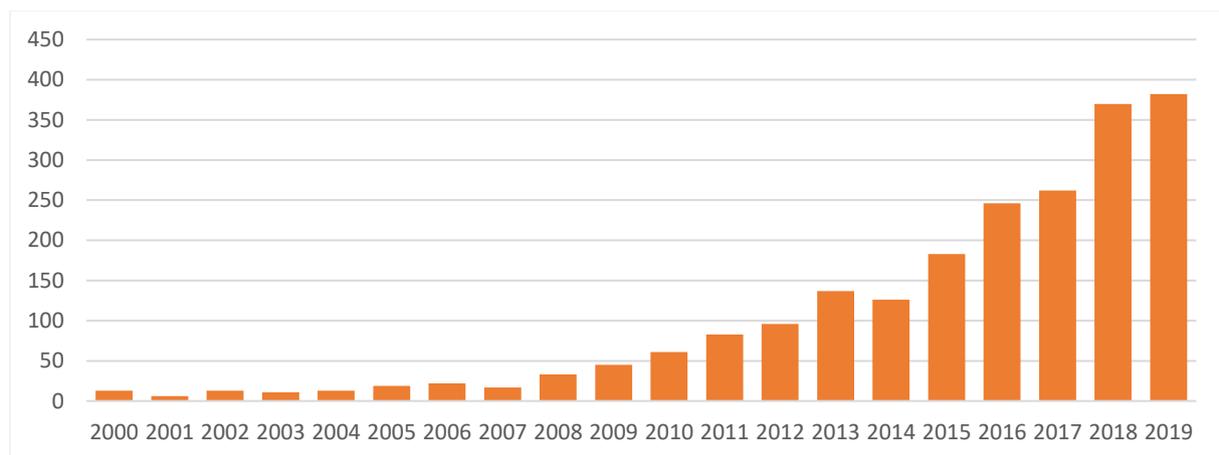


Figure 6: Number of nudging publications per year(Web of Science search, results from social sciences, arts, and humanities)

Notably, publications span a significant number of research areas. Business and economics, psychology, and other behavioral sciences are the three most prominent ones, but several other fields also account for large proportions of the nudging literature (see Figure 7).

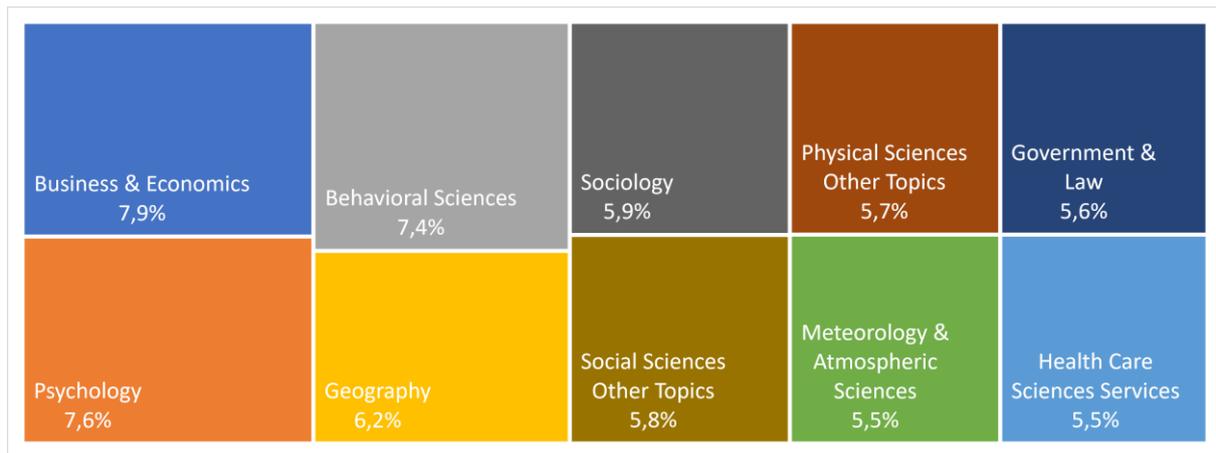


Figure 7: Share of nudging publications per discipline(Web of Science search, results from social sciences, arts, and humanities, filtered to the 10 largest research areas)

Despite this heterogeneity in research areas, more than half of nudging research is published in just four countries: the United States, England, Germany, and France (the author’s own analysis based on Web of Science search).

However, nudging has not just grown quickly in the academic domain. More than a dozen governments around the world have created “nudge units” that employ behavioral insights to increase the effectiveness of governments (Afif, 2017). One of the first, the British behavioral insights team, was established originally as part of the UK cabinet office but has since expanded to seven offices around the globe. The behavioral insights team has conducted more than 400 randomized control trials and works on issues ranging from tuberculosis treatment to encouraging sustainable food choices (The Behaviour Insights Team, 2018). In Germany, the government created the “wirksam regieren” (govern effectively) unit, which conducts trials on issues such as measles immunizations or household appliances labels (Bundesregierung, 2020).

While this appears to demonstrate a tremendous growth of the field, one must be careful in drawing such conclusions. The concepts underlying nudging have been around much longer than the term, so some of the apparent growth in research and applications may be what is known as “old wine in new skins” rather than genuinely new research. The fundamental concepts of nudging trace back much further. Goodwin (2012) points to early work in behavioral economics and social psychology by Becker and Ross as the origins of the field (Becker, 1962; Ross, 1977). The heuristics and biases program is another origin of the field (Kahneman & Tversky, 1979; Tversky & Kahneman, 1974). Even early work by Simon (1956) analyzed the role of the environment in rational choice (though his understanding of the environment was less focused on the physical world).

3.2.2 Thaler and Sunstein's Definition

The rise of nudging has been unhampered or, perhaps, even aided by definitory ambiguity that is discussed further in this subchapter. Recall that Thaler and Sunstein defined nudging as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives” (R. Thaler & Sunstein, 2008, p. 6). They add that “[t]o count as a mere nudge, the intervention must be easy and cheap to avoid” (R. Thaler & Sunstein, 2008, p. 6). Thus, the original definition of nudging can be summarized in three criteria:

1. Nudges predictably alter behavior in a certain direction.
2. Nudges must preserve freedom of choice.
3. Nudges must not impose significant economic incentives or disincentives.

Under this broad definition, nudges can take a variety of forms: A sustainability food label is a nudge; so is the placement of healthy foods at a prominent position in the cafeteria. Providing feedback to people about their energy consumption is a nudge, as is reminding people not to litter. But even more mundane things such as directions provided by a global positioning system (GPS), a warning sign, or education count as nudges under this definition.

3.2.3 Criticism

All three parts of the definition can be and have been critically discussed.

The first part of the definition focuses on the predictable alteration of behavior as a standard of evidence that nudges must meet to count as such. In implementing nudges in practice, practitioners and researchers have translated this into employing randomized control trials that allow for statistically discerning the causal effect of an intervention in a treatment group relative to a control group. Sometimes this feature of nudges is understood to distinguish them from other environmental policy approaches such as environmental education, financial incentives, or bans that are not always empirically evaluated with the same stringency. The lack of stringency in evaluating non-nudging policies can be a problem if they have counterintuitive effects. Rebound effects can lower or entirely eradicate the environmental benefits of a policy (Santarius, 2012). Even fines can lead to an increase rather than a decrease in the targeted behavior (Gneezy & Rustichini, 2000). Equally, approaches based on providing people with environmental information frequently fail this effectiveness test (Klößner, 2015, p. 177).

But the notion that nudges must predictably alter behavior in a certain direction could also be viewed as scientifically problematic since it does not allow for falsification. The hypothesis that a nudge is effective could never be falsified because an ineffective nudge would cease to meet the criteria

required to be called a nudge. In practice, the literature seems to have largely ignored this issue, and publications that report “ineffective nudges” exist in the literature (Byerly et al., 2018; Lehner et al., 2016). The implied notion of nudging in those seems to be that the intent to predictably alter behavior in a certain direction suffices.

The second part of the definition, preserving freedom of choice, is used by Thaler and Sunstein to distinguish nudging from more intrusive policy approaches, such as bans. So-called “veggie days” restrict people who would like to eat meat from making that choice without going elsewhere. Banning incandescent light bulbs does not preserve freedom of choice either. This is not to say that limiting freedom of choice need not be part of an adequate environmental policy response to environmental challenges. However, as the debate over the suggested introduction of veggie days in Germany (Vasagar, 2013) or the implemented ban of incandescent light bulbs in the European Union indicate (Randall, 2009), public pushback can be strong if freedom of choice is limited, especially if people are unaware of the underlying problems (Steg & Gifford, 2005, pp. 62, 67). Correspondingly, freedom of choice is one of the highest-ranking quality-of-life indicators (Poortinga et al., 2004; Steg & Gifford, 2005, pp. 62–63).

Nevertheless, the second part of the definition has been questioned regarding the precise characterization of freedom of choice. Thaler and Sunstein seem to equate freedom of choice with a maintenance of choice set. That is, all options previously available to the choice must still be available. Still, one could envision other definitions of freedom that would focus on the autonomy of the chooser. Is a chooser free to choose if she is intentionally pushed toward a certain choice? If the next non-vegetarian meal is available only after a one-minute walk, would this count as maintaining freedom of choice? This question is explored in the subchapter on the ethics of nudging.

The third part of the definition specifies that nudges should not introduce “significant chang[es]” to economic incentives. Therefore, taxing, fining, or subsidizing a behavior is not considered to be nudging either, as are other approaches that significantly alter material incentives. This can be partly understood as an extension of the freedom-of-choice criterion to make choosing other than what is intended not excessively costly. It also differentiates nudging from classical *homo economicus* policy-making that emphasizes the use of financial incentives to guide behavior. This narrowing of costs to include only economic ones can be seen as an arbitrary distinction. Would a nudge that introduces severe emotional or cognitive costs count as one? Thaler and Sunstein seem to be aware of this problem. At a later point in their book they write that nudges should not significantly alter “any costs” (R. Thaler & Sunstein, 2008, p. 8), including cognitive ones.

Following this line of reasoning, one may ask to what degree of a change in cost should be called “significant.” Placing a product in a different section of a supermarket may change the cognitive cost of locating the product. When would such a change in cost be deemed significant? One assumes that a cost can be high enough to change behavior but still not be deemed significant under the definition provided by Thaler and Sunstein. Their book does not address this question directly. What counts as significant is only implicitly defined through the examples the authors provide.

Thaler and Sunstein list many examples of what they consider to be nudges, though these sometimes deviate considerably from their original definition. For example, they cite the “dollar a day” program, which pays teenage girls not to become pregnant, as a nudge. As is obvious from its name, this program seeks to influence decisions by providing economic incentives not to become pregnant; it should not be considered a nudge under their own definition (Gigerenzer, 2015, p. 363). One could also argue that Thaler and Sunstein do not deem an incentive of \$1 a day a “significant change” in cost and thereby re-raise the question of what constitutes a significant change in incentives.

A few overall points of critique regarding the definition have been raised as well. The definition seems to contradict itself on the question of whether only intentional modifications of the decision environment can count as nudges (Barton & Grüne-Yanoff, 2015, p. 342). The first part of the definition describes nudges as “any aspect of the choice architecture that alters people’s behavior.” Such a definition could plausibly encompass the role of sunshine on purchase decisions as a nudge, provided that it predictably influences the purchase behavior in question. The second part of their statement, however, refers to an “intervention” that “must be easy and cheap to avoid.” This part of their definition suggests that nudges are characterized by an intention on the side of the choice architect to guide behavior. Sunstein, in a later text, describes the weather as nudging behavior (Sunstein, 2014). Obviously, the weather has no intention to influence behavior. Thus, based on this later text from Sunstein, one can only assume that no intention is required to characterize an intervention as a nudge.

Several features often associated with nudging are not part of the original definition, which does not exclude the provision of information, rational persuasion, or education. A rational argument to choose a certain option would count as a nudge under the definition provided by Thaler and Sunstein. Neither does the original definition rely on the concept of cognitive biases or decision-making flaws to characterize nudging, even though those are explored in depth in the book. In response to criticism of the concept, Thaler and Sunstein have repeatedly emphasized this wide definition of nudging (Sunstein, 2014).

The outlined definition of nudging has also been criticized by some as overly broad. Gerd Gigerenzer, one of the vocal critics of the nudging approach in particular and of dual-process theory in general, challenges the definition as including “almost everything that affects behavior” (Gigerenzer, 2015, p. 363). Grüne-Yanoff and Hertwig, emanating from the same school of thought, contend that “[t]here is no precise definition of a nudge, and policies subsumed under the heading differ widely” (Grüne-Yanoff & Hertwig, 2016, p. 152).

3.2.4 Alternative Definitions

Noting these challenges, several other authors have developed alternative nudging definitions.

Bovens (2009) defines nudging as the “manipulation of people’s choices via the choice architecture” so that “some pattern of irrationality is exploited” to guide people toward choices that are either in their own or in society’s best interest. This definition is significantly narrower, since it excludes interventions such as information provision or education that are generally not considered as exploiting irrationality.¹

Kaiser, Arnold, and Otto, taking a psychological perspective, view nudges as “nonfinancial and noncompulsory structural forces” (Kaiser, Arnold, & Otto, 2014, p. 203). They add that nudges are “structural conditions that aggravate or alleviate, and they are not the driving forces behind people’s behavioral decisions” (Kaiser et al., 2014, p. 204). This definition encompasses the freedom-of-choice component (“noncompulsory”) and the significant-change-of-financial-incentives component (“nonfinancial”) of the original definition. However, it also adds a further restriction. Nudges only count as nudges if they are not the “driving force[...] behind people’s [...] decisions” (Kaiser et al., 2014, p. 204). Thus, this definition would exclude provision of information, education, and, potentially, warnings as well.

Grüne-Yanoff and Hertwig (2016, p. 153) propose a lengthier nudge definition based on Rebonato (2012), which is worth quoting in full:

A nudge is intended by the policy maker (choice architect) to steer the chooser’s behavior away from the behavior implied by the cognitive shortcoming and toward her ultimate goal or preference (e.g., healthier food choices).

¹ It might be interesting to debate whether something like a rational argument, unbiased education, or provision of neutral information is actually feasible. Any messaging, be it through choice of words, the context in which it is provided, or other design decisions may influence the recipient without him or her being fully aware of it. Thus, it might be true that purely rational communication is impossible.

A nudge seeks to realize this influence by exploiting empirically documented cognitive shortcomings in human deliberation and choice, without changing the financial incentives (disincentives).

A nudge does not affect those features over which people have explicit preferences (e.g., money, convenience, taste, status, etc.), but rather those features that people would typically claim not to care about (e.g., position in a list, default, framing).

The behavior change brought about by the nudge should be easily reversible, allowing the chooser to act otherwise. Grüne-Yanoff and Hertwig (2016, p. 153)

They believe that what is genuinely new about nudges is that they “exploit [...] people’s cognitive and motivational deficiencies in ways that help them to make decisions that their better self (or superego) would make” (Grüne-Yanoff & Hertwig, 2016, p. 153). This more restrictive definition adds several components to the original: It requires nudges to be intended to change behavior, it requires them to nudge individuals toward their own goals and thereby excludes pro-social nudges such as environmental ones, it requires nudges to exploit cognitive biases, and it excludes nudges that influence design characteristics about which people have preferences.

Hausman and Welch (2010) propose a wider definition that explicitly considers non-financial incentives as well. Partially citing Thaler and Sunstein, they write that nudges “influence choices in a way that [...] make[s] the chooser better off” and that are free of “obstacles that close off possible choices or make them more costly in time, inconvenience, unpleasantness, and so forth” (Hausman & Welch, 2010, p. 124).

Despite these attempts to increase the clarity of nudging definitions, no consensus has emerged in the literature, and the precise definition of the term is rarely discussed despite its widespread use. Implicitly, it seems that most authors go along with the initial vague definition of Thaler and Sunstein.

3.2.5 Own definition

To avoid the vagueness introduced by Thaler’s and Sunstein’s definition, to circumvent perhaps overly strong restrictions placed on the definition by other authors, and to enable a precise debate in the following chapters, the author proposes this dissertation’s own definition of nudging:

Nudges are interventions that aim to increase the well-being of the individual or society by relying on cognitive shortcuts. Nudges must not significantly alter incentives or the choice set.

Therefore, on top of the original definition, nudges in this dissertation are required to be intentional and to focus on cognitive shortcuts. This excludes the traditionally separate field of education and information provision from further consideration in this dissertation in the cases where they do not

rely on cognitive shortcuts. Yet because quite a few cases exist where the framing of information intends to trigger cognitive shortcuts, it is still discussed in the subchapter on nudging techniques. Additionally, this definition extends the nudging label from interventions that are empirically effective to those that aim to be effective as well, to avoid the outlined problems of applying the label to the former only.

The underlying philosophy of nudging, the supposed oxymoron libertarian paternalism, was developed in an earlier publication by Thaler and Sunstein (R. H. Thaler & Sunstein, 2003). The libertarian part of libertarian paternalism, the authors wrote, is the “insistence that, in general, people should be free to do what they like—and to opt out of undesirable arrangements if they want to do so” (R. Thaler & Sunstein, 2008, p. 5). The paternalistic part is that “that it is legitimate for choice architects to try to influence people’s behavior in order to make their lives longer, healthier, and better” (R. Thaler & Sunstein, 2008, p. 5). In their essay, they argue, quite similarly to their ideas supporting nudging, that people do not always make decisions that are in their best interest and that some form of paternalism is unavoidable when designing choice environments. They propose that libertarian paternalism is desirable, since it allows people to go their own way if they do not agree with a paternalistic intervention. The legitimacy of this argument has been criticized as part of a broader ethical discussion on nudging. This discussion is explored in the following subchapter.

3.3 The Ethics of Nudging

The ethics of nudging have been debated frequently and critically, both in the popular and in the scientific literature. Perhaps for historical reasons, coverage in Germany has been particularly critical. Media articles mentioning nudging in the context of “psychological trickery” (Habich, 2018), “nudged into disaster” (Ekardt, 2017), or “the bad habit of nudging: when majority preference is above the law” (Horn, 2019) appear regularly. But criticism has not been present only in the public domain. In the academic domain, Gerd Gigerenzer has emerged as one of the most vocal critics by questioning the value of the concept as such and suggesting alternatives (e.g., Gigerenzer, 2015).

The debate about the ethics of nudging ties into old philosophical schools and ethical debates between deontological ethics, tracing back to Immanuel Kant on the one hand, and consequentialist ethics, tracing back to Jeremy Bentham on the other hand. Simply put, deontological ethics inspect the intention and moral principles behind an act to determine its moral value. Consequentialist ethics, on the other hand, look toward the consequences of an act to appreciate its moral value. Depending on the school of ethics, distinct aspects of nudging are deemed important. From a deontological perspective, the purity of the intention, such as the potential of nudges to manipulate, plays a larger

role, while consequentialist ethics are more focused on the result of nudging to determine its moral value.

Ethical debates surrounding nudging have also vacillated between debating the ethics of nudging as an overall concept with varying definitions and debating specific nudges. While earlier publications discussed the ethics of nudging overall (e.g., Bovens, 2009) over time, arguments have become more specific to certain classes of nudging (e.g., Barton & Grüne-Yanoff, 2015).

Critiques have not focused simply on the content of certain arguments but also have framed issues in specific ways conducive to the respective stand. This starts with but is not limited to the language that authors use. For example, authors with a positive view of nudges write about them as “enlist[ing] [...] behavioral bias[es]” (Sunstein, 2015), while those more critical write about nudges that “exploit” (Grüne-Yanoff, 2012) or “shap[e] people’s choices” (Hausman & Welch, 2010, p. 129).²

A full-fledged analysis of the outlined arguments for and against the ethical permissibility of nudging would exceed the scope of this dissertation.³ To keep the discussion succinct, the remainder of this subchapter discusses four of the most frequently raised objections in detail.

3.3.1 Argument 1: Nudges Limit Autonomy

Despite Sunstein’s and Thaler’s insistence that nudging maintains freedom of choice, a frequent line of criticism argues that nudging may not be as freedom-maintaining as it may seem at first glance.

These critiques argue that freedom of choice and autonomy require more than the mere maintenance of the choice set. For instance, Saghai (2013, p. 488) writes that “[c]hoice-set preservation is a necessary condition, but not a sufficient condition, for the preservation of freedom of choice.”

Mills (2015) provides a more extensive argument for why nudges might reduce autonomy:

Choice architecture is heralded as a policy approach that does not coercively reduce freedom of choice. Still we might worry that this approach fails to respect individual choice because it subversively manipulates individuals, thus contravening their personal autonomy. (Mills, 2015, p. 495)

² These word choices raise the question of whether authors attempt to nudge their readers to approve or disapprove of nudging. I will leave it to the reader to determine whether such a choice of words, perhaps intended to steer the reader in a certain direction, should be considered a nudge in itself and whether a text can be free of those influences.

³ For a full-fledged review, see Rebonato (2012), Barton and Grüne-Yanoff (2015), and other papers addressing the same issue.

This argument that some nudges are manipulative, and manipulation is wrong, has also been raised by others (Hansen & Jespersen, 2013, pp. 6–8; Noggle, 2018, sec. 3.5). These authors assert in varying forms that the lack of transparency of nudges makes them manipulative compared to open attempts of influence or persuasion.

Some of these critiques distinguish a nominal freedom of choice from an effective freedom of choice (Rebonato, 2012, pp. 8–9). Along similar lines, Guala and Mittone (2015, p. 386) distinguish option freedom and autonomy freedom. Both arguments contend that some nudges preserve only the narrower option freedom of choice but not the more extensive autonomy freedom. Suppose, for the sake of the argument, that a nudge is 100% effective in nudging people to become organ donors. In this scenario, people would still theoretically have the chance to opt out of organ donorship, but no one would do so because the nudge is so effective. In this case, nominal freedom of choice is maintained because it is theoretically possible to opt out. However, effective freedom of choice is not maintained because no one actually does opt out due to the effectiveness of the nudge. The critics question whether such a narrow conception of freedom of choice is desirable.

A similar line of reasoning contends that nudges reduce autonomy. Hausman and Welch (2010), define autonomy as “the extent to which [people] have control over their own evaluations and deliberation” (Hausman & Welch, 2010, p. 128). They argue that nudges can reduce the aforementioned control over one’s own deliberations and thus limit autonomy. If nudges are effective, people’s “actions reflect the tactics of the choice architect rather than exclusively their own evaluation of alternatives” (Hausman & Welch, 2010, p. 128). A similar argument about the degree of control retained by the nudgee is also advanced by Saghai (2013). He contends that nudges may not be able to easily “opt out of the arrangements [...] because nudges often unconsciously alter the way we perceive the options we are offered” (Saghai, 2013, p. 488).

A first line of response to the autonomy criticism might be that some examples stray so far from the original definition of nudging that the criticism does not apply to most nudges. Thaler’s and Sunstein’s understanding of nudges was that they “must be easy and cheap to avoid” (R. Thaler & Sunstein, 2008, p. 6). A nudge that is 100% effective is not avoidable, would not meet this criterion, and, consequently, would not be considered a nudge in most cases.

The most frequent reply to the autonomy criticism has been that some nudging is unavoidable. Even if some nudges reduce autonomy, they cannot be wished away (Sunstein, 2015, p. 513). For example, some item must be first in a list of options even if that fact reduces the autonomy of the chooser. The same condition applies to many supposedly neutral interventions. “As for information and educational campaigns, one of the main lessons from psychology is that it is impossible for such programs to be

‘neutral,’ regardless of how scrupulously designers try to achieve that goal” (R. Thaler & Sunstein, 2008, p. 243). Thus, for many situations, the neutral situation envisioned by autonomy proponents might not exist. In such situations, nudges might be called for to counter unavoidable influences of a specific decision environment to create a more level playing field.

Nevertheless, some nudges can reduce autonomy under some circumstances, for instance, “[i]f choice architects do not respect subjects’ ends, or if opt-out is seriously limited” (Sunstein, 2015, p. 517). However, if “publicity and transparency are guaranteed, then there is far less threat to autonomy” (Sunstein, 2015, p. 516). This requirement of transparency is described further in Thaler and Sunstein’s book. There, they write, “The publicity principle bans government from selecting a policy that it would not be able or willing to defend publicly to its own citizens” (R. Thaler & Sunstein, 2008). Other transparency standards have also been proposed. Bovens (2009) suggests that, “[E]very nudge should be such that it is in principle possible for everyone who is watchful to unmask the manipulation” (Bovens, 2009). Such a standard would, for instance, exclude many forms of subliminal advertising.⁴

Last but not least, Sunstein also argues that nudges can, in many cases, increase rather than decrease autonomy by enabling individuals to pursue their own goals (Sunstein, 2015, p. 516). If, for example, a nudge helps a person pursue a self-declared goal of stopping smoking, it could increase that person’s autonomy, Sunstein might argue. Several other examples of such nudges can be found. For instance, a nudge in a supermarket that helps consumers pursue their stated preference of buying more sustainable products could increase their ability and autonomy to follow through on this interest.

3.3.2 Argument 2: Nudges Exploit Biases

A second line of nudging critiques argues that nudges exploit human reasoning weaknesses rather than helping to correct them (e.g., Grüne-Yanoff & Hertwig, 2016). They criticize the assumption of nudging that the cognitive biases underlying nudging are so stable that they cannot be changed and charge that many nudges rely on keeping people uninformed. For example, social norm interventions may withhold information to push behavior in a certain direction. As noted by Grüne-Yanoff and Hertwig (2016), Thaler and Sunstein themselves provide one such example in their book: “If you want to nudge people into socially desirable behavior, do not, by any means, let them know that their

⁴ A question that has sometimes been raised in this context is whether subliminal advertising would count as nudging. However, such an intervention would be unlikely to meet the “easy to avoid” standard set by Kahneman and Thaler or the transparency requirements set by them or Bovens. While Vicary’s famous subliminal advertising experiment, which indicated that undetectably flashing “Drink Coca-Cola” in cinemas increased sales, turned out to be a hoax, similar effects have been demonstrated in controlled environments (Karremans et al., 2006).

current actions are better than the social norm” (R. Thaler & Sunstein, 2008, p. 68). Bovens (2009) offers a similar example to illustrate the argument: “If we explain the endowment effect to employees, they may be less inclined to Save More Tomorrow.”

Gerd Gigerenzer, one of the most forceful proponents of this line of reasoning, argues that educating people about their biases will help them make the correct choices themselves rather than nudging them toward their supposed choice by a choice architect. Central to his argument is the idea that people are more educable than suggested by Tversky and Kahneman (Gigerenzer, 2015, p. 379) and that cognitive biases are flaws that can be addressed through education.

Proponents of this line of reasoning often contrast nudging with boosting (e.g., Hertwig & Grüne-Yanoff, 2017). “The objective of boosts is to foster people’s competence to make their own choices” (Hertwig & Grüne-Yanoff, 2017, p. 973). In the boosting approach, these decision competences are fostered by changing “skills, knowledge, decision tools, or [the] external environment” (Hertwig & Grüne-Yanoff, 2017, p. 974).

In practice, however, some boosts look a lot like nudges. For instance, Gigerenzer suggests displaying frequencies in absolute terms (1 in 100) rather than in relative terms (1%) to aid interpretability (Gigerenzer et al., 2007). While the motivation may differ for a boost, such an intervention could very well be labeled a nudge. As a result, the question of whether the line between education and nudging is as sharp as is suggested by these critiques has been a subject of debate. Sunstein’s nudging definition does not require the involvement of cognitive biases, and he believes that many education interventions are actually nudging as well (Sunstein, 2015, p. 520). Others have also found that nudges and boosts overlap at least partly (Hertwig & Grüne-Yanoff, 2017, p. 977).

Proponents of nudging also point to the lack of “opposition between education and nudges” (Sunstein, 2015, p. 520). They do not argue that nudging is an alternative to education but rather view it as a complement. Even when people are perfectly educated, their decisions are influenced by choice architecture. For example, a well-educated consumer may still be influenced by the sequence in which products are displayed at a supermarket, and this sequence might nudge her away from the choices made on the basis of her education. Thus, there might be a need for educating people as well as designing the choice architecture in an appropriate manner.

As a second counterargument, Sunstein raises the question of whether education is always effective in addressing cognitive biases in all settings: “There are serious empirical questions about the value and efficacy of education in some settings that have concerned behavioral scientists” (Sunstein, 2015). The question of whether biases can be addressed through education is largely an empirical question,

and answers seem to vary by domain and bias. Early research indicated that debiasing is rarely successful (Fischhoff, 1982), but some examples of successful debiasing interventions have emerged since (Morewedge et al., 2015; Nisbett et al., 1987).

3.3.3 Argument 3: Nudges Requires Benevolent Choice Architects

A third objection to nudging has been that it requires the choice architect to “know what is best for others” (Gigerenzer, 2015, p. 376). Gigerenzer questions whether the choice architect can be free of the biases that he or she is seeking to mitigate and whether choice architects always have the best interest of the nudgee at heart. For instance, online retailers may display social norms (“Others like you have bought ...”) to meet their own ends rather than the customers’ ends. Others have also questioned how choice architects arrive at the standard for rational choices and “true” preferences of individuals that underpin the cognitive biases and nudging literature (Whitman & Rizzo, 2015).

A second line of argument has pointed to the heterogeneity of people’s goals as problematic. Not all people may share the same idea of what constitutes a good decision and, thus, nudges may nudge some people in a direction they would not desire even if the direction of the nudge is desirable to the majority (Barton & Grüne-Yanoff, 2015, p. 346; Nagatsu, 2015, p. 485).

In rebutting this argument, Sunstein does not dispute that choice architects, like any policymakers, may be malevolent (Sunstein, 2015, p. 521). Rather, he points to the avoidability of nudges as a backstop to the costs they impose. If nudges are avoidable, people nudged away from their preferences can ignore the nudge and decide to go in the direction they wish. In this respect, Sunstein argues, nudges are much better than more coercive forms of regulation that do not allow people to go their own way.

Thaler and Sunstein (2008, p. 9) also argue that many decisions can be improved by leveraging the expertise of others. They provide the example of a novice chess player who could play much better by incorporating helpful hints from an experienced professional player. They propose that, in many situations, people are novices and could benefit from such nudges. In short, they argue that a large supply of contexts exists where it is easy to discern the true preferences of people and help them to achieve them more fully.

Third, Thaler and Sunstein argue that nudges should “make the choosers better off, as judged by themselves” (R. Thaler & Sunstein, 2008, p. 5). They support this argument by providing multiple surveys of the judgments of people regarding certain nudges that reveal support for a wide range of nudges (e.g., Hagman, Andersson, Västfjäll, & Tinghög, 2015; Reisch, Sunstein, & Gwozdz, 2017).

Last, one may question whether this is really an argument specific to nudging. Any rule-making process, be it for nudging or other forms of regulation, will have to make judgments on what types of decisions are desirable to an individual or to society at large. If one does not want to object to public rule-making *per se*, it seems unclear why this criticism should be applied to nudging and not others.

3.3.4 Argument 4: Nudges Are Not Effective Enough

A fourth argument has been that nudges are not effective enough. This argument comes in two variants.

First, it has frequently been stated that nudges do not have long-term effects on the choosers (e.g., Bovens, 2009). “Once [the] intervention is removed, [the] behavior reverts to preintervention state” (Hertwig & Grüne-Yanoff, 2017, p. 974). For instance, a nudge to switch off the light when leaving the room may simply influence behavior in the single room where the nudge message is placed. Thus, in some respect, this argument is similar to the proposition that one should set out to correct the underlying biases through education, as outlined in Subchapter 3.3.2.

Second, it has been argued that nudges are not powerful enough to tackle many of the large problems at hand (Ekardt, 2017; Marteau et al., 2011). For instance, Marteau et al. (2011) argue that “nudging towards healthier behaviour may struggle to make much impression on the scale and distribution of behaviour change needed to improve population health.” Ekardt (2017) states that nudges by themselves are insufficient to address the massive behavioral change required to solve the climate crisis.

An extension of this line of reasoning might be that nudges may serve as a metaphorical fig leaf to pretend that one is doing something rather than actually addressing the problem. For example, companies may claim that they are nudging customers into a desired direction as an argument to escape further regulation.

Even while these arguments highlight the potential limitations and pitfalls of nudging, one can still ask whether these are valid arguments against employing this tactic. A nudge may be effective only in the situation in which it is employed and it may solve only a part of a bigger problem, but it may still make an important and distinct contribution that is not addressed by other solutions. Even when other measures, such as education or regulation, are implemented, it seems that choice architecture will continue to exert major influence. The underlying research on biases and heuristics by Tversky and Kahneman suggests that decision-making biases are quite pervasive and influence many decisions and decision contexts.

Again, whether nudges are effective is then largely an empirical question. Their effectiveness is often carefully evaluated with robust experimental designs and quantitative measurements, and the evidence is publicly available (e.g., Bundesregierung, 2020; The Behaviour Insights Team, 2018). These suggest that many nudges have frequently been quite effective in changing behavior and making a distinct contribution.

3.3.5 Balancing the Arguments

The four outlined ethical arguments against nudging highlight several categories that should be considered in evaluating the ethics of nudging: Autonomy, transparency, harm, potential alternatives, and welfare all play a role in evaluating the ethics of nudging.

However, before synthesizing the counterarguments, let us reconsider the original nudging proposition: to “make major improvements to the lives of [people] by designing user-friendly environments” (R. Thaler & Sunstein, 2008, p. 11), to make them “better off, as judged by themselves” (R. Thaler & Sunstein, 2008, p. 5), and to address the cognitive flaws that bias many of our decisions. The benefit of nudging is that it places the many triggers and causes of human behavior into the limelight and builds environments that consider these factors to serve people’s own individual or collective goals.

Overall, none of the arguments outlined above appears strong enough to provide a reason to generally refrain from nudging. Sunstein (2014, p. 1) writes, “It is reasonable to object to particular nudges, but not to nudging in general.” Existing policies balance autonomy, welfare, and harm and do not set any of them as absolute categories; the same approach might be suitable to nudging. In general, people accept that general regulations lead to some reductions in autonomy. For example, people agree not to walk on the Autobahn so as to avoid death, even though this is a limit on their autonomy. Similar arguments can be made for education as an alternative regulatory approach or for the question of whether the regulator always knows better. It seems more sensible to consider the categories outlined above as costs and benefits of a regulation that should be examined. In this spirit, the objections outlined above are not so much wrong as they overestimate their own weight. Along these lines, Hausman and Welch (2010) observe:

The justification for [nudging], like the justification of openly coercive policies, rests on a comparison of benefits to the loss of autonomy, not, as Thaler and Sunstein suggest, on the view that nudges are costless. (Hausman & Welch, 2010)

To balance these costs and benefits, “Each case will need to be assessed on its own merits” (Bovens, 2009). In this assessment, several questions should be addressed: Does the nudge improve welfare for the nudgee or for society at large? Is the nudge detectable and avoidable for the nudgee? Would

education or other measures be a better alternative to a nudging approach? Is the nudge effective? Balancing these questions will require ethical arguments that substantiate the weight assigned to the costs and benefits. Deontological and consequentialist ethics, introduced at the start of this chapter, provide such ethical arguments varying in focus and weight and assigned to intentions and consequences. The long-standing arguments between deontological and utilitarian ethics cannot be resolved in this dissertation. Therefore, depending on the ethical school of thought, the answers on the legitimacy of certain nudges will differ. Such an approach seems like a reasonable compromise, given that a general rejection of nudging would benefit the status quo and those who already employ nudging toward their individual rather than societal ends.

With respect to the general legitimacy of nudging in the context of this dissertation, one can conclude that the sustainability crisis of the global food system (as outlined in Chapter 2) provides a legitimate and weighty end for the nudges that this dissertation aims to test. One must, however, evaluate nudges on a case-by-case basis to test whether their specific benefits outweigh their costs.

3.4 Nudging Techniques

A defining characteristic of nudges is their ability to alter behavior. To this end, most nudges rely on a set of techniques briefly presented in this subchapter. While a definitive and exhaustive list does not exist, and new nudges emerge regularly, a set of frequently employed nudging techniques has solidified over the past decade:

Defaults: Defaults prescribe what happens if no active choice is made. Defaults have been effective in nudging organ donorship (Johnson & Goldstein, 2003). In the environmental domain, defaulting people to green electricity tariffs significantly increases the share of people who choose green tariffs (Pichert & Katsikopoulos, 2008). Setting the printing default to double-sided instead of single-sided decreases paper use by 15% (Egebark & Ekström, 2016).

Physical changes to the environment: Physical changes to the environment take a wide variety of forms. Cafeteria interventions aiming to nudge people toward more healthy food have demonstrated that factors such as plate size, display order, or vertical position of the food have an effect on behavior (Thorndike et al., 2014; Velema et al., 2017; Wansink & van Ittersum, 2013). The marketing literature reports that several other factors, such as lighting, wall color, scents, or background music can influence consumer choice (e.g., Gröppel-Klein, 2012). Clues orienting consumers within an environment, such as arrows painted on the floor, can also guide consumer choice (Payne et al., 2016). In fact, physical changes in the environment can take such a variety of forms that reporting them as one group may hide important underlying variations. The same applies to the term “contextual

factors,” which subsumes the effects of the physical environment in much of the psychological literature. Thus, where helpful, this dissertation divides this category into the following additional subcategories: sorting, vertical position, orientation, floorplan layout, shelf space, music, smell, and color. Even these subcategories contain heterogeneous interventions. For example, sorting interventions can, by themselves, be quite diverse. In some instances, products are sorted by brand; in other cases, they are sorted by ingredients; and in yet other cases, products are sorted by how sustainable they are.

Social Norms: Perceptions of how other people choose in a certain situation or how they view a choice situation are called social norms. These social norm perceptions can have a significant impact on choice, even though few people are consciously aware of this influence. For example, hotel towels are reused more often when a message communicates that other people frequently reuse their towels than when a plain call is issued for reusing towels (Goldstein et al., 2008). In public parks, people litter more often if they observe others doing so as well (Reno et al., 1993). Communicating social norms (e.g., you are using 15% less electricity than your neighbors) on electricity bills has been effective in decreasing electricity use (Allcott, 2011).

Feedback: Sometimes people are not fully aware of the choices they make or the consequences these choices have. Highlighting the choice or its consequences can change how people behave. For example, offering individuals feedback about their energy consumption via a letter was demonstrated to decrease electricity use as early as 1981 (Hayes & Cone, 1981). Feedback and social norm messages are often combined to increase effectiveness, and their individual contributions toward supporting an outcome are sometimes not reported.

Reminders or prompts: Prompts or reminders can be helpful when people do not take a course of action because they have forgotten about it. Text-message reminders to complete a course of vaccinations increase vaccination rates (Matheson et al., 2014). In the environmental domain, reminders can also be effective. Putting a sign next to the light switch prompting people to turn off the light when they leave the room decreases electricity use (Sussman & Gifford, 2012). Prompts can also take the form of warnings.

Commitments: Written commitment or verbal commitment to perform an action increases the likelihood of performing that action. Committing to take environmentally friendly modes of transportation increases the likelihood of actually doing so (Matthies et al., 2006).

Goal-setting: Goal-setting involves giving individuals or groups a goal. Goals can be defined by the designer of the nudge or the nudged individuals themselves. Goals are sometimes combined with feedback, which increases the effectiveness of both (McCalley & Midden, 2002).

Competition: Competitions between groups or individuals may increase environmental performance, though the evidence is not conclusive (Klößner, 2015, pp. 168–169). Sometimes, competition is conceptualized as comparative feedback (Abrahamse et al., 2005, pp. 279–280).

Providing information: Providing information about an environmental problem allows people to increase their knowledge and incorporate this information in their decision-making. Even though this category is frequently used in the environmental psychology literature, its boundaries seem vague. For example, a mass media campaign about the carbon footprint of flying could be distributed with the aim of reducing airline flights. But while such a message could be categorized as providing information, it could also be viewed as a prompt or reminder. It could even involve social norm information on how others react in this situation and thus be assigned to a third category. Furthermore, it is not obvious that every information provision should be considered a nudge under the definition used in this dissertation. While it is difficult, perhaps even impossible, to design a message that does not evoke any cognitive biases, it is less clear that all information provisions are designed with the intention to influence behavior in a certain direction. In cases where the intention is lacking, the provision of information would not be considered a nudge under the definition used in this dissertation. Despite these conceptual problems, this category is retained in the remainder of this chapter to present the results of reviews that used information provision as a category.

An alert reader will notice that the listed techniques are not entirely mutually exclusive. Communicating social norm messages without providing information is not possible. Competition without feedback on performance or communicating the performance of others (social norms) is also difficult to conceive. Similar arguments apply to the other categories. These ambiguities are a challenge when reviewing the overall effectiveness of certain techniques or even when attributing certain effects to a particular component of the intervention.

In exploring various nudging definitions and techniques, several characteristics of nudging techniques have emerged that are briefly presented here. Many other characteristics exist, and only a selection is presented here.

Intentionality: Intentional nudges are interventions by a choice architect that aim to move behavior in a pre-specified direction. An intentional nudge would be to present fruit at eye level in a cafeteria to encourage more fruit purchases. Non-intentional nudges are aspects of the choice architecture that

influence behavior without a person intending to do so. For instance, sunshine may increase the likelihood that people purchase ice cream. In many situations, it is difficult to determine whether a design decision was made intending to influence behavior or if it happened randomly. It may be impossible to determine whether the color of a wall was chosen for its intended effect on behavior without interrogating the person who made the decision. For potential regulation of nudges, the question of whether one can identify the intention to nudge is crucial. If, hypothetically, all nudges, whether intentional or not, had to be labeled, this could result in an infinite number of labels, probably defeating the purpose of such regulation.

Beneficiary: A nudge must not necessarily be intended to increase the welfare of the nudged person (Hausman & Welch, 2010, p. 125). Pro-social nudges aim to increase social welfare overall while pro-self nudges aim to increase private welfare (Hagman et al., 2015). A third category benefiting neither the individual nor society is easily conceivable, for instance, when corporations advance their own interests through nudging techniques. The definition used in this thesis would not consider such interventions nudging if they do not increase the well-being of the individual or society. Surveys indicate that pro-self nudges are more acceptable to many than pro-social nudges (Hagman et al., 2015).

Use of Heuristics: Nudges have also been distinguished based on whether they enlist heuristics to influence behavior. Barton and Grüne-Yanoff (2015) differentiate nudges into three categories: heuristics-triggering, heuristics-blocking, and informing. Sunstein (2014, p. 511) seems to agree with this view by differentiating nudges to those that enlist and those that combat biases while also adding a third category that does neither. The definition used in this thesis would only consider nudges that enlist or combat biases as nudges (see 3.2.5).

System 1 and System 2: Nudging techniques generally fall into two categories depending on the mode of mental processing. System 1 nudges do not require the chooser to pay active attention and reflect on the nudge to be effective (Hansen & Jespersen, 2013, pp. 14–15). For example, a system 1 nudge can leverage habits to become effective. System 2 nudges do require reflective thinking to be effective. Sometimes the categorization of a technique depends on its implementation. While a descriptive social norm (i.e., a person not littering) does not require reflective thinking, a written message communicating a social norm does. Feedback is another case where a written feedback message requires reflection while forms of haptic, visual, or audio feedback are imaginable that do not.

System 1 – Automatic System	System 2 – Reflective System
Defaults	Goal-Setting
Physical Changes	Competition
Prompts & Reminders	
Social Norms	
Feedback	
	Information Provision

Table 3: System 1 and system 2 nudges

While the term “nudging” is new, many of the underlying concepts are not, as the previous examples illustrate. The main contribution of nudging is not the novelty of the underlying mechanisms but that many of the decision-making deficiencies described in the cognitive sciences can be utilized for public policy goals such as sustainable consumption.

3.5 Nudging Sustainable Behavior

A variety of domains for sustainable behavior have been proposed in different publications. Stern (2000) suggested using environmental activism, nonactivist behaviors in the public sphere, private-sphere environmentalism, and other environmentally significant behaviors. Byerly, Balmford, Ferraro et al. (2018) propose family planning, land management, meat consumption, transport choices, waste production, and water use as domains while reviewing the pro-environmental nudging literature. Lehner, Mont, and Heiskanen (2016) propose energy, food, mobility, and waste as domains in their nudging review.

The domains proposed by Lehner et al. (2016), as with many of their variations in other reviews, are neither exhaustive nor mutually exclusive. Electric cars could plausibly fall under both the mobility and the energy literature. Citizen behavior, a fifth category that is sometimes included, cuts across all categories. These domains also do not consider that the decision environments may be quite similar across domains. Sustainable purchasing in a store, be it for food or for clothing, may be more similar than these distinctions suggest. The same could be argued for sustainability-related decisions made on websites. Therefore, this dissertation proceeds with caution in using the above categories while keeping in mind the outlined deficiencies.

The preceding subchapters have provided some evidence of nudges that predictably alter behavior. However, are nudges overall effective in aiding sustainable behavior? Several publications have summarized the effectiveness of nudging interventions for sustainable behavior, generally with positive results (Byerly et al., 2018; Lehner et al., 2016; Thorun et al., 2016; Umpfenbach, 2014). The

overall effectiveness, however, gives way to a more nuanced picture when specific behavior types and nudging techniques are distinguished.

The following table summarizes the results of three publications that have evaluated the effectiveness of nudging across nudging techniques and behavior domains (Byerly et al., 2018, p. 7; Klöckner, 2015, p. 177; Lehner et al., 2016, pp. 169–171). These publications aggregate more than 200 experimental interventions and attempt to gauge the effectiveness of various nudging techniques across four behavioral domains: energy, food, mobility, and waste. The three sources vary in the definitions and methodologies they employ to reach these results. For example, Byerly et al. (2018) define sustainable behavior based on the impact of a behavior, even if it was not intended to be sustainable, while the other two take an intent-based perspective. They also vary in the level of detail of the assessment. Klöckner (2015) provides rather rough estimates for the overall effectiveness of techniques while Byerly et al. (2018) evaluate 160 interventions in significant detail. Despite these differences, the following table cautiously seeks to aggregate these three sources into one high-level perspective.

	Energy	Food	Mobility	Waste
Defaults	+ (Lehner)	(Byerly*) ? (Lehner)	- (Byerly) + (Lehner)	+ (Byerly)
Physical Changes	~ (Lehner)	+ (Lehner)	+ (Lehner)	
Social Norms	~/+ (Lehner)	+ (Lehner)	- (Byerly) ~ (Lehner)	~ (Byerly)
Reminders & Prompts	~ (Klöckner)			
Commitments		+ (Byerly*)	~ (Byerly)	+ (Byerly)
Goal-Setting	~ (Klöckner)			
Competition	- (Klöckner)			
Information Provision		~ (Byerly*)	~ (Byerly)	+ (Byerly)

*Table 4: Effectiveness of sustainable nudging interventions (adapted from Byerly et al., 2018, p. 7; Klöckner, 2015, p. 177; Lehner et al., 2016, pp. 169–171) Legend: - Studies show no effect, ~ Mixed effectiveness, + Effective, ? evidence missing, * The Byerly et al. category is named meat consumption*

Table 4 illustrates the diversity of results for various techniques and domains. Nudging can contribute in some domain-technique pairings (for instance, defaults for waste) but not for others (for instance, social norms for mobility). The table also highlights diverging assessments of various authors for

different fields. For example, Byerly et al. (2018) view defaults as an effective way of nudging mobility behavior toward sustainability, while Lehner, Mont & Heiskanen (2016) arrive at a different result. The results likely differ because the effectiveness of nudging depends on more attributes than the behavior domain targeted and the utilized nudging technique. For example, whether a nudge targets automotive driving efficiency, driving reductions, the use of public transport, or the construction of new public infrastructure can have significant implications for its effectiveness.

3.6 Nudging Sustainable Purchasing in Supermarkets

A successful sustainability transformation of the global food system must consider the rapidly growing share of food consumption decisions made in supermarkets. However, only a small share of research has focused on nudging the sustainability of these consumption decisions.

Nevertheless, the same events that kicked off the overall sustainable development agenda also increasingly shine a spotlight on sustainable consumption as an essential element of sustainable development. The 1994 Rio Earth Conference and the 1994 Oslo Symposium on sustainable consumption (Jackson, 2004, p. 1029) were the starting points of a process that led to sustainable consumption being included as the 12th of the United Nations' 17 sustainable development goals (United Nations, 2016). Important scientific contributions along the way have underlined the importance of sustainable consumption for planetary ecosystems (Geiger et al., 2018; Rockström et al., 2009; Thøgersen, 2014).

Sustainable purchasing, the object of this dissertation, is a subfield of the wider field of sustainable consumption. Sustainable purchasing narrowly focuses on the purchase decision, thereby omitting the usage and disposal phases that are part of the wider definition of sustainable consumption (Geiger et al., 2018).

An increasing share of global food purchase decisions takes place in supermarkets, a setting that lends itself to nudging. Supermarkets form decision environments where consumers rely heavily on system 1 thinking. When shopping, consumers must make hundreds of decisions under incomplete information within a limited amount of time. Up to two-thirds of these purchases are not pre-planned and are bought spontaneously based on quick, rule-of-thumb decision-making (Inman et al., 2009, p. 23).

These dynamics give the supermarket decision environment considerable influence over consumer decisions. The placement of frequently bought products at the back of the market nudges consumers to notice other products while they walk to the back. Background music can increase the likelihood to purchase more expensive products (Areni & Kim, 1993). Additionally, scents in the air can increase a

store's revenue (Zentes et al., 2012, p. 643). Lighting and colors emphasize certain products over others and make them more noticeable. Placement at eye level also makes products more noticeable. Sorting by brand rather than by product characteristics highlights brands as an important decision criterion in making purchase decisions. Point-of-sale signs can increase purchases of healthy products (Thapa et al., 2014). In summary, supermarkets have long known about the power of decision environments and have nudged consumers toward buying more products that are profitable for the supermarket.

Since an in-depth review of all sustainable food purchase nudges is beyond the scope of this dissertation, four promising nudges from sources in environmental psychology, behavioral economics, and marketing are selected for a detailed literature review in the next chapter: Social Norm Messages, Feedback, Eye-Level Position, Sorting.

4 Literature Review for Selected Nudging Techniques

Since nudges existed before the term nudging was coined, a significant amount of literature exists for many techniques. Social norm, feedback, and placement interventions have all been demonstrated to be effective in some settings. Nevertheless, how applicable and transferable are these findings to organic food purchasing? What promise do these nudging techniques hold for the sustainability transformation of the global food system? What areas have not yet been sufficiently researched? These are the questions this chapter seeks to address by reviewing diverse bodies of research in literature addressing the fields of economics, marketing, and psychology.

To build on this prior work, one must delve into the specifics. Nudges are manipulations of the decision environment and, as such, they are dependent on the specifics of the decision-making context. A nudge that is effective for an easy behavior, such as reusing a towel in a hotel, may not work for a challenging behavior, such as eliminating air travel. A nudge that relies on a message being read may work better if little competing information or other cognitive loads exist in the decision environment. A nudge that is effective in making people choose something of personal benefit, such as a healthy product, may not work for a product without a personal benefit.

A few reviews synthesize prior findings considering the effectiveness of the chosen nudging techniques, but none addresses the specific focus on sustainability at the point of sale or the particulars of the decision-environment in which a nudge was employed. On the more specific end, Biel and Thøgersen (2007) study the impact of social norms on pro-environmental behavior, and Kluger and DeNisi (1996) study the impact of feedback on behavior generally. Steg and Vlek (2009) provide a broad overview of behavioral interventions targeting pro-environmental behavior that consider feedback, social norms, and structural changes, among other techniques. Abrahamse, Steg, Vlek, and Rothengatter (2005) review interventions targeting energy conservation and consider feedback and social modeling. These reviews, however, rarely consider the specifics that may be quite important in distinguishing nudges and in designing appropriate nudging techniques for sustainable food consumption. Therefore, the need for a review focusing on sustainable food purchasing is clear.

To highlight this specificity of previous nudging experiments and to identify gaps in prior research, this chapter provides a narrative review of research on social norm messages, feedback, and placement. Where available, this review focuses on pro-environmental purchasing; where it is not available, the wider literature on pro-environmental behavior overall is consulted. For some parts, evidence from

related fields, such as attempts to nudge consumers toward healthy food purchases or toward any purchases, is included when research on pro-environmental behavior has not been carried out. This varying depth of prior research, the need to consult varying fields with different terminologies, and the focus on specific circumstances rather than generalizations frustrated attempts to place this review in the form of a systematic review. Instead, a narrative review was chosen as a more appropriate structure.

Generally, two types of quantitative studies can be distinguished in the literature: Correlational studies and intervention studies. Correlational studies mostly examine the influence from observing pre-existing structures in the data. However, as the name indicates, these studies can only indicate correlations and are potentially biased if important variables are omitted. Intervention studies seek to change decision environments either in the lab or in field experiments. If properly randomized, these can indicate causal effects rather than simply correlations. Since the focus of this dissertation is on identifying and testing interventions that can help solve the sustainability crisis of the global food system, rather than on theory development, the review draws on intervention studies where available.

This review is organized into three subchapters. The first focuses on social norm influence, the second studies feedback, and the third examines placement interventions.

4.1 Social Norms

Social norms are an often-underestimated factor with powerful influence on human decision-making. When asked why a certain decision was made, humans tend to find rational and often non-social reasons for their behavior, even if these reasons did not drive the behavior in the first place. Rarely are social norms—the behavior of others or whether others approve of a certain choice—mentioned as influential for a decision. Nonetheless, experimental evidence reveals that the perception of how others acted in a certain situation or whether others approve of a certain choice can be influential factors in decision-making.

For instance, a study by Nolan, Schultz, Cialdini, Goldstein, and Griskevicius (2008) asked participants what messages they would judge as particularly convincing to conserve energy. They then tested the three most convincing messages (save the environment, save money, social responsibility) as judged by the respondents in a second field experiment with other participants and added a social norm message as well. The social norm message was more effective than any of the other messages in nudging households to conserve energy. However, even after this outcome, the participating households rated the social norm message as the least influential among the tested messages. This

experiment serves as powerful evidence that people are often not aware of the factors driving their decisions.

4.1.1 Theory

Why are people influenced by social norms? People follow norms to avoid disapproval and to seek approval from others (Deutsch & Gerard, 1955, p. 630). Over time, this process can become internalized; conforming to norms leads to feelings of self-approval, while not conforming can lead to feelings of anxiety and guilt. Festinger's (1954) theory of social comparison processes views social influence as a result of a human drive to evaluate the appropriateness of decisions by comparing them with the decisions of others. Cialdini and Goldstein (2004) view social norm compliance as the result of basic human needs for self-perceived accuracy of beliefs, a longing for group affiliation, and the need to maintain a positive self-concept. Conforming to social norms can serve these goals. As the study by Nolan et al. (2008) demonstrated, these processes can be effective without the participants' conscious awareness of their influence.

Multiple theories seek to systematize the influence of social norms on behavior. The theory of planned behavior (TPB) is one of the most-cited and most-tested psychological theories seeking to explain behavior. It has long demonstrated the influence of social norms on forming intentions and performing behaviors. In the TPB, behavior is directly predicted by intentions and perceived control over behavior. For instance, whether a person consumes less energy is predicted by whether a person intends to consume less and whether a person feels in control of consuming less. Intentions and perceived control are, in turn, predicted by subjective norms (a form of social norms understood as the perceived expectation of important others), attitudes, and perceived control regarding the behavior. Building on the same example: Whether the person intends to consume less energy depends on whether the person believes that conserving energy is associated with positive outcomes, whether others approve of conserving energy, and whether the person feels in control of conserving less energy. These relationships are illustrated in Figure 8.

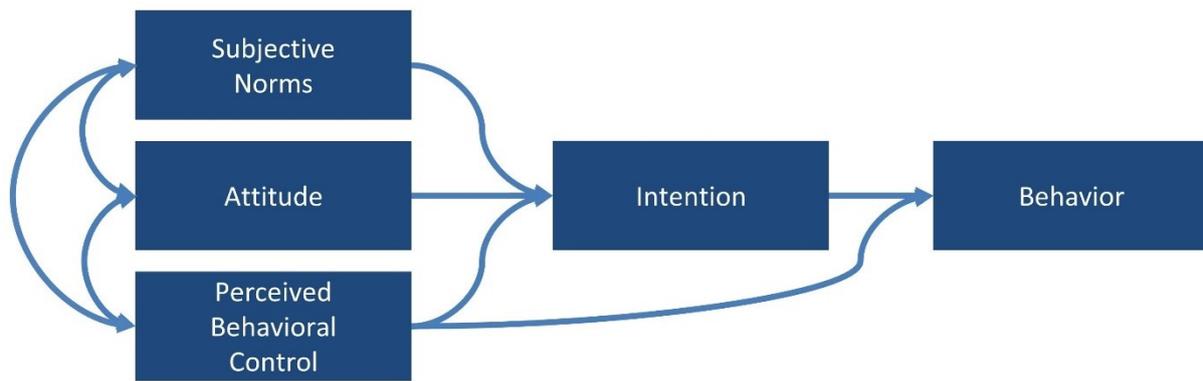


Figure 8: Theory of planned behavior (Ajzen, 1991)

In the original TPB, subjective norms were understood to describe what others approve of. Later, this view was widened to encompass what others do (Fishbein & Ajzen, 2010). Again, keeping with the previous example, this means that whether one perceives others as conserving energy is a significant predictor of the intention to conserve energy and, indirectly, the behavior to do so.

Many TPB studies follow a correlational design. In this design, the relation between the constructs is measured in a survey and tested in a structural equation model. These models do not prove that social norms cause specific behaviors. However, they do indicate that social norms are correlated with behavioral intentions and that they can explain additional variation in behavior when added to correlational models.

Social norms are a significant predictor of behavioral intentions in many TPB applications (Ajzen, 1991; Armitage & Conner, 2001). This indicates that social norms can explain some of the gap between attitudes and behavior that often becomes apparent in surveys on pro-environmental behavior. For example, a shopper may find it quite important to see everyone else in the supermarket buying organic groceries when deciding whether to buy organic herself.

Meta-reviews of TPB behavior studies suggest that about one-quarter to one-half of the variance in intentions can be explained by social norms and attitudes taken together (Ajzen, 1991; Armitage & Conner, 2001; Ravis & Sheeran, 2003; Sheeran & Orbell, 1999). Interestingly, these reviews also find that all of the TPB predictors taken together explain only 25% to 30% of variance in overall behavior (Kaiser et al., 2005). This finding serves as an important reminder that still only a small share of human decisions can be accounted for by models.

Several other theories seek to explain the influence of social norms on human behavior. The norm activation theory views pro-social and pro-environmental behavior as the result of a three-step process (Schwartz, 1977; Schwartz & Howard, 1982): First, awareness of the negative consequences of a behavior is gained; second, a feeling of responsibility for the negative consequences of the

behavior emerges; and, third, personal norms viewed as the perception of a moral obligation to perform the concerned behavior arise. Various conceptualizations of the norm activation model have been proposed. Here, the version as a mediator model, proposed by de Groot and Steg (2009), is presented in Figure 9.

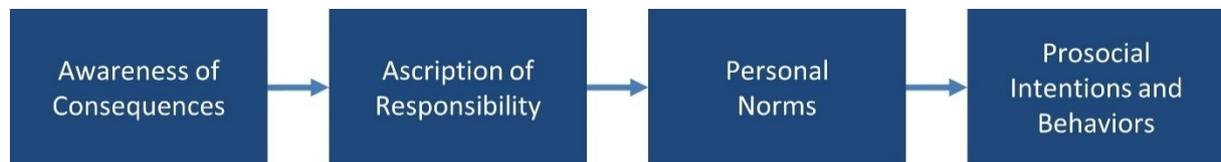


Figure 9: Norm activation model (De Groot & Steg, 2009; Schwartz, 1977; Schwartz & Howard, 1982)

The value belief norm (VBN) theory proposed by Stern (2000) is a derivative of norm activation theory tailored to pro-environmental behavior. In this theory, an ecological worldview leads to the awareness of the environmental consequences of behavior. This awareness of consequences leads to a perceived ability to reduce the threat (a construct quite like perceived behavioral control in the TPB) and a pro-environmental personal norm. This pro-environmental personal norm predicts pro-environmental behavior in the model. These relationships are illustrated in Figure 10.

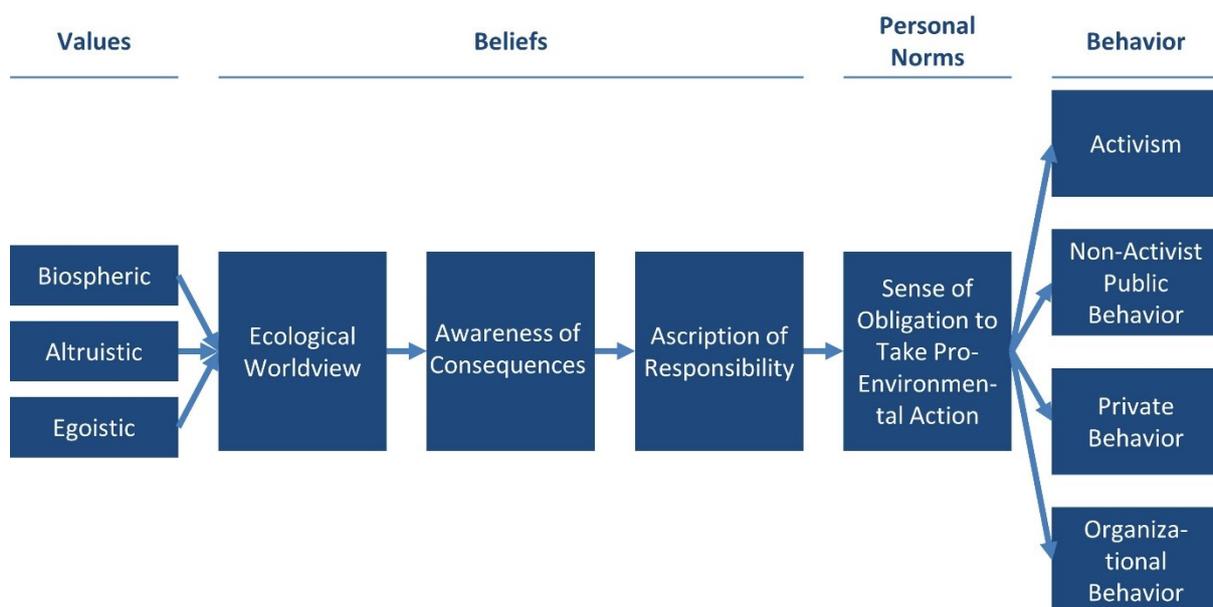


Figure 10: Value belief norm model (Stern, 2000, labels abbreviated)

Which of these models is the most adequate in predicting pro-environmental behavior? A comparison by Kaiser et al. (2005) contrasted the theory of planned behavior with the value belief norm model with survey data from 468 university students and found them to be similar in explanatory power. Both explain roughly 25% to 30% of behavior. Nonetheless, their analysis also indicated that the TPB captures the relationship between variables appropriately while the VBN does not. Thus, from an empirical standpoint, the TPB appears preferable.

Social norm influence has not just been indicated in correlational designs. Experimenters as early as Sherif (1936) and Asch (1951) have demonstrated that behavior can be influenced by manipulating social norms. The experiments by Sherif revealed that estimations of the movement of a light source depend on how others in the same room estimated the movement. Asch displayed four lines to experimental subjects and asked them to indicate which of the latter three was closest in length to the first. While on their own, 100% of subjects were able to identify the correct line. However, when they were placed in a group with confederates who selected a wrong line, a large minority of 32% also chose the wrong line. Interestingly, follow-up experiments revealed this effect to be stronger when task importance was higher (Baron et al., 1996).

The idea that social norms can be more influential when made salient is the central concept of the focus theory of normative conduct (Cialdini, Kallgren, & Reno, 1991; Cialdini, Reno, & Kallgren, 1990). Since multiple social norms can be relevant in many situations, the theory argues that the focal norm—that is, the norm that is most salient—will direct behavior. This idea was tested in experiments with confederates who made specific norms more salient. For instance, anti-littering norms become more salient when a person walking by stops to pick up litter, thereby inducing observers not to litter themselves (Kallgren et al., 2000).

At other times, researchers have manipulated norms not by hiring confederates but by communicating the norms in the form of written messages. For example, the message “90% of people purchase renewable energy” aims to influence behavior by communicating what is normally done or normally approved of by others. In an experiment, hotel guests were more likely to reuse their towels when presented with a social norm message (“the majority of guests reuse their towels”; Goldstein et al., 2008, p. 472) than when presented with a plain environmental message (“help save the environment”; p. 473).

With the rapid growth of the field of social norm research, an extensive taxonomy of various types of social norms has emerged. One of the most frequent distinctions is the one between descriptive norms and injunctive norms (e.g., Cialdini et al., 1990). Descriptive norms are perceptions about what others do or do not do in a certain situation (e.g., many buy organic milk). Injunctive norms are perceptions about what others approve of or disapprove of in that same situation (e.g., everybody approves of buying organic milk). Often, descriptive and injunctive norms are aligned, but when they are not, descriptive norms seem to be more powerful in influencing behavior (Bicchieri & Xiao, 2009). In their meta-review, Farrow et al. (2017, p. 10) also find especially consistent effects of descriptive norms.

Prescriptive norms and proscriptive norms are sometimes distinguished as well (Cialdini et al., 2006). Prescriptive norms describe what ought to be done in a certain choice setting (“keep the environment

clean”). Proscriptive norms describe what ought not to be done in that same setting (“do not pollute the environment”).

Another important distinction is the distinction between self-perceived and actual norms. For example, people believe many risky behaviors, such as binge drinking or unprotected sex, as much more prevalent (self-perceived descriptive norm) than they are in reality (actual descriptive norm). In these situations, highlighting the actual social norm via social norm messages can be effective in changing behavior (e.g., Neighbors, Larimer, & Lewis, 2004).

4.1.2 Influence on Pro-Environmental Behavior

Social norms have been demonstrated to be influential in a range of pro-environmental behaviors in domains including energy and water use, recycling, littering, and pesticide and fertilizer use. Even more arcane behaviors such as the reuse of towels in hotels or the stealing of petrified rocks from national parks have been analyzed. The breadth of the literature prevents attempts to present all findings from this body of research in the next subchapter, so only studies that attempted to influence social norms through an intervention are presented here. For further reviews, see Farrow et al. (2017), Abrahamse and Steg (2013), and Biel and Thøgersen (2007).

Perhaps because it is a field where the behavioral outcome is easily quantified, energy use and, specifically, electricity use have received a large share of research attention in the literature on social norms and pro-environmental behavior. In this field, social norm messages have been effective in triggering small but significant changes in household electricity consumption. Providing households with messages about their own energy consumption, the average consumption in the neighborhood, and injunctive social norm messages can decrease household energy consumption by about 2% (P. W. Schultz et al., 2007). However, providing only descriptive norm messages can produce a boomerang effect for those already exceeding the norm. In a condition without the injunctive norm, households that previously used less energy than their neighbors increased their consumption after receiving the descriptive norm message.

Allcott (2011) reports energy savings of 2% as a result of a social norm message intervention. Again, effects are quite heterogeneous depending on prior consumption. The 10% of households with the highest pre-treatment consumption reduced their energy consumption by 6.3%, while the 10% of households with the lowest pre-treatment consumption reduced their energy use by only 0.3%. In contrast to Schultz’s findings, no evidence is found of injunctive norm messages playing a role in stopping low users from increasing their usage. Costa and Kahn (2013) find an effect of similar size.

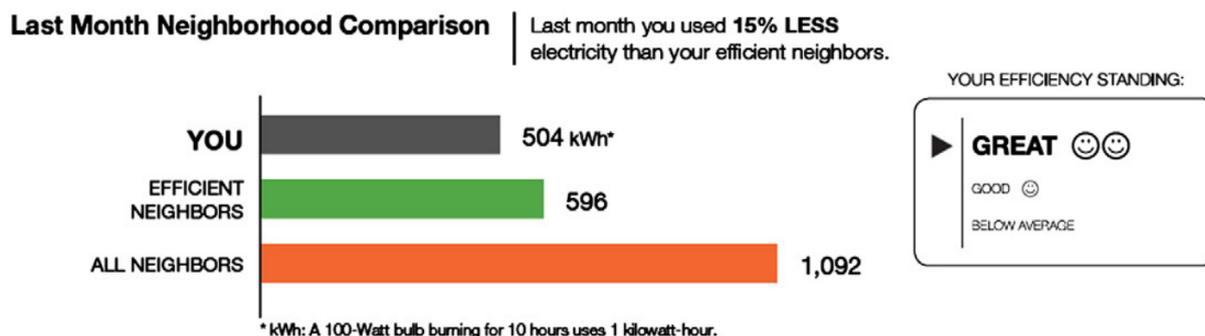


Figure 11: Energy report with social norm message (Allcott, 2011, fig. 1., used with permission)

Social norm messages are more effective in triggering household energy savings even if households believe that other information (e.g., about saving the environment) will be more effective in helping them. In an elegant experiment, Nolan, Schultz, Cialdini, Goldstein, & Griskevicius (2008) demonstrated that social norm messages were more effective in triggering energy savings than three messages that similar households had selected as the most influential.

Likewise, descriptive norm messages are effective in non-energy experiments as well, including one study in which they were found to persistently reduce water use (Ferraro et al., 2011). Effects from a single message mailed to households lasted two years, and messages were more effective and longer-lasting when they contained a social norm component. Recycling behavior can also be increased by placing descriptive social norm messages on doorhangers (P. W. Schultz, 1999). Social norm messages are again demonstrated to be more effective compared to an information plea only. While these effects are statistically significant and remarkable given the simplicity of the intervention, their effect sizes are still small. For instance, the descriptive norms increased participation in the recycling program from 42% in the baseline period to 46% in the intervention period. Burn and Oskamp (1986) and Burn (1991) also tested descriptive norm messages, though in combination with other elements, and found them to effective in increasing recycling behavior.



Figure 12: Plain towel reuse sign (Goldstein, Cialdini, and Griskevicius, 2008, fig. 1., used with permission)

Two studies examining social norm influence on the reuse of towels in hotels conducted by Goldstein, Cialdini, and Griskevicius (2008) as well as Schultz, Khazian, and Zaleski (2008) have spawned an entire body of literature about towel reuse. Descriptive norm messages (“the majority of guests reuse their towels”) are effective in increasing towel reuse compared to messages focused only on environmental protection (see Figure 12) (Goldstein et al., 2008). Even more effective are provincial norms; in other words, messages that reference the situational circumstances of the choosing individual (“the majority of guests in this room reuse their towels”). Communicating aligned descriptive and injunctive normative information increases the impact on behavior (W. P. Schultz et al., 2008). Others have attempted to replicate these findings but with varying success: A study by Reese, Loew, and Steffgen (2014) corroborated the effects while a study by Bohner and Schlüter (2014) did not find descriptive norms to be more effective than standard messages.

Descriptive and injunctive norm messages were also used in a study on the theft of petrified rocks from Arizona’s Petrified Forest National Park (R. Cialdini, 2003). In this setting, they hypothesized, communicating the descriptive norm (“Many past visitors have removed petrified wood from the Park, changing the natural state of the Petrified Forest”; Cialdini, 2003, p. 107) is potentially counterproductive since it focuses visitors on the frequency of stealing petrified wood. In contrast, an injunctive norm message (“Please don’t remove the petrified wood from the Park, in order to preserve the natural state of the Petrified Forest.”; Cialdini, 2003, p. 107) may fare better. As expected, an injunctive message was more effective in reducing theft than the descriptive message.

Survey research indicates the influence of social norms on many other environmentally relevant decisions. Thøgersen's 2006 study revealed several social norm constructs to explain behaviors such as composting kitchen waste, buying organic milk, using public transportation for shopping, or buying organic light bulbs. Travel mode choice (Blöbaum et al., 1998), public transport use (Bamberg et al., 2007), and electric car purchases (Bobeth & Matthies, 2018) are other pro-environmental behaviors demonstrated to have been influenced by social norms in survey studies.

4.1.3 Influence on Pro-Environmental Purchasing

Despite the wealth of social norm literature, surprisingly few studies have focused on pro-environmental purchasing in general and pro-environmental purchasing of organic food specifically.

A few correlational findings from survey studies are available. Ham, Jeger, and Ivković (2015) tested a variation of the theory of planned behavior in a survey study in Croatia that included both injunctive norms and descriptive norms as predictors of the intention to purchase green (i.e., environmentally friendly) food. They discovered both to be significant predictors of green food purchasing intentions. Han (2014) analyzed antecedents of consumer intentions to buy socially responsible apparel products, again with a modified theory of planned behavior. He found descriptive norms to be a significant predictor of both organic and fair-trade apparel purchase intentions. Interestingly, injunctive norms were only predictive of fair-trade but not of organic apparel purchase intentions. Al-Swidi, Huque, Hafeez, and Shariff (2014) studied the influence of subjective norms (which they conceptualized as a mix of injunctive and descriptive social norms) on organic food purchase intentions in Pakistan. They discovered subjective norms to have a strong influence on organic food purchasing intentions. Chen (2007) also found subjective norms to be a significant predictor of the intention to buy organic foods in a survey study in Taiwan. Another intention study by Vermeir and Verbeke (2008) analyzed the role of social norms on the intention to purchase sustainable dairy products in a theory of planned behavior setting. Again, they found positive effects of social norms on behavioral intentions. A survey study by Thøgersen (2009) suggests that subjective social norms may influence behavior through being internalized as personal norms (understood as a personal feeling of obligation) for organic food purchasing.

These survey studies are powerful evidence that social norms and purchase intentions for environmentally friendly products are correlated. The studies do not, however, measure actual purchases or even self-reported purchases but rather simply look at the intention to purchase as a predictor of behavior. Moreover, additional experimental studies are needed that demonstrate that it is indeed possible to manipulate green purchases using social norms.

A study on the behavioral antecedents of organic milk purchases conducted by Klöckner and Ohms (2009) is notable, because it used covert observation to quantify actual organic milk purchases rather than self-reported intentions or behaviors. The authors also discovered that social norms predicted organic milk purchasing behavior. Additionally, they found the explained variance of their model to be lower for actual behavior compared to self-reported behavior. This research highlights the need for studies that examine actual rather than self-reported behavior.

A few such intervention studies are available. A notable study communicated sustainability feedback and injunctive social norms through a device attached to supermarket carts (Kalnikaite et al., 2011; Kalnikaitė et al., 2013). This device scanned the barcodes of products and transmitted information about the sustainability of a product through a set of light-emitting diodes (LEDs). While this intervention probably should be classified as a feedback intervention, it did contain an injunctive norm element. Depending on the sustainability of the food in the shopping cart, a happy, neutral, or sad emoticon was displayed on the device. The quantitative analysis provided by the publications, however, does not allow for drawing conclusions on their effectiveness.



Figure 13: Social norm as part of multiple messages (Payne et al., 2015, no permission required for use)

Payne et al. (2015) studied the impact of a social norm intervention on purchases of fruits and vegetables rather than pro-environmental purchasing. They found a descriptive social norm message on a grocery store carts to be effective in increasing produce purchases in four supermarkets by 8% to 12%. Their message, however, contained several other elements besides the social norm (see Figure 13). Thus, in the absence of a control group, by simply varying the social norm message the source of the effect cannot be identified.

Demarque et al. (2015) tested social norm influence in a simulated online grocery shop and found that social norm messages almost doubled the share of sustainable groceries purchased, from 24% to 44%. They also varied the descriptive social norm messages they communicated between a weak form (“9% of previous participants purchased one ecological product”) and a strong form (“70% purchased at least one ecological product”) and found the latter to be more influential.



Figure 14: Descriptive social norm placard (Richter, Klöckner, Thogersen, 2018, no permission required for use)

In spite of all this evidence for the power of social norms explaining and influencing purchasing behavior, Richter, Klöckner, and Thogersen (2018) found no influence of descriptive and injunctive norm placards they placed in supermarkets in Germany and Norway (see Figure 14). To the contrary, they discovered a boomerang effect, though a different type than the one Schultz et al. (2007) reported. In

their experiment, consumers reacted to the placard by purchasing more fish overall rather than increasing the share of sustainable fish purchased. They hypothesize that targeting the entire segment of sustainable grocery purchases could have avoided such a boomerang effect.

4.1.4 Determinants of Social Norm Influence

Many factors can increase or diminish the influence of social norms on behavior and thus change the impact of social norm interventions. Broadly, these factors can be grouped into four categories (though these are not entirely mutually exclusive): characteristics of the norm message, characteristics of the person, characteristics of the behavior, and characteristics of the situation.

The exact phrasing and design of social norm messages is quite important for their influence on behavior. According to Schultz (2014), interventions produce stronger effects when they come from a close reference group and when individuals are not already motivated to perform the target behavior. Payne et al. (2015, p. 288) argue that easy interpretation and the provision of behavioral benchmarks are important. Smith and Louis (2008) find the source of the norm to be important as well. In their study, out-group norms did not influence behavior, while in-group norms did. Believability of the social norm message is also an important criterion: If the message is not thought to be believable, it is unlikely to be processed (Melnik et al., 2011, p. 724). The size of the group communicating the social norm can also play a role. Research by Asch indicated that larger groups had more influence in a line length estimation task (Asch, 1956).

Additionally, personal characteristics of the target of a social norm message play a role. Perhaps unsurprisingly, social norm influence varies depending on the extent to which an individual is already conforming with the norm. Schultz et al. (2007) found evidence of the highest influence for households with the highest deviation from the norm. Subjects in their experiment tended to gravitate toward the norm both when they were above it and when they were below it. Accordingly, descriptive norm interventions can produce boomerang effects. When presented with a descriptive norm (e.g., your neighbors consume, on average, 3,000 kWh of electricity per month), customers already better than the norm may gravitate toward the norm and reduce their pro-environmental efforts. Combining descriptive and injunctive norm information can reduce this boomerang effect (P. W. Schultz et al., 2007). Moreover, the influence of social norms varies depending on the cognitive load of the subject. Melnik, Herpen, and Fischer (2011) found that high cognitive load can make both injunctive and descriptive norms less effective in influencing behavioral intention. They find descriptive norm messages to be more effective under low cognitive load. Costa and Kahn (2013) found energy conservation nudges to be much less effective for political conservatives than for liberals. Moreover, social influence can be stronger for individuals ambivalent about a behavioral topic. For example,

social norms are a much stronger predictor for energy savings behavior when subjects are not highly involved in the topic compared to when they are (Göckeritz et al., 2009). Lapinski and Rimal (2005) view bystander apathy (people failing to help someone in need of assistance) as another example of strong normative influence in ambiguous situations. In these situations, they argue, people observe other bystanders as not acting and therefore deduce that this is the correct path of action for themselves.

Behavior characteristics are another determinant for the influence of social norms. Biel and Thøgersen (2007, p. 105) argue that social norm interventions are less effective in cases where the pro-social behavior is costly. Norm influence can vary for public behavior domains compared to private domains. Lapinski and Rimal (2005) support this argument by citing the limited effectiveness of normative interventions for the private behavior of condom use relative to the public behavior of alcohol consumption.

Situation characteristics also affect social norm influence on behavior. When people observe one social norm to be broken, they are more likely themselves to violate not only the same norm but also other norms in the same setting. For example, the presence of graffiti on a wall caused people to litter twice as much as they did without the graffiti (Keizer et al., 2008). Along similar lines, the theft of an envelope visibly containing money more than doubled in a littered environment compared to a clean environment (Keizer et al., 2008). Sometimes, the specifics of a situation can lead to unexpected behavioral responses. For instance, focusing on specific categories in supermarkets can have an unintended effect (Richter et al., 2018). In their case, a descriptive norm intervention targeting sustainable fish consumption resulted in increased overall fish purchases without strongly affecting the share of sustainable fish purchased. Biel and Thøgersen (2007) argue that situation framing can have a significant effect on social norm effectiveness as well. They contend that a business framing of a situation leads to less influence of moral considerations (and therefore norms) than a private framing does.

In summary, it should become apparent that the effectiveness of norm intervention relies heavily on a set of factors that are often omitted when reporting their effectiveness.

In addition to these context factors, another challenge is frequently encountered when seeking to identify effective social norm messages. Previous interventions often combine many components to influence behavior. This makes it difficult to pinpoint the source of an aggregate effect. For example, Payne et al. (2015) combine a descriptive social norm, an injunctive norm in the form of an emoticon, pictures of the targeted produce items, and text listing the targeted items. The absence of a control group varying only the social norm message prevents a determination of whether the social norm

message caused the increased produce share they reported or whether some other component of their design triggered the change. Sometimes, social norm messages and behavior feedback are combined in interventions, which Abrahamse and Matthies (2013) coin comparative feedback (e.g., Allcott, 2011). Again, in the absence of appropriate control groups, no conclusions about the effectiveness of social norms *per se* can be drawn.

Summarizing the effectiveness of social norms in influencing behavior reviews find social norm approaches to be effective, though small in effect size (Abrahamse & Steg, 2013; Farrow et al., 2017). Despite the many findings on the influence of social norms for pro-environmental behavior, few have attempted to design social norm interventions for pro-environmental purchasing. To the author's best knowledge, not a single intervention study has analyzed the influence of social norms on organic food purchasing in supermarkets.

4.2 Feedback

Even in an age of human-induced global environmental destruction, the environmental consequences of everyday decisions can be obscure to the decider. Sometimes, awareness about the existence of the environmental consequences of a behavior is lacking. Other times, information about the quality and quantity of a decision's environmental impact is lacking. In some cases, however, people are not even aware of their own behavior.

Organic food purchasing may be one example of this phenomenon where consumers lack self-awareness. In a representative study of the German population, 29% of consumers claim to always or very frequently buy organic groceries, and 56% of consumers claim to buy organic groceries at least frequently (Scholl et al., 2017, pp. 12, 55). However, the German share of organic grocery purchases was only 4.8% in the same year (Bund Ökologische Lebensmittelwirtschaft, 2017, p. 21). Primarily, this casts doubt on the validity of self-reported data regarding organic food purchasing. Still, the size of the gap between self-perception and actual behavior also suggests that consumers are not aware of their own behavior.

Providing feedback to people about a behavior, its consequences, or the discrepancy between self-perception and actual decisions is a method that can create such awareness of one's own behavior and thereby alter it.

4.2.1 Theory

How does feedback influence behavior? Several psychological theories considering cognitive dissonance, goal-setting, motivation, and learning have proposed a variety of mechanisms.

In an early work on the subject, Festinger (1957) argued that feedback alters behavior by directing attention toward gaps between attitudes, self-perceived behavior, and actual behavior. These self-perceived inconsistencies—called cognitive dissonance—feel uncomfortable and cause individuals to act since they strive for consistency within themselves. For instance, becoming aware of the large gap between self-perceived organic purchases and actual organic purchases may lead an individual to purchase more organic products. However, adjusting behavior is not the only possible reaction to cognitive dissonance. In response to the feedback, one may also change the attitude or self-perception to decrease inconsistency. In the instance of the organic food purchaser, reducing one’s self-perception of organic purchases would also reduce cognitive dissonance (though this may conflict with other goals of the individual). Two further possibilities of dealing with cognitive dissonance exist. One may reject the feedback and disregard the information, or one may escape the situation altogether. Therefore, in summary, individuals have four options in reaction to the feedback-standard comparison. They can change their behavior to match the standard, change the standard to match the behavior, reject the feedback, or escape the situation (Kluger & DeNisi, 1996, p. 260).

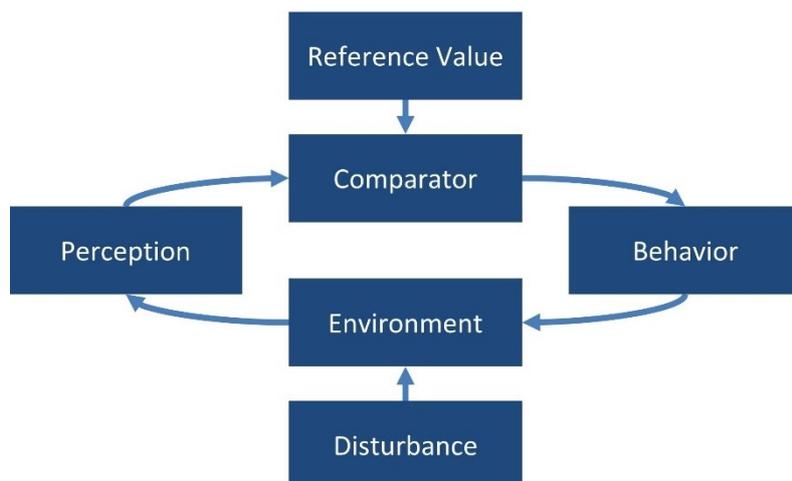


Figure 15: Feedback loop (labels abbreviated, Carver & Scheier, 1982)

Control theory proposes a feedback loop as the essential mechanism that turns feedback into behavior change (Carver & Scheier, 1982, p. 112). In this feedback loop, a perception is compared with an external reference value via a comparator. For example, the perception of being successful at conserving energy is compared with a report by the utility company indicating high energy consumption (reference value). If a discrepancy between the reference value and the perception is noticed, a behavior is performed to reduce the discrepancy. For instance, a person could purchase energy-efficient light bulbs to reduce the discrepancy. This behavior then impacts the environment, which is sometimes altered by other disturbances as well. This environment then forms the starting point for the next perception and so on. While it sheds some light on feedback, control theory has been criticized as too mechanistic and lacking a worthy explanation of where goals come from (Locke & Latham, 2002, p. 708). Goal-setting theory deals with these goals more explicitly.

Goal-setting theory views feedback as a central mechanism that reveals progress in the pursuit of goals (Locke & Latham, 1990, 2002, p. 708). If a person's goal is to purchase only organic products, but she does not know she is actually purchasing only 5% organic, then there is no way the person can discern whether she is actually on track to achieve the goal. Receiving this feedback that the target is not met usually leads to an increase of effort (Matsui et al., 1983). Additionally, combining goals with feedback is more effective than setting goals alone (e.g., Bandura & Cervone, 1983).

Feedback intervention theory builds on control theory and goal-setting theory, among others, to develop a more nuanced picture of why, how, and when feedback intervention can impact behavior (Kluger & DeNisi, 1996). The theory is made up of five building blocks (Kluger & DeNisi, 1996, p. 259).

- First, like control theory and cognitive dissonance theory, behavior is viewed as driven by a comparison between feedback and a goal or standard.
- Second, goals and standards are organized hierarchically in their model. For example, the goal of choosing organic milk in the supermarket aisle would be lower in the hierarchy than the goal of generally purchasing organic food, which itself would be outranked by the goal of living in an environmentally friendly manner.
- Third, Kluger and DeNisi view attention as limited. Therefore, only salient feedback-standard gaps can influence behavior.
- Fourth, they argue that attention is normally focused on a middle level of the goal hierarchy.
- Finally, the authors propose that feedback interventions change the locus of attention; that is, the interventions change where the attention is directed.

These five theses form a more complete account of how feedback can influence behavior, and Kluger and DeNisi test this theory in a meta-analysis of several hundred feedback interventions.

Surprisingly, their meta-analysis discovers feedback to often be counterproductive in reaching a desired behavior. More than one-third of feedback interventions were found to have negative rather than positive effects on behavior (Kluger & DeNisi, 1996). They argue that this is due to feedback interventions that shift the locus of attention away from the lower end of the goal hierarchy to the higher end. When feedback interventions are focused on task-learning, such as choosing an organic milk rather than drawing attention to task motivation or to meta-tasks such as questions on one's overarching self-related goals (e.g., do I really want to trade personal comfort with sustainable behavior?), they can be quite effective. They write that feedback "provided for a familiar task, containing cues that support learning, attracting attention to feedback-standard discrepancies at the task level [...], and is void of cues to the meta-task level [...] is likely to yield impressive gains in performance, possibly exceeding 1 [standard deviation]" (Kluger & DeNisi, 1996, p. 278). This theory provides the grounding for many of the since-conducted feedback interventions.

4.2.2 Influence on Pro-Environmental Behavior

A wide body of research has analyzed the effects of feedback on behavior, not only for pro-environmental behavior but also in the psychological literature at large. Feedback interventions have been reported as effective in changing behaviors ranging from heavy drinking among college students (Neighbors et al., 2004) to employee absenteeism (Gaudine & Saks, 2001) to handwashing (Fuller et al., 2012)—though these interventions often combine feedback with other measures, and not all interventions are effective (e.g., Lee, Neighbors, Kilmer, & Larimer, 2010).

In the pro-environmental behavior domain, feedback has also been studied extensively, with much of the research focusing on energy consumption and recycling.

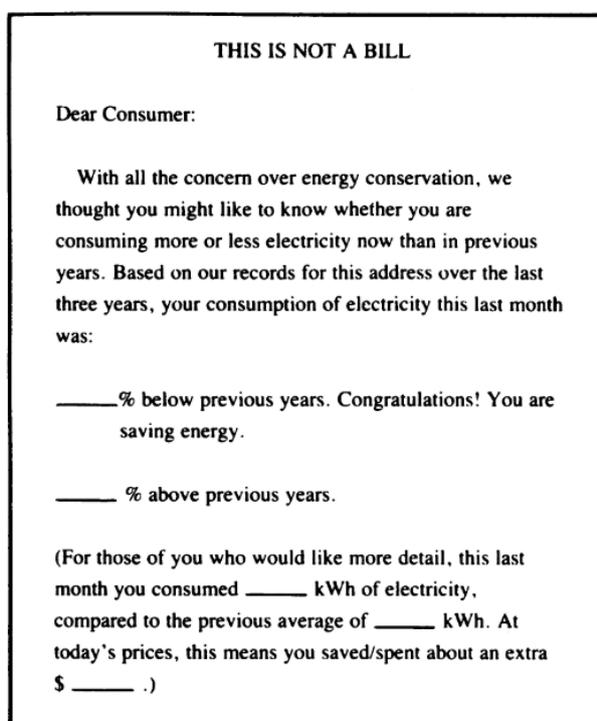


Figure 16: Feedback letter (Hayes and Cone, 1981, Fig. 1, used with permission)

Early work by Hayes and Cone (1981) found a monthly feedback letter (see Figure 16) to significantly reduce energy consumption by roughly 5% during the intervention period. The effects subsided, however, once the feedback period ended.

Midden, Meter, Weenig, & Zieverink (1983) found individual feedback forms as well as comparative feedback forms, coupled with financial incentives, to be effective in reducing energy consumption. The coupling with financial incentives, however, had only small additional effects over the individual feedback.

Interestingly, they also found evidence of a significant change in consumption in their control group. They hypothesize that the control households' knowledge that they were being monitored might have changed their behavior—a so-called Hawthorne effect.

Others have focused on technological means of providing feedback. Hutton, Mauser, Filiatrault, and Ahtola (1986) tested the effect of an energy cost indicator that displayed the daily accumulated cost of energy in two Canadian provinces and in California. However, they did not find significant behavior changes compared to an education-only intervention in all but one of their experimental conditions. Van Houwelingen and van Raaij coupled feedback with goal-setting (van Houwelingen & van Raaij, 1989) and also used an energy cost feedback device. In their daily feedback condition, households reduced natural gas use by 12.3%—more than the goal that was set externally at 10%—and these

effects persisted for more than one year. They also studied the role of feedback frequency for its effectiveness. Monthly feedback was significantly less effective than the daily feedback provided by the device.

Messages aiming to evoke cognitive dissonance by comparing behavioral feedback to attitudes have also been tested in an energy conservation setting (Kantola et al., 1984). In this experiment, a cognitive dissonance message that not only gave consumers feedback on their behavior but also highlighted inconsistencies between behavior and attitudes had a greater conservation effect than a feedback message lacking the cognitive dissonance component. Additionally, this experiment also provides evidence of the need for measuring actual rather than self-reported behavior. In their experiment, self-reported behavior did not differ between groups, but actual conservation behavior did.

In the recycling domain, similar feedback interventions have been tested. De Leon and Fuqua (1995) designed a group feedback intervention that increased paper recycling in a university apartment complex by 25%. With a combination of feedback and pre-commitment strategies, they were able to increase paper recycling by 40%. These large effects may be partly explained by the circumstances of the study. Recycling feedback was publicly communicated via the campus newspaper, and groups were able to see feedback for other groups (i.e., they were presented a descriptive social norm). Additionally, the results may also not generalize to a larger population since only about one-quarter of invited participants took part in the intervention, and it could plausibly be argued that only the most motivated households participated. Goldenhar and Connell (1991) designed another group feedback recycling intervention that used posters in student halls to educate students and provide feedback on recycling performance. They report feedback to increase self-reported recycling compared to education-only and control groups. Interestingly, feedback coupled with education had the same effect as feedback alone in their intervention, suggesting that knowledge was not a barrier to action in this domain.

Targeting curbside recycling, Schultz (1999) found individual and group feedback messages placed on doorhangers to be effective in increasing observed recycling (the group feedback condition used in this experiment may be better characterized as a descriptive norm intervention). He also found a differential effect of the feedback message depending on prior recycling rates. The tercile of households that recycled the least before the intervention increased their participation by 19 percentage points while households that recycled the most before the intervention actually decreased their participation by six percentage points.

Abrahamse, Steg, Vlek, and Rothengatter (2007) tested the effect of online individual and group feedback coupled with goal-setting on energy savings. While both intervention groups did reach their

goal of reducing self-reported energy use by 5%, they did not find these changes to be statistically significant due to large within-group variations in energy savings.

Siero, Bakker, Dekker, and Van den Burg (1996) tested two variations of a feedback intervention at a metallurgical company. In the first condition, they gave a unit information about energy conservation, set a goal, and provided individual feedback. In the second condition, a unit also received comparative feedback about the performance of the first unit. The comparative condition was more effective in conserving energy.

McCalley and Midden (2002) found a combination of goal-setting and a feedback device to be effective in reducing washing machine energy use by 21%, while neither technique was individually successful.

4.2.3 Influence on Pro-Environmental Purchasing

Despite the general abundance of feedback research, little is known about the role of feedback in pro-environmental purchase decisions. Feedback may be especially relevant for sustainable purchase decisions, since the effects of purchasing more organic products are not very salient to the consumer (Klößner, 2015, p. 167). For example, organic and other sustainable products are not very different in visual appearance, taste, or smell compared to their conventional counterparts. Thus, sustainable purchasing feedback may be needed to highlight the purchase choice to the consumer.

Only two publications studying feedback for in-store sustainable purchasing were encountered by the author despite an extensive literature search. Additionally, and surprisingly, no randomized feedback studies targeting pro-environmental purchase behavior have been published to the author's best knowledge.

Kalnikaite et al. (2011; 2013) tested a sustainability feedback device that attached to the shopping carts at a supermarket. Providing feedback on the length of transport and combining this information with an emoticon helped 18 purchasers buy goods with lower transport distances. Their design, however, does not allow for drawing quantitative conclusions regarding its effectiveness due to the lack of randomization and likely sequencing effects in the procedure they used.

Zapico, Katzeff, Bohné, and Milestad (2016) tested an organic food purchasing dashboard with employees of a Swedish supermarket. In their non-randomized five-month study, they found the organic food dashboard to increase the organic share in a treatment group of 65 supermarket employees. They found previous medium organic purchasers to increase their purchases the most. Additionally, they found that customers who overestimated their own organic purchases increased their organic share more than customers who did not. Since no measures of dispersion were reported, no conclusions about the statistical significance of these results can be drawn.

Feedback could also be operationalized with much less technologically advanced systems—e.g., by providing information about past purchases through signs at the point of sale, extra information on the purchase receipt, or stickers on the receipt. But to the author’s best knowledge, no such intervention results have been published.

In summary, feedback can be quite effective in influencing both general and pro-environmental behavior. To be effective, it must direct attention to the task level, be received immediately after the behavior, be frequent, and be tailored to the individual. However, little is known about the potential of feedback to boost pro-environmental purchasing. Large feedback-standard discrepancies reported by survey research indicate that feedback may have significant potential to increase pro-environmental purchasing in supermarkets.

4.2.4 Determinants of Feedback Influence

Feedback intervention studies can be distinguished by a variety of criteria, and several factors influence their effectiveness.

Individual feedback provides information about individual behavior, while comparative feedback often provides information about the performance of groups that may or may not contain data from the individuals. Comparative feedback is quite similar conceptually to the communication of descriptive social norms (especially when only the behavior of others is communicated), and it may be effective because it makes these social norms salient (Abrahamse et al., 2007, pp. 266–267). A combination of individual and group feedback has been found to be effective by some researchers (Siero et al., 1996; Staats et al., 2004). Others, such as Midden, Meter, Weenig, and Zieverink (1983) and Abrahamse et al. (2007, p. 274), “did not find any additional effect of comparative feedback over individual feedback”.

Feedback is considered more effective if it is frequent, tailored to the individual, and given immediately after the corresponding behavior (Abrahamse et al., 2005, pp. 278, 281; Hutton et al., 1986; Klöckner, 2015, p. 167; van Houwelingen & van Raaij, 1989). The above-cited study by van Houwelingen and van Raaij (van Houwelingen & van Raaij, 1989) discovered a stronger effect of daily feedback compared to monthly feedback. However, these two conditions also varied in the mode of feedback delivery, thereby limiting the generalizability of this finding.

Some authors argue that interventions combining feedback with other methods are more effective because “different households are prevented from action by different barriers” (Abrahamse et al., 2007, p. 266; Gardner & Stern, 1996). As cited above, McCalley and Midden (2002) found a combination of goal-setting and feedback to be effective, while neither technique was individually

successful in their study of washing machine energy use. Often, however, these designs do not allow for discerning the contributions of simply the feedback intervention on an overall effect (e.g., Abrahamse et al., 2007).

A substantial share of tested feedback interventions has actually decreased performance (Kluger & DeNisi, 1996), which may be due to insufficient attention on the locus of attention generated by the feedback interventions and other still poorly understood moderators. Kluger and DeNisi also found that many studies are selectively cited by reporting only positive effects and neglecting negative or non-significant results. An example of such a misconstrual is the study by Hutton et al. (1986) that reported non-significant results in almost all variants of their feedback intervention. Nonetheless, authors like Abrahamse (2007, p. 266) cite the study by Hutton et al. as “Feedback [...] is especially effective when it is given frequently.”

Feedback intervention theory differentiates feedback by the locus of attention cued by the feedback intervention. However, these findings have not been explicitly considered in the pro-environmental behavior literature on feedback interventions. The author was unable to identify a single mention of the locus of attention in the pro-environmental behavior literature. The same applies to the question of salience of the feedback message, which is considered important in feedback intervention theory. Few authors report the circumstances and characteristics they employed to deliver the feedback message, and it is difficult to deduce salience of the messages from their descriptions. Size of the message or poster, exact wording, location, or environmental clues such as competing information in the environment may all matter for the effectiveness of the message but do not receive much attention in the literature. Manipulation checks, which would evaluate whether the feedback message was actually seen and understood, are rarely part of the reported interventions.

Another concern regarding feedback and cognitive dissonance interventions is that they may be counterproductive by changing the attitude toward a behavior rather than changing the behavior itself. One could envision a situation where an individual is confronted with information about his or her own inconsistency between an attitude in favor of energy savings and a high electricity demand. Such an intervention could possibly lead the individual to adjusting the attitude to be less favorable toward energy savings. However, Kantola et al. (1984) tested this hypothesis but did not find any evidence of a change in attitudes as a result of feedback and cognitive dissonance messages.

Several studies rely on self-reported measures of behavior to estimate the effectiveness of feedback. Such self-reported measures can elicit answers driven by social desirability (e.g., Luyben, 1982), thereby overestimating the true effect of an intervention. Abrahamse et al. (2007) found an effect in

self-reported but not in actual energy savings behavior. Kantola et al. (1984) discovered the reverse to be true in their data.

4.3 Placement

Rarely, if ever, will consumers mention that they bought a product because it was conveniently located within a store. However, almost two-thirds of purchases in supermarkets are not on the shopping list of consumers when they enter the market (Inman et al., 2009, p. 23), and food manufacturers spend tens of billions of dollars to be placed in an advantageous position in supermarkets (Forster, 2002). How do consumers make these unplanned decisions? What clues in the store environment make them purchase so many more items than they planned to when entering the store?

Let us imagine a stereotypical consumer who goes to the supermarket “just to purchase some milk.” But while walking through the aisles toward the milk shelves—coincidentally located at the very back of the market—she notices and picks up the bananas that are on offer and are piled up in a large, well-lit stack at the market entrance. She then chooses the organic milk among five different varieties on offer, and, just before she reaches the cash register, she notices the toilet paper—which soon will be depleted at home—and takes it with her as well.

This is obviously a contrived example. Still, it highlights how many decisions are potentially made based on the in-store environment. What if the milk had been placed right at the entrance and she could have walked directly to the cash register without noticing any of the other products in the market? What if a small stack of bananas had been placed in a more hidden and dark location on a bottom shelf tucked between the aisles? What if the toilet paper had not been placed on the “racetrack” around the market? What made her choose the organic milk over the other varieties in the section? Food manufacturers have noted the influence of placement on purchase decisions, and they pay supermarkets to be placed in attractive positions. Some estimate that up to 15% of revenue—an amount in the tens of billions of dollars in the United States alone—are spent by food manufacturers to secure attractive positions within the markets (Forster, 2002).

When visiting German supermarkets with an eye toward the placement of sustainable products, a diversity of approaches becomes apparent. Some markets place all organic foods in one block at the entrance. Others place them as a block within their respective category, for example, a block of organic dairy products on the dairy shelves. A third group places organic products next to their organic equivalents. Along the same lines, vertical positioning is quite heterogeneous from market to market. This diversity indicates a surprising lack of clarity on how organic groceries are effectively placed, a

diversity that is even more surprising given the considerable influence that store environments have on purchase decisions.

Product, price, placement, and promotion is the classic marketing adage for how to effectively market products in any domain. It seems obvious that, to be purchased, a product must be noticed. However, the prominence given to placement in this adage stands in stark contrast to the amount of attention that the influence of placement has received in the marketing literature in general and in the sustainable consumption literature in particular (e.g., Campo & Gijsbrechts, 2005, p. 384; Klöckner, 2012, p. 45).

Qualitative research indicates a strong need to improve understanding of in-store barriers to organic purchasing. The perceived inconvenience of the purchase process and lack of availability of organic products have often been cited as a deterrent to organic food purchases by consumers (Ergin & Ozsacmaci, 2011; Hughner et al., 2007; Zanolli & Naspetti, 2002). Hjelmar's (2011) in-depth qualitative interviews with Danish consumers identified convenience and visibility at the point of sale as the main mechanisms for increasing organic product market share, especially for occasional customers. Zanolli and Naspetti (2002, p. 651) also identify availability, product location, and convenience as the main barriers for occasional consumers in Italy.

4.3.1 Theory

How does placement influence consumer decisions? Generally, the placement literature has been more concerned with empirically evaluating the effectiveness of specific strategies than with theorizing about the underlying mechanisms (Valenzuela et al., 2013, p. 882). Nevertheless, a few studies have theorized about placement effects.

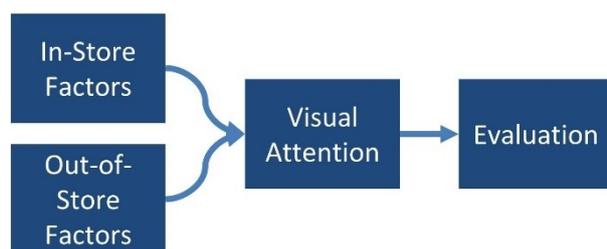


Figure 17: Attention evaluation model (Chandon et al., 2009, labels abbreviated)

Chandon, Hutchinson, Bradlow, & Young (2009) present a three-step model that seems to be implicitly shared by many others: They start with several in-store and out-of-store factors as the first step. These factors then influence visual attention, which in turn influences evaluation, including product choice (see Figure 17). They explicitly consider four in-store factors—

number of facings, horizontal shelf position, vertical shelf position, and price—but their model does not make predictions as to how and why these influence purchases.

In seeking to explain the high share of unplanned purchase decisions, Inman et al. (2009) argue that

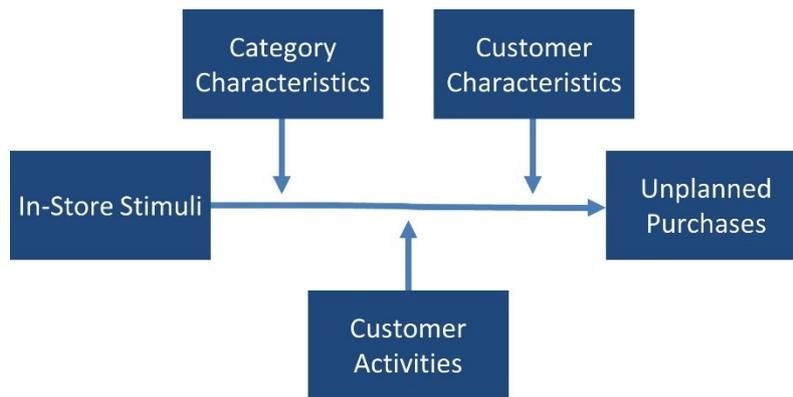


Figure 18: Unplanned purchase model (Inman et al., 2009, labels abbreviated)

in-store stimuli trigger unrecognized or forgotten needs. These needs are then translated into unplanned purchases depending on a variety of category characteristics, customer characteristics, and customer activities (see Figure 18). Similar to Chandon et al. (2009), they

view in-store stimuli as increasing attention, which in turn increases choice.

Valenzuela and Raghurir (2009) suggest a different pathway from placement to purchase decisions based on inferred social norms. They examine the proposition by Inman et al. (2009) and Chandon et al. (2009) that in-store factors affect purchases by directing consumer attention toward centrally placed items. Based on a series of five experiments, they argue that centrally placing items does not influence choice through increased attention but rather through consumer inferences about the popularity of an item. In other words, consumers believe centrally placed items to be more popular and then choose the items because of that belief, a notion remarkably similar to the influence of descriptive social norms described previously. They also demonstrate that this effect is weakened if individual preferences for or against a certain product are made more salient, and consumers look less to clues in the environment to make their choice.

Atalay, Bodur, and Rasolofoarison (2012) used eye tracking to demonstrate that the central product within a category receives more attention (counter to the claim by Valenzuela and Raghurir, 2009) and is chosen more often than other products. This effect persists even if the central product is not in the center of the field of vision, so it cannot be explained by easier recognition of items in the center of the field of vision. Their eye-tracking study also reveals that consumers do not remember very well which products they looked at in the store. This calls into question the frequently used memory-based measures of in-store attention in which consumers are asked which products they remember seeing after visiting a store.

Consumers hold a range of position-based beliefs about the price, popularity, and promotional status of products, and these beliefs influence product choice (Valenzuela et al., 2013). For example, products placed on the top row are generally and correctly believed to have a higher price than

products on the bottom row. But consumers also hold some false beliefs. For instance, they incorrectly expect the most popular products to be placed in a central position.

Sorting strategies can also influence purchase decisions through increasing the salience of the organizing product attribute (Areni et al., 1999). For example, sorting a category by how sustainable the products are suggests to consumers that sustainability is an important decision criterion. The placement of a product within a certain category may also evoke a specific use for the product, which in turn influences the consumer's purchase decision (Desrochers & Nelson, 2006, p. 359). For example, placing the tomato salsa next to the chips evokes a use as a snack dip while placing it next to noodles may evoke its use as a sauce.

4.3.2 Influence of Sorting

Within the placement literature, sorting effects have received only cursory attention both for food products in general and for organic food products in particular (Bezawada & Pauwels, 2013; Campo & Gijbrecchts, 2005, p. 384; van Herpen et al., 2012, p. 295). Additionally, these research efforts lack a common terminology and even a common title for this line of work. Research can be found under keywords such as location issues, assortment, arrangement, clustering, positioning, sorting, grouping, and categorization—often with slightly varying foci and not strictly comparable results (Areni et al., 1999; Desrochers & Nelson, 2006; van Herpen et al., 2012, 2015).

Several sorting strategies for organic food products are available for marketers. Placing organic products in a separate section—also called clustering, block positioning, separate display, and unique feature positioning—is often contrasted with placing them next to their conventional alternatives (comparative positioning or mixed display), though both strategies can be implemented at the same time (double placement). Moreover, these strategies vary in the location of the organic block. Some locate the block within the shelf carrying the same category. Others place the block at the store entrance or in an end-of-aisle display. Sorting strategies also vary by the chosen sorting attribute within a section. Frequently, products are sorted by brand but sometimes by other criteria, such as price or flavor.

Laboratory eye-tracking studies suggest that sorting effects are a result of differences in awareness for products depending on their shelf position. Products in the horizontal center of a shelf are noted about one-third more than those on the left or right (Chandon et al., 2009, p. 11). These differences in awareness do not, however, seem to matter much as to whether the products are considered or chosen. Eye-tracking studies by Sorensen (2008) suggest that end-of-aisle locations are the most-noted locations within markets.

Some correlational research has analyzed the influence of placement on sales without changing the location of products but rather by inferring their effect from a naturally occurring variation in market setup. In one of the earlier studies, Chevalier (1975) examined the influence of displays (understood as extra locations) on product sales. In experiments with 16 test items in four U.S. supermarkets, he found products of the same category to respond similarly to being displayed in an extra location. This result was independent of the market share of the products. Products that were growing in market share were more responsive to extra display than more mature products. These generalizations should be taken with caution, however, because they are based on a limited number of categories and products.

In another correlational study, Nakamura, Pechey, Suhrcke, Jebb, and Marteau (2014) analyzed the role of end-of-aisle displays in alcoholic and non-alcoholic beverages sales and found them to be associated with strong increases in sales at one supermarket. Alcoholic beverages were sold between 23% and 46% more often when displayed at the end of an aisle. Non-alcoholic beverages were sold by 52% up to 114% more often when featured in an end-of-aisle display. However, their study seems hampered by reverse causality issue. Do items sell more because they are placed in an end-of-aisle display as suggested? Or are they placed in the end-of-aisle display because they sell more and are therefore more attractive products for such a location?

For sustainable groceries, van Herpen et al. (2012) report clustering items by organic brands within a shelf area to positively correlate with sales. Horizontal position or the number of facings had little influence on sales in their study of 60 supermarkets in the Netherlands, but organizing a shelf by brand was associated with increased sales. Later research on mildly sustainable products suggests that positioning effect may interact with the price of an organic product. Block positioning can be more effective for high-priced organic articles, and comparative positioning can be more effective for low-priced organic articles (van Herpen et al., 2015), though, again, this is simply a correlational finding that might be influenced by accidentally omitted confounders.

Others have studied the impact of sorting experimentally since the validity of correlational findings is threatened by the potential omission of confounders. Such experiments have been rare, since they can be costly and time-intensive to conduct (Chung et al., 2007, p. 584; Frank & Massy, 1970, p. 66).

Drèze et al. (1994) are among the few researchers studying placement effects in field experiments. They find horizontal position and facings to have small effects but vertical position to be highly influential. In their randomized experiments in 60 U.S. supermarkets, they experimented with two placement strategies: allocating shelf space depending on how often a product was sold to avoid

stockouts and allocating shelf space to facilitate cross-category purchases or ease of shopping. They found modest sales increases of 4 to 6%, on average, as a result of these strategies.

In an experiment on the reorganization of the wine section of a supermarket, Areni et al. (1999) actually found that a more prominent positioning of wine from a specific region decreased sales of the wine. They attribute this finding to their reorganization of the wine section by region. After the reorganization, it was easier for consumers to compare wines from region to region, with the region as a defining characteristic of the wine becoming more salient. Accordingly, more wines from popular regions were sold, and fewer wines from less popular regions were sold, despite the fact that they were now more prominently positioned.

Several experimental studies have failed to identify hypothesized effects. De Wijk et al. (2016) studied whether the walking direction in supermarkets influences sales. They hypothesized that products that are encountered first are bought more than those encountered later, testing this hypothesis by rearranging the bread section in a market. But counter to their hypothesis, their intervention did not have an effect in an experiment at two Dutch supermarkets. Sigurdsson, Larsen, and Gunnarsson (2011) changed the location of bananas within a store with three setups: placing them at the checkout stand, placing them on the sweets shelf, and placing them in both locations. Despite a survey that indicated high interest in and positive attitudes toward consumption of fruits and vegetables, the placement locations had no effect on consumer buying behavior.

Not all studies of sorting examine the impact on sales. Groeppel-Klein and Kamm (2014) measured the impact of a clustered arrangement of organic items on retail store image. In their study with 199 participants in two German supermarkets, they found more positive attitudes regarding the retailers' organic range to be prevalent when the organic products were grouped together. Again, this is a correlational rather than an experimental finding. Denver and Christensen (2014) tested how consumers group food items. Specifically, they were interested in whether items were grouped by type (fruit vs. vegetable), by organic production (organic vs. conventional), or by other factors. Not surprisingly, they discovered that respondents who grouped organic items together had a higher willingness to pay for them than those who did not.

4.3.3 Influence of Vertical Position

Compared to the divergent findings on various sorting strategies, there is much more agreement on the ideal vertical product position. In fact, vertical position has been found to be one of the most influential factors for a product's sales. Middle- and top-shelf positions are commonly viewed as benefitting sales the most.

Eye-tracking experiments support this finding. Chandon et al. (2009, p. 11) found that products on the middle shelf were noticed roughly one-third more than products on the bottom shelf. However, in their laboratory experiments, the increased notice paid to these products did not result in a better evaluation or choice. In their experiments, products displayed on the bottom shelves were chosen more often than those displayed on the middle shelves. Products in the vertical center of a category (independent of whether the category is placed at the top or bottom of the shelves) are noticed more often than other products.

Additionally, correlational studies support the hypothesis that at or slightly below eye level is the best position for sales. While an early study by Frank and Massy (1970) found inconsistent and modest effects (while the researchers themselves are critical of potentially omitted confounders), later correlational studies by Chung et al. (2007) discovered clear indications of eye-level positions benefitting sales of dairy products. They found the optimal height to be about 60 inches (150 cm) above the floor.

For organic groceries, correlational studies support the benefits of positioning a product at eye level, but the evidence is not conclusive. Van Herpen, van Nierop, and Sloot (2012) found a vertical position at eye level to be optimal in their analysis. In terms of consumer sentiment, Hjelmars (2011) reports that organic food consumers react positively to eye-level placement.

Several experimental studies demonstrate consistent positive results of placing products at eye level. Research by Christenfeld (1995) revealed that consumers tend to select products from the middle rows if multiple rows of equal products are presented in stores. Dréze, Hoch, and Purk (1994, p. 324) found a “couple of facings at eye level [to have a greater effect] than five facings on the bottom shelf.” Positioning a product slightly below eye level, about 51 – 53 inches (130 – 135 cm) above the floor, was found to be the most effective in their field experiments. Sigurdsson, Saevarsson, and Foxall (2009) placed potato chips in differing shelf positions and found the middle shelf to be most effective in increasing sales. Glanz et al. (2014) tested a wider intervention, including eye-level positioning, which was also found to be effective.

Still, some authors dispute the importance of placement for organic sales. They argue that consumers may be willing to search for organic groceries even if they are not placed at a convenient location (van Herpen et al., 2012, p. 305). Therefore, it would be important to confirm these results experimentally. However, the author is not aware of any published experimental study evaluating the impact of eye-level positioning on organic groceries.

4.3.4 Determinants of Placement Influence

In-store purchase decisions, like almost all human decisions, are quite complex. Many factors influence the relationship between position and sales, and a multitude of factors has been proposed in the literature. Broadly, these can be distinguished in three categories: consumer characteristics, product characteristics, and store characteristics.

Some consumer characteristics—such as use of a shopping list, frequency of shopping trips, time spent in a store, self-control, and cash payments for purchases—decrease the number of unplanned purchase decisions (Inman et al., 2009, p. 18). Nonetheless, even with these strategies in place, almost half of consumer purchases are unplanned (Inman et al., 2009, p. 18).

Consumer decision scripts are another important consumer-related factor. Placing products in a block near the entrance of a store may be ineffective if consumers search for them in the corresponding store aisle. Additionally, consumers may want to compare prices of organic products with their conventional alternatives and thus mistrust a block placement at the entrance. Conversely, strongly motivated customers may view a single block with all organic products as convenient, since they would not consider conventional alternatives anyway.

Research by Raghubir and Valenzuela suggests that consumers have expectations about where the most popular products are placed and that these expectations mediate the effect of placement on choice. Thus, it can be argued that consumer expectations about market and shelf layout, which may differ from region to region and from culture to culture, also play a role.

Additionally, product characteristics can impact the influence of placement. Impulse product categories display stronger reactions to location changes compared to non-impulse categories, and low-market-share brands react differently than high-market-share brands (Chandon et al., 2009, p. 1; Cox, 1970, p. 57). The hedonicity of a product may also play a role. Inman et al. (2009) argue that placement effects are greater for hedonic products compared to non-hedonic ones. The interpurchase cycle of a product (the duration between purchases of the average consumer) also affects the influence of placement changes. Extra displays have higher impact for products with a high interpurchase cycle (Inman et al., 2009). Van Herpen et al. (2015) propose that consistency of price levels and display influence the effectiveness of various sorting strategies. They propose that offering intermediately priced products in separate locations while offering low-priced products in mixed displays increases choice the most.

Store characteristics also modify placement's influence on sales. The most-studied characteristic is probably the influence of facings, or the amount of shelf space allocated to a certain product. While

this is a frequently studied subject, results are remarkably heterogeneous. Desmet and Renaudin (1998, p. 456) are often cited as having revealed a positive relationship between shelf space and products (e.g., by van Herpen et al., 2012, p. 295), yet their correlational study reports space elasticities ranging between $-.11$ and $.29$. Put differently, a doubling of shelf space results in sales changes between -11% and $+29\%$. Thus, at least for some stores, their results indicate a negative relationship between space and sales. Dreze, Hoch, and Purk (1994, p. 324) found the number of facings to be “one of the least important success factors” for sales of a product. An eye-tracking study by Chandon et al. (2009) indicates a positive but marginally decreasing effect; in other words, increasing facings from 4 to 8 has a greater effect than increasing facings from 8 to 12. The effect of shelf space on sales is itself moderated by several other factors. Early research by Cox (1970, p. 57) indicates that the effects of space differ between impulse and staple brands as well as between brands with low and high consumer regard, although these are extrapolations from just four tested products. Chandon et al. (2009, p. 15) report from their laboratory experiments that “low-market-share brands were more responsive to facing increases than high-market-share brands”. Desmet and Renaudin (1998, p. 443) found “space elasticities [to] increase with the impulse buying rate of the product category”. Doubling display space increased sales of hard fruits by 44% in a frequently cited early study, but this reading of the evidence is based on much laxer standards for statistical significance compared to other studies— $.25$, even though $.05$ is normally used (Curhan, 1974, p. 291).

Van Herpen et al. (2012, p. 293) found no correlation between facings and market share for organic products in their correlational study. They speculate that this may be due to consumer willingness to search for organic products even when they have few facings (van Herpen et al., 2012, p. 305). This factor may lessen the importance of space.

Despite the number of studies analyzing location issues, few studies conclusively reveal the effects they are cited to demonstrate. Reverse causality issues hamper several studies with correlational designs (Desmet & Renaudin, 1998; van Herpen et al., 2012). They do not conclusively demonstrate whether shelf space truly causes more sales or whether popular products are given more space because they sell well (e.g., to avoid stockouts). Regarding several experimental laboratory studies, it is unclear whether they generalize to a point-of-sale environment with actual purchases (Chandon et al., 2009; Desrochers & Nelson, 2006; Valenzuela & Raghuram, 2009; van Herpen et al., 2015). Eye-tracking results may be biased by an observer or by the Hawthorne effect, which applies to a situation in which subjects change their behavior because they know they are being watched. Experimental studies at the point of sale are often limited to one market, a handful of products, and short time periods, which may limit external validity (Cox, 1970; Wilkinson et al., 1982), probably due to the difficulty and costliness of rigidly controlling influencing variables for in-store experiments (Chung et

al., 2007, p. 584). Many studies extrapolate findings for single products to entire product categories without providing a clear reasoning as to why that should be the case. Similarly, it is unclear whether much of the research generalizes across countries, cultures, consumer types, or store sizes. Thus, it is clear that more research, especially in the sustainability domain, is needed to further the understanding of placement influence.

Nevertheless, both sorting and vertical position have been demonstrated to exert major influence on the products that consumers purchase in the supermarket. It is far from clear, however, whether these findings generalize to organic groceries, and this question deserves further attention.

4.4 Interim Conclusion

In summary, the three nudging techniques—social norm message, feedback, and placement—have all been demonstrated to be effective in specific settings. Their influence, however, is dependent on several context factors that limit direct transferability of the techniques. If these are not considered, social norm intervention can cause boomerang effects. Likewise, ill-designed feedback interventions and placement strategies can be counterproductive. The review also reveals that the effectiveness of nudging interventions should be evaluated in a realistic setting, because, even with an extensive line of research in support, interventions sometimes fail. Finally, this review indicates that none of the nudging techniques has been examined in a realistic experimental study to evaluate their effectiveness in nudging organic food purchases.

5 Empirical Intervention Studies

The lack of intervention studies evaluating the effectiveness of social norms, feedback, and placement for sustainable purchasing was identified as a significant research gap in the literature review. Addressing this gap, this chapter presents the result of three realistic large-scale interventions implemented with more than 21,000 participants and more than 100 supermarkets in Northern Germany.

Study 1 examines the impact of social norm and feedback messages on organic food purchases in general. Study 2 analyzes the impact of a sorting intervention that repositioned a large share of the organic food segment within the supermarkets. Study 3 evaluates the effect of placing organic cereals at eye level instead of placing them on the bottom shelf.

Since this dissertation studies the potential of nudges to aid the sustainability transformation of the global food system, these interventions are designed with scalability in mind. Not only do they serve the purpose of studying the influence of nudges on organic food purchasing, they are also designed in a fashion that would allow supermarkets to scale them to all of their stores with minimal costs.

To implement these interventions in a realistic setting, the interventions were co-designed with the supermarkets. This entailed balancing feasibility, scalability, and ideal experimental design. For example, in designing the feedback intervention, the technical feasibility of communicating feedback to tens of thousands of customers had to be considered.

In spite of the ongoing debate on the environmental benefits of organic groceries (see Chapter 2), the purchase of organic food was chosen as the object of study in these interventions for two reasons: First, organic food offerings are already available in many supermarkets and therefore can be studied in a realistic choice setting. Additionally, they may serve as a prototype for further pro-environmental choices, such as the choice between meat and meat substitutes. Second, organic products are perceived by consumers as environmentally friendly. As a result, despite concerns regarding the actual environmental benefits highlighted in Chapter 2, their subjective benefits are high, and they are therefore a useful proxy for other pro-environmental purchasing behavior.

5.1 Study 1: Social Norms and Feedback

Study 1 tested the impact of social norm and feedback messages on organic grocery sales for 21,078 loyalty card holders at 14 supermarkets across Northern Germany.

5.1.1 Hypotheses

Since past studies have sometimes been unclear with respect to the source of the measured effects, this study proposes and tests several hypotheses that eliminate alternative explanations of a potential effect reported in past experiments examining social norm and feedback messages.

The first hypothesis is based on the idea that simply making salient the existence of organic food products in a message to supermarket customers may increase the likelihood that these products will be purchased, even in the absence of feedback or social norm components. To rule out that an effect is caused by such an increase in salience of organic products, rather than the social norm or feedback message, a treatment group that received a plain organic marketing message was included in the intervention.

Hypothesis 1 (H1): A plain organic marketing message increases organic purchases compared to a control group without any message.

The second hypothesis aims to rule out an impact of conventional marketing messages without any reference to organic food items. It would be conceivable that communicating any marketing message via the chosen medium might influence consumer purchases, for instance, by triggering processes of self-reflection or more conscious purchasing by the consumers. Alternatively, a conventional marketing message might put consumers in a bargain mental mode and thereby decrease organic purchases. Consequently, a plain conventional message was included as a separate treatment group in the design. Accordingly, the second hypothesis evaluates whether the plain conventional message had an impact on organic purchases.

Hypothesis 2 (H2): A plain conventional marketing message changes organic purchases compared to a control group without any message.

The third and fourth hypotheses are the main object of interest in this study. They analyze the effectiveness of social norm and feedback messages compared to plain organic messages. The effect of interest here is not whether a social norm message or a feedback message has any impact on organic purchases but rather whether it is more effective than a plain organic message. This approach rules out the possibility that graphics or other elements of the message or the medium are responsible for the influence of the message, since these other elements are kept equal between the two conditions.

Hypothesis 3 (H3): A social norm message increases organic purchases compared to a control group with a plain organic message.

Hypothesis 4 (H4): A feedback message increases organic purchases compared to a control group with a plain organic message.

Based on the idea that social norm messages can have differential effects depending on the magnitude of their deviation from the norm, the fifth and sixth hypotheses propose a differential impact of the norm depending on prior organic consumption of the consumers (e.g., Schultz et al., 2007). For example, one could envision a scenario where no overall effect is detected because differing responses from various customer segments equalize each other.

Hypothesis 5 (H5): A social norm message increases organic purchases more for consumers with low prior organic purchases than those with high prior organic purchases.

Hypothesis 6 (H6): A feedback message increases organic purchases more for consumers with low prior organic purchases than those with high prior organic purchases.

The focus theory of normative conduct suggests that more salient norms are more influential. As a result, one would expect the norm to be more influential directly after the message was received compared to a later point in time. This idea is tested in hypothesis 7 for social norms and in hypothesis 8 for feedback.

Hypothesis 7 (H7): A social norm message increases organic purchases more for the purchase directly after it was communicated.

Hypothesis 8 (H8): A feedback message increases organic purchases more for the purchase directly after it was communicated.

5.1.2 Method

Experimental design

The study was designed as a randomized in-store field experiment. An equal number of participants was randomly assigned to the five treatment and control groups. This randomized approach ensures that treatment and control groups do not significantly differ in their observable and unobservable characteristics and that later findings can be attributed to the treatment effect rather than to pre-existing differences. The study employed a parallel design; that is, all groups received their treatment during the same treatment time period.

Participants, setting, and duration

A total of 21,079 loyalty card holders at 14 supermarkets in Northern Germany participated. The studied markets are situated in rural, urban, and suburban locations. Since participants had already opted in to receiving marketing communications and had granted permission for analysis of their data during signup for their loyalty card, no additional permissions had to be secured to conduct the study.

All eligible loyalty card holders at the participating 14 supermarkets were included in the study. Card holders were eligible if they made at least six purchases in the three months prior to the baseline

period. The 21,079 eligible card holders were then randomly assigned to five treatment and control groups (see Figure 19).

		Allocated	Analyzed	Mailed Surveys	Complete Responses
Treat	Social Norm	4,290	4,260	1,114	93
	Feedback	4,188	4,161	1,119	94
Control	Plain Organic	4,239	4,218		
	Plain Marketing	4,174	4,159		
	No message	4,188	4,162	1,119	99

Figure 19: Participant flow

Of the 21,079 card holders, 119 were excluded due to implausible values. Data from a total of 20,960 cards was included in the analysis. Postcards with an online survey link were mailed to 3,352 participants, and 286 complete responses were received. This equals a response rate of 8.5%. The 8-week baseline and intervention periods lasted from April 16, 2018, to June 12, 2018, and from June 13, 2018, to August 12, 2018, respectively.

Intervention

To test the effectiveness of the messages, a social norm message, a feedback message, and several control messages were designed. In the design of the messages, advice from the literature was followed to make them as effective as possible.

These messages were then delivered to participants through a checkout-coupons system already in place at the markets. These checkout coupons, approximately 17.2 cm by 5.7 cm in size, are individually printed for each loyalty card holder at the cash register, and cashiers hand them to customers with their receipts. This system allowed for the delivery of specific messages to loyalty card customers depending on the group to which they were assigned.



Figure 20: Translated social norm message

The social norm message that was tested in the experiment employed a prescriptive social norm based on the review by Farrow et al. (2017), which reported these to be especially effective. Due to ethical considerations, the message was based on actual sales data in previous months rather than testing multiple

messages with different norm thresholds (e.g., Richter et al., 2018). A group reference to “our customers” was also included based on the idea that communicating a norm from a close reference group would make the messages more effective.



Figure 21: Translated feedback message

The feedback message was designed jointly with the marketing department of the participating supermarkets. Technical constraints and marketing considerations limited the ability to directly put advice from the literature into practice. Technical constraints prevented communication of the organic share back to the purchasers. While it would have been desirable

from a research perspective, the marketing department of the supermarket decided not to draw consumer attention to the case where they had not bought any organic products at all. The absence of a negative feedback loop indicating a discrepancy between the actual organic purchase behavior and a standard or goal may have led to reduced effort by participants (see e.g., Kluger & DeNisi, 1996, p. 264). As a result, a feedback message was delivered only to purchasers when they bought one or more organic products. This message confirmed the fact that they had just bought at least one organic item and indicated that more organic products were available in the store.



Figure 22: Translated plain organic message

The coupons used to deliver the messages are usually employed to encourage cross purchases of other products through a monetary incentive. It was decided to keep such a monetary incentive on the coupon to avoid a potential perception of loss when receiving a coupon without an incentive. Additionally, this allowed for tracking who redeemed the coupons and whether the message was more effective for customers who redeemed, and thus had read, the coupons. The incentive was not specific to organic purchases to avoid biasing purchase behavior through the incentive. Participants received a discount of €1.50 on any future purchase of €30 or more.

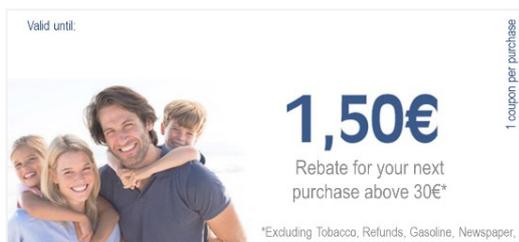


Figure 23: Translated plain marketing message

The EU organic label was included as a large-scale photograph on all coupons except the plain marketing message to ease translation of the norms message to purchase behavior. The entire category of organic groceries rather than specific products or categories

was targeted to avoid a rebound effect, such as the increase in sales of the targeted category (as reported, for instance, by Richter et al., 2018). To increase the salience of the messages, up to three coupons per participant were distributed during the six-week printing period for coupons.

To test the hypotheses, participants were randomized into two treatment and three control groups. The treatment groups received the descriptive social norm message and the feedback message. Two control groups received a plain organic message and a plain marketing message to test whether the inclusion of a monetary incentive on the coupon or some other aspect of the coupons influenced purchase behavior. A third control group did not receive any coupons or other intervention.

To identify whether the messages successfully influenced social norm perceptions, to analyze the representativeness of the sample, and to detect potential behavioral antecedents of behavior, a postcard with an online survey link was sent to 3,352 participants in the experiment. A total of 286 complete responses were received. Participants were surveyed several weeks after the intervention was concluded (in September, October, and November 2018) to avoid biasing purchase behavior through the survey.

Outcomes

The primary outcome of interest in the study was the organic revenue share, which is computed by dividing the revenue from all organic purchases by the revenue for all food purchases. The organic revenue share measures actual consumer behavior rather than requiring consumers to self-report behavior from memory, as has been done in many other studies. The revenue share rather than absolute revenue was used to avoid capturing time trends of revenue in the outcome variable. For example, revenue variations depending on holidays would have been captured in absolute revenue but not in the organic revenue share. The number of units sold was eliminated as a potential outcome variable, since different package sizes for organic and conventional food could have biased the analysis. Since the organic revenue share was unobtrusively measured based on store scanner data from checkout, no observer effect or Hawthorne effect is expected.

A few secondary outcomes were of interest in this study. First, counts of printed messages in each market and each group were of interest to evaluate whether the coupons were printed and delivered to the customers. Second, redemption counts of the coupons were also of interest, since they tracked whether customers read, understood, and acted on the message. Third, self-reported perceptions of social norms and organic purchasing behavior were included in the survey to evaluate whether the messages actually manipulated social norms and purchase intentions.

Baseline Comparisons

To ensure that no widely differing treatment and control groups were selected by chance, baseline characteristics of the groups were compared.

Group	Organic Revenue per Receipt	Organic Revenue Share	Organic Units per Receipt	Organic Units Share	Receipts per Card	Revenue per Receipt	Units per Receipt
Social Norm	1.27	3.60%	0.69	3.54%	9.39	30.30	17.77
Feedback	1.23	3.48%	0.68	3.47%	9.49	29.99	17.68
Control 1	1.26	3.59%	0.68	3.54%	9.42	30.07	17.70
Control 2	1.23	3.42%	0.67	3.42%	9.16	30.30	17.78
Control 3	1.24	3.49%	0.67	3.48%	9.39	30.21	17.80
ANOVA	F(4, 20186) = 0.17, p = 0.95	F(4, 20186) = 0.5, p = 0.73	F(4, 20186) = 0.11, p = 0.98	F(4, 20186) = 0.19, p = 0.94	F(4, 20186) = 1.25, p = 0.29	F(4, 20186) = 0.15, p = 0.96	F(4, 20186) = 0.07, p = 0.99

Table 5: Baseline characteristics of treatment and control groups

Analyses of variance (ANOVAs) for each variable presented above were run, and no significant differences between the treatment and control groups was found in the baseline data. Since ANOVAs tend to be robust toward non-normal distributions in the case of similar group sizes (Field et al., 2012, p. 413), no normality or homoskedasticity tests were conducted.

Representativity of survey participants for German population

One concern with the sample of chosen loyalty card customers was that they are not representative of German consumers overall. To alleviate this concern, the demographics of the survey respondents were compared to German population averages.

Variable	Value	Survey Respondents	German population	Delta
Age^a	< 20	1.4%	-	+1.4%
	(20,40]	19.4%	30.1%	-10.7%
	(40,60]	50.0%	35.7%	+14.3%
	(60,80]	27.5%	26.6%	+0.9%
	> 80	1.8%	7.6%	-5.8%

Gender^b	Female	59.2%	50.7%	+8.5%
	Male	40.8%	49.3%	-8.5%
Net Income^c	< 1,000 €	8.0%	12.4%	-4.4%
	1,000 - 2,000 €	34.9%	30.8%	+4.1%
	2,000 - 3,000 €	29.4%	23.3%	+6.1%
	3,000 - 4,000 €	17.6%	13.6%	+4.0%
	4,000 - 5,000 €	7.6%	8.8%	-1.2%
	> 5,000 €	2.5%	11.1%	-8.6%
Education^d	No High School Diploma	0.7%	4%	-3.3%
	Basic High School Diploma (Hauptschule)	16.9%	32%	-15.1%
	Intermediate High School Diploma (Realschule)	34.5%	33%	+1.5%
	Advanced High School Diploma (Abitur)	13.9%	15%	-1.1%
	College or University Degree	34.1%	18%	+16.1%
Household Size^e	1	17.3%	20.9%	-3.6%
	2	52.7%	33.5%	+19.2%
	3	18.4%	18.0%	+0.4%
	4	7.4%	18.5%	-11.1%
	> 4	4.2%	9.0%	-4.8%

a Data from Statistisches Bundesamt (2019a), Ages less than 20 removed by author to make figures comparable, n/a removed from survey responses. b Data from Statistisches Bundesamt (2018a), n/a removed from survey responses. c Data from Statistisches Bundesamt (2018a), n/a removed from survey responses, German population data recalculated assuming uniform distribution within income categories. d Data from Statistisches Bundesamt (2017), n/a removed from survey responses, German population data recalculated to match categories by author. e Data from Statistisches Bundesamt (2018a), n/a removed from survey responses.

Table 6: Survey respondents compared to German population

The survey responses reveal some biases limiting generalizability to the German population. Customers aged 40 to 60 are overrepresented while customers between 20 and 40 as well as customers older than 80 are underrepresented. A higher share of female respondents was observed in the sample compared to the general population. The sample is biased toward low- and middle-income customers and underrepresents customers with more than €5,000 and less than €1,000 of net household income. In terms of household size, two-person households are overrepresented and households with four or more members are underrepresented. In terms of education, college and university degrees are overrepresented while basic high school diplomas are underrepresented in the

sample. Overall, the analysis indicates that the data is not fully representative of the German population and any extrapolations to a higher level must be taken with care.

Representativity of survey participants for full sample

Since only a small share of the overall sample was contacted for the survey, and the response rate of 8.5% was comparably low, self-selection into the survey is a source of concern. Therefore, survey respondents were compared to the rest of the sample based on the purchasing data obtained for both the respondents and the non-respondents. With this data, any significant differences in observed behavior between respondents and the remainder of the sample can be analyzed.

	Non-respondents	Respondents	t-test
Organic Revenue per Receipt	1.25	1.23	t = 0.082, p = 0.93
Organic Revenue Share	3.51%	3.49%	t = 0.07, p = 0.94
Organic Units per Receipt	0.68	0.70	t = -0.26, p = 0.79
Organic Units Share	3.49%	3.56%	t = -0.18, p = 0.85
Receipts per Card	9.35	10.94	t = -3.21, p = 0.0015
Revenue per Receipt	30.16	31.51	t = -0.97, p = 0.33
Units per Receipt	17.73	18.93	t = -1.39, p = 0.17

Table 7: Survey respondents compared to non-respondents

The t-tests did not reveal any statistically significant differences in observed behavior for all but one of the observed behavior baseline variables. Respondents made, on average, 1.6 purchases more during the baseline period than did non-respondents. Importantly, no significant difference in the share of organic products purchased was found between respondents and non-respondents.

Representativity of full sample for corresponding supermarkets

Another issue potentially limiting external validity is whether loyalty card customers are different from non-loyalty card customers in the analyzed markets. To test this, organic revenue shares for loyalty card holders were observed and compared to the corresponding organic share of the entire market.

Market	Organic Share Entire Market	Organic Share Loyalty Card Only	Difference ^a
1	10.25%	6.75%	-3.50%
2	5.65%	4.84%	-0.81%
3	4.08%	3.42%	-0.66%
4	5.01%	3.17%	-1.84%
5	3.47%	2.69%	-0.78%
6	3.89%	3.29%	-0.60%
7	3.74%	2.01%	-1.73%
8	5.71%	3.61%	-2.10%
9	7.18%	5.80%	-1.38%

^a Since only one data point describes the entire market, no inferential statistics can be calculated.

Table 8: Entire market compared to loyalty card organic share

Market totals for 9 of the 14 markets in the sample were obtained. The data indicates that, on average, loyalty card holders had an organic revenue share that was almost one-quarter less than the organic revenue share in the market overall. The data also highlights the high variance of organic revenue shares across markets. The highest organic share (10.25%) was almost three times as high as the lowest share (3.74%). Loyalty card holders have substantially lower organic shares than other customers, which can be read as evidence that they are less motivated to purchase organic food.

Statistical Methods

The primary outcome of interest was to analyze group differences of the organic revenue share between different treatment and control groups. A standard ordinary least squares (OLS) regression was used to assess the statistical significance of differences between treatment and control groups. For the differential effects dependent on baseline organic share, an interaction term between the baseline organic revenue share and the treatment group was included. To study short-term effects, the data was limited to the time periods of interest only.

For the analysis of secondary outcomes, two different statistical methods were used. Coupon redemption shares were also evaluated using OLS regression. The survey-based social norm and intention perceptions were analyzed with a Wilcoxon rank sum test, since the underlying one-item constructs were measured only on an ordinal scale.

5.1.3 Results

Results are presented along the hypothesized chain of effects. First, delivery and uptake of the messages were scrutinized. Second, a manipulation check on social norm and intention perceptions

included in the survey was conducted. Finally, the actual observed behavior—the sales data—was analyzed.

Message delivery and uptake

If the coupons were to influence purchase behavior, they had to be read and understood by participants. While reading or understanding was not observed directly, coupon redemptions can be interpreted as a proxy of whether a person read and understood the coupon message.

Group	Prints	Redemptions	Share Redeemed
Social norm	9,612	535	5.6%
Plain organic	9,661	325	3.4%
Plain marketing	9,246	1,508	16.3%

Table 9: Coupon prints and redemptions in social norm intervention

The social norm message coupon was redeemed more often than the plain organic message coupon. Regression analysis was used to test whether this change was statistically significant ($R^2 = .05$, $F(2, 12634) = 305.9$, $p < .001$). Social norm coupons significantly increased the number of redeemed coupons relative to the plain organic message ($b = .049$, $p < .001$). This is equivalent to a 63% increase in redemptions for the social norm message coupons relative to the plain organic message coupons. The plain marketing coupon, which lacked any reference to organic food, was even more likely to be redeemed than the plain organic coupon ($b = .29$, $p < .001$) and the social norm coupon. Robust p-values are reported above since homoscedasticity and normality assumptions were not met.

Group	Adjusted Prints ^a	Adjusted Redemptions ^a	Adjusted Share Redeemed ^a
Feedback	3,109	309	9.9%
Plain organic	2,341	183	7.8%
Plain marketing	2,177	524	24.1%

^a To make them comparable to the treatment group, control group prints were adjusted to include only the printed coupons that were printed when organic food items were purchased. Redemptions and redemption shares were adjusted accordingly.

Table 10: Redemptions in feedback intervention

Feedback message coupons were printed only when a purchaser bought at least one organic item. Control group messages were printed for each purchase. Thus, to make control group prints and redemptions comparable to the treatment group, they had to be limited to just the purchases that included at least one organic item. Regression analysis was used to determine whether the intervention significantly changed the number of redeemed coupons ($R^2 = .01$, $F(2, 12225) = 58.72$, $p < .001$). Feedback coupons significantly increased the number of redeemed coupons relative to the

plain organic message ($b = .031, p < .001$). The plain marketing coupon, without any reference to organic food, was even more likely to be redeemed than the plain organic coupon ($b = .08, p < .001$) and the social norm coupon. As for the social norm messages, robust p-values are reported since homoscedasticity and normality assumptions were not met.

Manipulation check

To determine whether the social norm message was successful in changing social norm perceptions, one social norm perception item was included in the survey. A total of 184 usable responses were obtained from the social norm treatment group and the control group that did not receive any messages.

Frequency of others buying organic food	Social norm treatment group	Control Group 3
Never	0	0
Rarely	11	7
Sometimes	46	49
Often	32	39
Always	0	0

Table 11: Frequency of others buying organic food

A two-sided Wilcoxon rank sum test revealed no significant difference in the perception of organic food purchases by others between the two groups ($p = 0.32$). This means that no effect of social norm messages on self-reported social norm perceptions was detected by the time the survey was administered. This is a source of concern, since it may indicate that the intervention was too weak to significantly impact social norm perception. Nevertheless, such a null effect may also have been caused by the small number of survey participants and the two- to four-months-long time period between receiving the social norm messages and administration of the survey.

To determine whether the feedback message was successful in manipulating self-perceived organic purchasing behavior, one self-perceived organic purchasing item was included in the survey. A total of 193 usable responses were obtained from the treatment group and the control group that did not receive any coupons.

Frequency of self-buying organic food	Treatment	Control Group 3
Never	5	10
Rarely	21	19
Sometimes	44	47
Often	21	23
Always	3	0

Table 12: Frequency of self-buying organic food

A two-sided Wilcoxon rank sum test revealed no significant difference in the perception of organic food purchases between the two groups ($p = 0.53$). Thus, for the surveyed participants, the feedback was not effective in changing their self-perceived organic purchasing frequency. This is a source of concern, since a failure of triggering the aforementioned negative feedback loop may have limited the message's effectiveness. As for the social norm messages, such a null effect may also have been caused by the small number of survey participants and the two- to four-months-long time period between receiving the social norm messages and administration of the survey.

Purchasing Behavior

Hypothesis 1 & 2

The first two hypotheses (H1 & H2) were designed to test whether a plain organic message or a plain marketing message delivered as a coupon had any effect on purchases when compared to a control group receiving no messages at all. Randomized treatment allowed a test of these effects in a simple linear regression statistically equivalent to an ANOVA. To increase precision and absorb the large variations in organic share between consumers before the intervention started, the baseline organic share was included in an additional specification.

$$\text{organic_share}_i = \beta_0 + \beta_1 d_plain_organic_i + \beta_2 d_plain_marketing_i + u_i \quad (1)$$

$$\text{organic_share}_i = \beta_0 + \beta_1 d_plain_organic_i + \beta_2 d_plain_marketing_i + \beta_3 \text{organic_share_baseline}_i + u_i \quad (2)$$

The variable *organic_share* indicates the percentage spent on organic food items by individual *i*. The dummy coded variables *d_plain_organic* and *d_plain_marketing* indicate whether individual *i* was part of the plain organic message group, the plain marketing message group, or the control group without any coupon. The variable *organic_share_baseline* indicates the share of organic purchases of individual *i* during the baseline period. The regression results are presented in the following table.

	<i>Dependent variable:</i>	
	Post Organic Revenue Share	
	(1)	(2)
Plain Organic	0.0011 (0.0016)	0.0006 (0.0010)
Plain Marketing	-0.0004 (0.0016)	-0.0001 (0.0010)
Baseline Organic Revenue Share		0.7994*** (0.0059)
Constant	0.0340*** (0.0011)	0.0060*** (0.0007)
Control Group	No message	No message
Observations	11,600	11,435
R ²	0.0001	0.6200
Adjusted R ²	-0.0001	0.6199
Residual Std. Error	0.0700 (df = 11597)	0.0425 (df = 11431)
F Statistic	0.4796 (df = 2; 11597)	6,217.7920*** (df = 3; 11431)
<i>Note:</i>		*p < 0.1; **p < 0.05; ***p < 0.01

Table 13: Regression results, plain organic and plain marketing messages

As the regression results illustrate, there is no evidence that either the plain organic message or the plain marketing message significantly influenced the organic share of food purchases in either specification. Neither the plain organic coefficients nor the plain marketing message coefficients reach statistically significant levels in either specification. These results are helpful in eliminating the notion that other aspects of the employed messages, such as an increase in salience of the organic label or even the mere presence of coupons, caused an unintended change in the organic share.

Hypotheses 3 & 4

The next set of hypotheses proposed that the social norm and feedback messages caused a change in the organic share compared to a plain organic message. Again, due to randomized assignment to treatment and control groups, a simple linear regression suffices to test these hypotheses, and the baseline organic share was included to increase precision in an additional specification.

$$\text{organic_share}_i = \beta_0 + \beta_1 d_social_norm_i + \beta_2 d_feedback + u_i \quad (3)$$

$$\begin{aligned} \text{organic_share}_i = \beta_0 + \beta_1 d_social_norm_i + \beta_2 d_feedback \\ + \beta_3 \text{organic_share_baseline} + u_i \end{aligned} \quad (4)$$

Each specification was run twice: once with the no-message group as a control group and once with the plain organic message group as a control group. The results are presented in the following table.

<i>Dependent variable:</i>				
Post Organic Revenue Share				
	(3)	(4)	(3)	(4)
Social Norm	0.002 (0.002)	0.001 (0.001)	0.001 (0.002)	0.001 (0.001)
Feedback	0.001 (0.002)	0.001 (0.001)	-0.0001 (0.002)	0.0003 (0.001)
Baseline Organic Revenue Share		0.792*** (0.021)		0.807*** (0.020)
Constant	0.034*** (0.001)	0.006*** (0.001)	0.035*** (0.001)	0.006*** (0.001)
Control Group	No message	No message	Organic coupon	Organic coupon
Observations	11,602	11,445	11,684	11,516
R ²	0.0002	0.597	0.0001	0.621
Adjusted R ²	0.00004	0.597	-0.0001	0.621
Residual Error Std.	0.070 (df = 11599)	0.045 (df = 11441)	0.072 (df = 11681)	0.044 (df = 11512)
F Statistic	1.224 (df = 2; 11599)	5,658.219*** (df = 3; 11441)	0.527 (df = 2; 11681)	6,291.151*** (df = 3; 11512)

Note: *p < 0.1; **p < 0.05; ***p < 0.01, Robust standard errors are reported in parentheses.

Table 14: Regression results, overall purchase behavior

The regression analysis fails to confirm both the hypotheses. Neither the social norm intervention nor the feedback intervention significantly increased the organic revenue share. This result is consistent both when compared to the control group that received no message and when compared to the control group that received an organic coupon only.

Hypotheses 5 & 6

To test hypotheses 5 and 6, an interaction term between the treatment variable and the baseline organic share was included. Since the baseline organic share captures behavior over many months, no regression to the mean was expected (van Houwelingen & van Raaij, 1989). To avoid biasing treatment estimates, the organic share baseline was included as an independent variable for this specification.

$$\text{organic_share}_i = \beta_0 + \beta_1 d_treat_i \text{organic_share_baseline}_i + \beta_3 \text{organic_share_baseline}_i + u_i \quad (5)$$

The results are presented in the following table.

<i>Dependent variable:</i>		
Post Organic Revenue Share		
	(5)	(5)
Social Norm	0.002 (0.002)	0.001 (0.002)
Feedback	0.001 (0.001)	0.0003 (0.001)
Baseline Organic Revenue Share	0.832*** (0.023)	0.785*** (0.029)
Social Norm * Baseline Organic Revenue Share	-0.042 (0.053)	0.004 (0.056)
Feedback * Baseline Organic Revenue Share	-0.030 (0.034)	0.017 (0.039)
Constant	0.005*** (0.001)	0.006*** (0.001)
Control Group	Plain organic	No message
Observations	11,516	11,445
R ²	0.621	0.597
Adjusted R ²	0.621	0.597
Residual Std. Error	0.044 (df = 11510)	0.045 (df = 11439)
F Statistic	3,778.969*** (df = 5; 11510)	3,394.975*** (df = 5; 11439)

Note: * p < 0.1; ** p < 0.05; *** p < 0.01, Robust standard errors are reported in parentheses.

Table 15: Regression results interaction with baseline organic share

No interaction effects were detected independent of the control group.

Hypothesis 7

To test whether results decayed too quickly to be detected in the overall treatment period, specific receipts rather than the entire control and intervention periods were analyzed as specified in hypothesis 7 (social norms) and hypothesis 8 (feedback). It was hypothesized that the effect of the social norm message would be strongest for the first purchase after distribution of the first message coupon.

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{first_handout_lagged}_k + u_k \quad (6)$$

The variable *organic_share_k* represents the organic revenue share of purchase *k*. The variable *first_handout_lagged* indicates whether the first message coupon was distributed with the previous

purchase. Observations were limited to the treatment group receipts where the coupon was distributed and the first purchase after the handout of the coupon.

It was also hypothesized that the social norm message coupons might have been noticed only by the customer who redeemed the coupon, who therefore must have read and understood its content. This hypothesis is tested in the following specification.

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{first_redemption}_k + u_k \quad (7)$$

Again, the variable *organic_share_k* represents the organic revenue share of purchase *k*. The variable *first_redemption* indicates whether a coupon was redeemed for this purchase. To avoid biasing results, observation was limited to the treatment group purchase at which the first coupon was redeemed and the purchase at which the coupon was printed (i.e., any individuals who did not redeem at least one coupon are excluded from this analysis).

Last, as an ancillary analysis to hypothesis 7, it was hypothesized that individuals exceeding the communicated norm may have reacted differently to those falling behind the norm.

$$\begin{aligned} \text{organic_share}_k = & \beta_0 + \beta_1 \text{first_redemption}_k \text{d_decile}_k \\ & + \beta_3 \text{organic_share_baseline}_k + u_i \end{aligned} \quad (8)$$

The results of specifications (6), (7), and (8) are presented in the following table.

	<i>Dependent variable:</i>		
	organic_revenue_share		
	(6)	(7)	(8)
lag.first_print	-0.002 (0.002)		
first_redemption		0.003 (0.010)	0.005 (0.008)
pre.organic_revenue_share			0.979*** (0.086)
first_redemptionTRUE:pre.organic_revenue_share			-0.020 (0.125)
Constant	0.037*** (0.002)	0.077*** (0.008)	0.008 (0.006)
Observations	7,263	690	686
R ²	0.0001	0.0001	0.542
Adjusted R ²	-0.0001	-0.001	0.540
Residual Std. Error	0.101 (df = 7261)	0.136 (df = 688)	0.092 (df = 682)
F Statistic	0.441 (df = 1; 7261)	0.103 (df = 1; 688)	269.188*** (df = 3; 682)

Note: *p < 0.1; **p < 0.05; ***p < 0.01, Robust standard errors are reported in parentheses.

Table 16: Regression results, specific receipts social norms

Again, none of the hypotheses could be confirmed. Neither the first purchase after the message was distributed nor the purchases at which the messages were redeemed displayed a significant increase in organic revenue share. Additionally, no interaction with the previous organic revenue share was found as well.

Hypothesis 8

The same three specifications as for social norms were tested for the feedback coupons.

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{first_handout_lagged}_k + u_k \quad (9)$$

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{first_redemption}_k + u_k \quad (10)$$

$$\begin{aligned} \text{organic_share}_k = \beta_0 + \beta_1 \text{first_redemption}_k \text{ organic_share_baseline}_k \\ + \beta_2 \text{organic_share_baseline}_k + u_i \end{aligned} \quad (11)$$

Again, a specification including the interaction was added to the planned analysis. Since feedback messages were distributed only to customers who purchased at least one organic item, regression to the mean is a concern. Potentially, consumers purchase fewer organic groceries during this visit if they already purchased some in the previous one. To address this problem, a control group was built that

compared the customers who received a feedback coupon with others in the no-message condition who also purchased at least one organic item during their last store visit.

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{first_organic_lagged}_k \text{feedback_group}_k + \beta_2 \text{feedback_group}_k + \beta_3 \text{first_organic_lagged}_k + u_i \quad (12)$$

The results are presented in the following table.

	<i>Dependent variable:</i>			
	organic_revenue_share			
	(9)	(10)	(11)	(12)
first_handout_lagged	-0.071*** (0.005)			
first_redemption		-0.024* (0.013)	-0.036*** (0.011)	
organic_share_baseline			0.908*** (0.085)	
first_redemption* organic_share_baseline			0.137 (0.126)	
first_organic_lagged* feedback_group				0.0001 (0.006)
feedback_group				-0.003 (0.005)
first_organic_lagged				-0.079*** (0.004)
Constant	0.129*** (0.004)	0.128*** (0.009)	0.048*** (0.009)	0.133*** (0.003)
Observations	3,489	428	426	8,936
R ²	0.062	0.008	0.554	0.077
Adjusted R ²	0.061	0.006	0.551	0.077
Residual Std. Error	0.139 (df = 3487)	0.131 (df = 426)	0.088 (df = 422)	0.137 (df = 8932)
F Statistic	228.963*** (1; 3487)	3.492* (1; 426)	174.632*** (3; 422)	249.298*** (3; 8932)

Note: *p < 0.1; **p < 0.05; ***p < 0.01, Robust standard errors are reported in parentheses.

Table 17: Regression results, specific receipts feedback

Interestingly, results for specific receipts for the feedback messages were significant. However, the direction of the effect is the reverse of the hypothesis. This effect did not persist when the no-message

group was included as a control group. This indicates that the significance of results in the other specifications was due to a regression to the mean effect.

5.1.4 Discussion

Main Findings

The objective of Study 1 was to determine whether social norm and feedback messages are effective tools to increase the organic revenue share in a supermarket setting. The large-scale randomized control trial conducted in this study did not reveal any evidence of an increase or decrease in the organic revenue share as a result of the employed social norm and feedback messages. Neither was there any evidence of a boomerang effect in which high prior consumers of organic food reduced their consumption and low prior consumers of organic food increased theirs. Nor did the analyses find any evidence of more short-lived effects directly after message delivery. These results are consistent across multiple specifications and control groups. Consumers did, however, demonstrate a stronger response to the social norm and feedback messages by redeeming the attached incentive significantly more often. However, no evidence of a change in perceived norms or perceived own frequency of buying organic food was found in a subsample of participants who completed a survey. The tested plain marketing messages and plain organic marketing messages failed to significantly change purchase behavior as well.

A few noteworthy descriptive findings emerged during the analysis, which might be helpful for future research on the subject. Organic shares vary strongly from market to market and from customer to customer. This high variance reduces the precision of estimates and may obscure smaller effects. Prior organic purchases were a useful predictor of future purchases in the sample and were helpful in increasing precision. Strong time trends were also notable in the data and may have confounded literature findings with a pre-post design. Finally, loyalty card customers purchased substantially less organic food than non-loyalty card customers in the studied sample.

Strengths

This intervention's design is remarkable in several ways: To the author's knowledge, it is the first published randomized control trial of social norm and feedback influence on organic food purchases and even the wider category of sustainable purchasing. Additionally, it is one of very few supermarket studies that individually randomizes participants into treatment and control conditions, and the large sample size of more than 20,000 participants in more than one dozen markets yields a higher degree of statistical power than many comparable studies. The survey of a subsample of participants was conducted after the intervention to avoid biasing results through a Hawthorne effect.

Detailed longitudinal data on a variety of metrics both on the individual⁵ and the supermarket level distinguishes this study from others. Notably, this study measured an objective outcome in a real-world setting. Measuring actual purchase behavior rather than self-reported behavior or behavioral intentions is an advance over many psychological studies in this field that measure intentions rather than behavior. The ability to track individual consumers through loyalty cards allowed for demonstrating differential effects for different customer segments. Individual rather than overall store data also made it possible to attribute effects to individual behavior change rather than to a changing customer base at a store. Through tracking of both coupon prints and coupon redemptions, it was possible to identify which customer received and read the messages used in this field experiment. Moreover, scanner data allows the tracking of long-term effects of the tested intervention.

The tested intervention is notable for employing a realistic, transferable, and low-cost intervention that could be scaled quickly if proven effective. The intervention was tested with all organic products in the respective stores, not just one or a few as in other studies, and with a large sample that roughly matches overall German consumers.

Limitations

A few limitations apply to the results of this study. It tested the intervention with loyalty card customers who made at least six purchases in the preceding three months only. The loyalty cards that were used to track purchases on an individual level were not necessarily used for each purchase, nor can it be dismissed that more than one person used the same card. Mixing the feedback and social norm messages with incentives may have influenced results as well. For the manipulation check, the multi-month time delay between receiving the social norm and feedback coupons and administration of the survey may have allowed any existing effects to decay in the meantime. Finally, the high variance of organic shares from market to market and from customer to customer may have lowered the statistical power of the analysis and, thus, obscured smaller effects in the data.

Generalizability

In terms of generalizability, this study is an advance over several other studies that were conducted under less generalizable conditions, for instance, in a laboratory setting, testing a low number of products, or based on small or convenience samples (e.g., Demarque et al., 2015; Taube & Vetter, 2019). Nevertheless, this study tested only one particular social norm intervention with a distinct

⁵ All individual-level data was pseudonymized in accordance with the General Data Protection Regulation (GDPR). Consent was obtained for collecting data as well as linking data from the survey and purchasing for the purposes of this research.

setup in terms of wording, time, place, and other message characteristics. It is not obvious that these results generalize to other social norm message applications for organic food purchasing. The loyalty card-only sample in this study purchases notably less organic food than the other consumers in the analyzed stores, which also may limit generalizability. While many studies assume that findings in this domain generalize across countries, it is not clear that the findings from a large-scale experiment at one German supermarket chain will apply to other countries with a different consumer sentiment regarding organic food and different consumption habits and supermarket environments. The effects may also be influenced by the specific demographics present in the targeted stores. Lastly, the intervention required a system for printing coupons at checkout that is not present at all supermarkets.

Interpretation

Several factors may explain the lack of influence of the messages in this study:

First, the post-intervention survey indicates that the messages failed to manipulate descriptive norm perceptions for the small share of surveyed participants. The choice of a relatively low descriptive norm communicated in the messages may have contributed to the messages' lack of impact. Potentially, consumers believed that many others buy organic food even before the intervention. In this case, the norm message would not have changed norms because consumers already believed the norm message before the intervention. However, there is also a possibility that the manipulation check was non-significant due to the long delay between intervention and survey as well as the small sample size of the survey.

Second, the coupons used to deliver the messages may have exerted only a small influence on purchase behavior. Part of this weakness may stem from the fact that coupons are read and comprehended only after a supermarket purchase is completed. As a result, their effect may have decayed by the time the next organic food purchasing decision was made a few days or weeks later, meaning the norm was not salient enough anymore. It is conceivable that nudges are more influential when applied directly at the time and place when a decision is made. More research is needed on identifying the appropriate timing and location of such nudges. It may also be interesting in the future to test nudging techniques that intervene directly at the time and place of the purchase decision. Study 2 and Study 3 provide results for such nudges.

Third, the designs of the messages may have changed their effectiveness. Inclusion of the monetary incentive may have confused consumers regarding the purpose of the message and the persuasiveness of the communicated information. The trustworthiness of the messenger, in this case the supermarket, potentially could have affected its result. Other parameters such as size, wording,

and focus on a category of products rather than specific products or included pictures may have also played a role.

Fourth, coupon messages may have been difficult to translate into sustainable purchase behavior. While the coupons included the EU organic logo as a picture, no attention was directed to specific products or product categories. While such an association may be problematic in its own right (Richter et al., 2018), it may also help in translating the message to behavior. Even though consumers make many spontaneous purchase decisions, habits also carry a strong influence. Perhaps, a message tailored to product categories with a high share of spontaneous purchase decisions (such as snacks) would have been more effective.

Fifth, high variance in the dependent variable may have limited the statistical power of the analyses. Sales of both organic and conventional products fluctuate substantially from purchase to purchase, from individual to individual, from market to market, and from week to week. These naturally occurring fluctuations make it difficult to detect the effects of the employed messages.

Finally, this study failed to confirm the influence of social norm and feedback messages on real-world pro-environmental behavior in the sustainable purchasing domain. This could be an indicator of the mild influence of social norm and feedback messages in this setting. Nonetheless, the lack of influence may have also been caused by the particulars of this intervention, for instance, by the aforementioned timing and location of the messages. Social norms and feedback messages may be influential only if specific preconditions are met. The results highlight that the context and exact specifications of a setting where social norm and feedback messages are employed may matter significantly for their effectiveness. A social norm message placed in a hotel room nudging a guest to reuse a towel may draw more attention than a similar message in a supermarket. Reusing a towel may be quite a simple behavior compared to finding, evaluating, and purchasing an organic grocery item. Along these lines, a few published and unpublished studies failed to find significant effect of social norms on sustainable purchase behaviors (e.g., Richter (2018) and Dorn & Stöckli (2018)) and indicate that the influence of social norms and feedback in a supermarket setting has perhaps been overestimated.

Recommendations

The overall finding that none of the two tested treatment messages and the two tested control messages significantly influenced behavior suggests that further pursuit of checkout coupons for message delivery may not be effective. Instead, researchers should study messages that are close in time and space to the targeted behavior, are not coupled with incentives, and originate from a trustworthy source, though these are obviously extrapolations threatened by inductive failure (see Subchapter 1.3).

For social norms, it might be worth pre-testing the messages in a laboratory to ensure that they have an influence on norms before testing them in the field. It might also be interesting to test social norm effects of actual persons (for instance, with actors in the supermarkets) to make them more immediately experienceable. For feedback, it might be worth including a negative feedback loop that indicates if the self-set standard is not met. As for social norms, it might be worth pre-testing messages in the laboratory to eliminate reactance to overly strong messages. It could also be interesting to experiment with more direct feedback at the shelf when the purchase decision is made, for example, through direct visual or aural clues at the shelf.

5.2 Study 2: Sorting

Study 2 tested the influence of implementing a sorting intervention for organic purchasing in 101 supermarkets in Northern Germany.

5.2.1 Hypotheses

Since many previous studies seem limited in their generalizability to actual in-store purchases, the hypotheses were tested in field experiments that manipulated actual point-of-sale environments in markets of a German supermarket chain. The advantage of this approach is its external validity and the transferability of results to other supermarkets. However, since rearranging products is time-intensive, and supermarkets are wary of confusing consumers through frequent major sorting changes, only a limited number of rearrangements can usually be implemented in real-life settings.

To increase its effectiveness and scalability and to decrease complexity and cost, Study 2 bundled three placement intervention techniques together: changing the sorting structure, increasing the number of locations, and increasing the shelf space of organic products. All of these techniques can claim some support for their effectiveness in the conventional marketing literature, but, to the author's knowledge, not a single experimental study has been published analyzing their individual or joint effectiveness for organic food purchasing.

These techniques influence purchasing through a variety of pathways. Sorting products in a certain way can make the sorting attribute more salient. If products are sorted by flavor rather than brand or environmental friendliness, this might suggest to consumers that flavor is an important attribute. Sorting can also interact with a consumer's decision sequence. If a consumer comes into the store to purchase milk and walks directly toward the dairy section, he might miss the organic milk if it is placed in a separate organic section of the market. Displaying a product in multiple locations and increasing their shelf space can make products more noticeable and could also drive consumer perceptions about which products are popular choices for other consumers.

The effectiveness of sorting changes depends on the previous setup of the targeted supermarkets. In the case of the supermarkets analyzed in Study 2, the targeted products had previously been placed in one block close to the entrance of the market. The intervention retained that placement and additionally placed the targeted products next to their conventional equivalents. For example, the branded organic cereals had previously been placed only in the block near the entrance. After the change, they were also placed in the cereals section, adjacent to the conventional cereals.

Based on these considerations, the first hypothesis proposes that such a sorting intervention increases the share of the targeted products.

H1: Placing a set of organic products next to their conventional alternative in addition to placement in a block increases the revenue share of the re-sorted products.

In this first hypothesis, the revenue share of the re-sorted products is the dependent variable of concern. However, one could hypothesize that a sorting change only leads to a substitution of one organic product by another, and the overall organic share is left unaffected. Therefore, the effect on the overall organic share is tested in hypothesis 2.

H2: Placing a set of organic products next to their conventional alternatives in addition to placement in a block increases the revenue share of organic products overall.

In targeting the intervention to specific markets, it would be important for marketers to know whether the effectiveness of the intervention depended on store characteristics. Specifically, it was of interest whether such a measure was more effective for markets that previously sold little of the targeted products, potentially because consumers did not find them, or for markets that previously sold many of them, potentially because consumers in these markets are highly motivated. There is little theoretical guidance on which of the two hypothesized pathways should be stronger. Marketers in the supermarket thought that the former hypothesis rather than the latter would be stronger, so hypothesis 3 was based on this assessment.

H3: The sorting intervention increases the purchases of re-sorted products more in those markets where they were previously sold less.

Such a differential effect may also hold depending on the prior organic share. One could assume that markets where a significant number of organic products are bought already react more strongly to the sorting intervention because consumers are generally more motivated in these markets.

H4: The sorting intervention increases the purchases of re-sorted products more in those markets where organic products were previously sold more.

5.2.2 Method

Experimental Design

Study 2 employs a quasi-experimental nonconcurrent design. Supermarkets were not re-sorted all at the same time, but sorting changes were staggered over a period of several months. Such a staggered introduction allows for deducing common time trends from markets that have not been treated yet and isolating those general time trends from the treatment effect.

Participating Markets

The participating markets were selected by the supermarket chain's management. Supermarkets were able to opt out if they did not want to participate. A total of 101 supermarkets in Northern Germany received the treatment, with 38 markets that lacked complete data for the full 8 weeks before and the full 8 weeks after the intervention being excluded from further analysis. This left 73 supermarkets with complete data for inclusion in the analysis.

Intervention

The intervention targeted a subsegment of one brand of organic products available in the market. These products had previously been placed in one organic block close to the market's entrance. The intervention left this block intact but additionally placed frequently purchased products next to their conventional alternatives in their respective store locations.

This sorting change entailed three components: an increase in shelf space, additional locations for the re-sorted products, and a different sorting regime. The intervention was scaled with the market size. For smaller markets, only the 50 best-selling products were re-sorted. For larger markets, the 100 best-selling products were re-sorted, and for the largest markets, the 200 best-selling products were re-sorted.

The sorting changes were implemented one market at a time by a team of two to four people, who spent several days re-sorting the products. The sequence of introduction was based on the geographic location of the markets, with sorting changes introduced from west to east. Overall, the process of re-sorting the markets took several months.

Outcomes

The primary measured outcome was the revenue share of the re-sorted organic grocery products relative to overall grocery revenues in the corresponding market. The outcome measurements were not changed after start of the study.

Baseline Comparisons

To determine whether the participating supermarkets are indicative of the larger set of all markets, they were compared to German averages on three descriptive statistics.

	Sample	German Average
Average Market Size	252% ^a	100% ^a
Average Market Revenue	113% ^{a,b}	100% ^a
Average Organic Share	4.0%	4.8% ^c

a Values indexed to 100% to keep sensitive data confidential. b Estimate based on 6 months of data. c (Bund Ökologische Lebensmittelwirtschaft, 2017).

Table 18: Summary statistics of sample compared to German supermarkets

The participating supermarkets are much larger than German average but remarkably similar in terms of market revenue and organic share. Thus, any extrapolations must be taken with care, especially regarding the size of the market.

Statistical Methods

Ordinary least square linear regression was used to estimate treatment effects. Since treatment was not randomized, omitted confounders are a concern. Thus, dummy-coded controls for market and time fixed effects were included to absorb time trends or fixed market effects.

5.2.3 Results

Hypothesis 1

The intervention effects were estimated based on a simple linear regression.

$$\text{re-sorted_share}_k = \beta_0 + \beta_1 \text{re-sorted}_k + u_k \quad (13)$$

The variable *re-sorted_share* captures the revenue of the re-sorted products relative to the overall food revenue of the market. The share, rather than absolute revenue, is used to lessen the influence of seasonal variations in overall market revenue. The variable *re-sorted* captures whether the market was re-sorted. To ensure that the estimate effects are not the result of omitted variables capturing the time trend or market-specific factors, a difference-in-difference specification was also estimated.

$$\text{re-sorted_share}_k = \beta_0 + \beta_1 \text{re-sorted}_k + \beta_2 d_market_k + \beta_3 d_week_k + u_k \quad (14)$$

The dummy-coded variables *d_market* and *d_week* capture fixed effects for certain weeks or certain markets. For example, the variable *d_week* could absorb a time trend in the share of re-sorted products over the experimental period.

The regression results for both specifications are presented in the following table.

	<i>Dependent variable:</i>	
	re-sorted_share	
	(10)	(11)
Re-sorted	0.00078*	0.00076***
	(0.00044)	(0.00004)
Constant	0.00448***	0.00445***
	(0.00031)	(0.00017)
Market Dummy Variables	No	Yes
Weekly Dummy Variables	No	Yes
Observations	148	3,635
R ²	0.021	0.941
Adjusted R ²	0.015	0.939
Residual Std. Error	0.003 (df = 146)	0.001 (df = 3498)
F Statistic	3.193* (df = 1; 146)	411.872*** (df = 136; 3498)

Note: * p < 0.1; ** p < 0.05; *** p < 0.01

Table 19: Regression results, re-sorted organic products

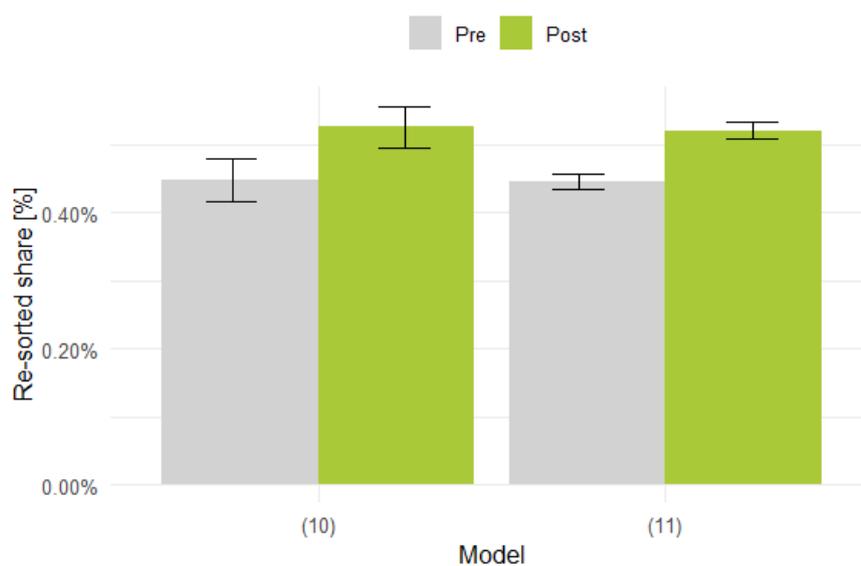


Figure 24: Regression results, re-sorted organic products

Both specifications illustrate remarkably consistent results. The share of the targeted products relative to overall food revenue increased by .078% and .076%, respectively. In other words, the re-sorting intervention increased the revenue share of the re-sorted products from 0.45% to 0.53%. This is equivalent to a 17% increase in the sales share of these products.

Hypothesis 2

To test the second hypothesis, only the dependent variable was modified in the previous specifications.

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{re-sorted}_k + u_k \quad (15)$$

$$\text{organic_share}_k = \beta_0 + \beta_1 \text{re-sorted}_k + \beta_2 \text{d_market}_k + \beta_3 \text{d_week}_k + u_k \quad (16)$$

The variable *organic_share* captures organic revenue relative to overall food revenue. The regression results are presented in the following table.

	<i>Dependent variable:</i> organic_share	
	(12)	(13)
Re-sorted	-0.0001 (0.0004)	-0.0001 (0.00004)
Constant	0.042*** (0.003)	0.046*** (0.0004)
Market Dummy Variables	No	Yes
Weekly Dummy Variables	No	Yes
Observations	148	3,635
R ²	0.0004	0.990
Adjusted R ²	-0.006	0.990
Residual Std. Error	0.023 (df = 146)	0.002 (df = 3498)
F Statistic	0.061 (df = 1; 146)	2,560.159*** (df = 136; 3498)
<i>Note:</i>	* p < 0.1; ** p < 0.05; *** p < 0.01	

Table 20: Regression results, overall organic products

No impact on the overall organic share is detected in either specification of the regression. These findings suggest that the effect on the re-sorted products did not carry through to the overall organic share, since the regressions would have been powerful enough to detect an effect of the magnitude detected when simply analyzing the re-sorted share.

Hypothesis 3

The next hypothesis proposed that the intervention had differential effects depending on the previous revenue share of the re-sorted products. To test this, the difference between the re-sorted share before and after the intervention was captured in the *delta_re-sorted_share* variable. The re-sorted share prior to the intervention was included as *pre_re-sorted_share*.

$$\text{delta_re-sorted_share}_k = \beta_0 + \beta_1 \text{pre_re-sorted_share}_k + u_k \quad (17)$$

The regression results are presented in the following table.

<i>Dependent variable:</i>	
share_delta	
pre_re-sorted_share	0.0271 (0.0397)
Constant	0.0007*** (0.0002)
Observations	74
R ²	0.0065
Adjusted R ²	-0.0073
Residual Std. Error	0.0009 (df = 72)
F Statistic	0.4684 (df = 1; 72)
<i>Note:</i>	* p ** p *** p < 0.01

Table 21: Regression results, differential effects re-sorted organic products

The results do not provide evidence of an interaction between the prior share of re-sorted products and the impact of the intervention. The impact of the intervention seems to have been equivalent across this dimension.

Hypothesis 4

This estimation was repeated for the overall organic share rather than simply the re-sorted products.

$$\text{delta_re-sorted_share}_k = \beta_0 + \beta_1 \text{pre_organic_share}_k + u_k \quad (18)$$

The regression results are presented in the following table.

<i>Dependent variable:</i>	
share_delta	
pre_organic_share	0.0094** (0.0042)
Constant	0.0004* (0.0002)
Observations	74
R ²	0.0660
Adjusted R ²	0.0530
Residual Std. Error	0.0008 (df = 72)
F Statistic	5.0865** (df = 1; 72)
<i>Note:</i>	* p ** p *** p < 0.01

Table 22: Regression results, differential effects overall organic products

The regression indicates that a high prior share of organic products was associated with a stronger increase in the share of the re-sorted products. This result provides evidence that markets with an

already high share of organic products increased their re-sorted share more than those with a previously low organic share.

5.2.4 Discussion

Main Findings

Study 2 examined the effectiveness of a sorting intervention in increasing the organic revenue share in the targeted markets. Placing a set of organic products next to their conventional alternative in addition to a pre-existing placement in a block increased the revenue share of the re-sorted organic products by about 17%.

This effect, however, did not carry through to the overall organic share in the markets where the intervention was implemented. Other organic products were likely bought less as a result of the more prominent placement for the re-sorted organic product. No evidence of an overall substitution of conventional products with organic products was found.

Strengths

To the author's best knowledge, this study is the first published experimental study testing the effectiveness of a sorting intervention on increasing the share of organic food purchases in supermarkets. This study is also an advance over sorting studies in the wider sense without a pro-environmental focus. These are often hampered by correlational designs with reverse causality issues, artificial laboratory environments, single-product focus, small samples, and limited geographic locations (see chapter 4.3). This study of 101 supermarkets spread across Northern Germany, focused on dozens of products, and implementing an intervention provides new evidence for the importance of sorting and placement for purchase decisions.

The main strength of this quasi experiment is that consumer behavior was tested in the actual decision environment at the point of sale. Additionally, the tested intervention is a realistic implementation option for the many supermarkets that currently display their organic food products only in a block placement and could potentially be scaled to many markets. Compared to the intervention tested in Study 1, a strength of the sorting intervention in this study is that it is influential at the precise time and place in which the purchase decision is made—when choosing the product at the shelf.

Detailed longitudinal data availability is another strength of this study. The measurement of actual purchase behavior at the point of sale, an objective outcome compared to subjective self-reported purchases in other studies, distinguishes this study from many psychological studies. The possibility to track both the effect on the targeted products as well as the overall organic share of food allows for identification of a boomerang effect that may have gone unnoticed with less-available data. The

availability of data allows the demonstration of robustness of results across multiple model specifications. The study is also unique in its large sample size of 101 analyzed supermarkets. The author is unaware of any other published experimental studies on location influence involving such a high number of supermarkets.

Limitations

Despite these strengths, the non-random introduction of the sorting intervention may have biased results, even though the robustness of results to the introduction of market and time dummy variables weakens this argument. Moreover, the design does not allow for disentangling the effects of the various mechanisms employed by the intervention. Since the intervention combined double placement, comparative placement, and an increase in shelf space in one intervention, only a joint evaluation is possible. High variance in sales data may have obscured smaller effects, for instance, in the overall organic share.

Generalizability

As for the previous study, it is important to note that the study tested one instance of the many options for sorting interventions only. Extrapolations to sorting interventions in general must be taken with care to avoid inductive failures (see Chapter 1.3). Several characteristics of the quasi experiment may limit the generalizability of results. A specific set of organic products was targeted in this experiment, and other products may react differently to placement changes. Furthermore, the specific dynamics of the German organic market may limit generalizability to other geographic locations. Finally, the effects may vary depending on the consumer demographics present at the targeted stores and the participating supermarket chain.

Interpretation

The results confirm that placement does play an important role in organic food purchases, though the reported effect sizes are substantially smaller than those reported in the literature. The results are similar to the experience of Dréze, Hoch, and Purk (1994), who also failed to find the hypothesized effect sizes in their field experiments. The results are also similar to those of Glanz et al. (2014), who found a similar increase in sales due to their placement intervention for healthy products.

Several hypotheses may explain the effectiveness of the approach for increasing the share of the targeted organic products. One hypothesis is that the new sorting sequence may have more closely matched the sequencing of consumer decisions. Perhaps, few consumers go into the supermarket knowing that they want to buy organic products, independent of what conventional alternatives are available. Rather, they come into the market aiming to purchase noodles, milk, and tomatoes. Then, only when they arrive at the location where the products are placed, they make a decision on whether

they want to choose an organic brand or a conventional brand. The possibility to compare price when organic and conventional alternatives are placed next to each other may also play a role. Another aspect of the intervention—placement of the products in two locations rather than the previous single location only—may have also led to the increase. Additionally, more shelf space was devoted to the products after the re-sorting intervention. These factors may have also played a role.

The lack of an overall effect on the organic share suggests that the placement changes led consumers to substitute a non-re-sorted organic product for a re-sorted organic product. This finding has important implications for interventions targeting single products rather than the overall category. An increase in the targeted products does not necessarily mean that the overall organic share increases.

Recommendations

This study confirms the influence of sorting on organic sales of the targeted products, but it questions its effectiveness in increasing the overall organic share. It would be interesting to explore in future research whether a sorting intervention targeting all organic options rather than just a subset would have a positive overall effect on the organic share. It could also be interesting to disentangle the influence of the various elements of this intervention—the increase in shelf space, the placement in two locations rather than just one, and the influence of the precise sorting scheme. More elaborate sorting strategies within the shelves could also be considered. It would also be desirable to conduct future research with similarly large or larger samples and time trend and store control variables to ensure that the experiments have enough power to detect small effects even when sales fluctuate. Finally, it should be noted that the sorting changes implemented in this intervention were quite work-intensive. Where possible, they should be combined with regularly scheduled re-sorting to decrease cost.

5.3 Study 3: Vertical Position

Study 3 analyzes the impact of changes in the vertical position on the sales of organic cereals at six supermarkets in Northern Germany.

5.3.1 Hypotheses

The effectiveness of eye-level placement in driving sales has long been part of conventional wisdom in the marketing literature and among the general public. Interestingly, however, the empirical and especially the experimental evidence supporting this claim for conventional groceries—at least in the published scientific literature—is sparse. Experimental results are often based on a single product in a single store only. Correlational research frequently suffers from potential reverse causality issues: Are products placed at eye level because they sell well? Or do products sell well because they are placed at eye level? For laboratory studies, it is often unclear whether the findings generalize to real-world shopping environments where consumers are exposed to a multitude of other influences such as time pressure or financial constraints. For organic groceries, even less evidence has been published. As an exception to the rule, a study by van Herpen, van Nierop, and Sloot (2012) found eye-level placement to be associated with higher sales in a correlational research design.

Nevertheless, to the author's best knowledge, no single experimental study has been published analyzing the impact of eye-level placement on organic products. This may be due to the costliness of rearranging store layouts and the complications of controlling for the multiple influences on a product's sales. Another factor is that much of the research may be proprietary and only rarely published in peer-reviewed journals (Sigurdsson et al., 2009, p. 741).

As with the previous study, Study 3 develops and tests a potentially scalable and transferable intervention rather than focusing solely on theory development. The starting point for this research is the observation that, currently, organic groceries vary in the vertical position in which they are placed across retailers and categories in Germany. Consequently, identifying an optimal vertical position could help to increase organic sales at those markets that currently place them in less-than-optimal positions.

Retailers rearrange their products regularly. Thus, the costs of rearranging products are minimal if the rearrangement is done as part of the regular routine. Such a low cost could aid scalability of this intervention. For this study, products had to be actively rearranged outside of regular rearrangements. Thus, to limit complexity and cost for rearranging products simply for the purpose of this experiment, this study is limited to the product category of cereals.

Since no previous experimental findings are reported for organic groceries, the correlational literature is used as a starting point for the hypotheses in this study. The literature suggests that a position between grab level and eye level is most beneficial to sales. Drèze et al. (1994) suggest that positioning products at about 56 inches (142 cm) above the floor is the optimal vertical position. Building on this finding, this dissertation proposes that top-half placement increases organic sales.

Hypothesis 1 (H1): Placing organic groceries on the top half of the shelves increases their share compared to placing them on the bottom half.

Marketers have more options than simply placing a product in the top half or not. A conventional shelf setup in a German supermarket has about six shelves available from the floor level to the top. Since space at eye level is sparse, and many products compete for this position, it would be of interest to study what effect other shelf positions have on the sales of organic groceries. Therefore, the second hypothesis aims to establish the effect of shelf vertical position on organic grocery sales.

Hypothesis 2 (H2): The increase in organic cereal sales varies depending on the precise shelf on which the organic cereals are placed.

5.3.2 Method

Experimental Design

The study is based on parallel in-store experiments at six German supermarkets. Shelves were rearranged at three treatment markets, and three control markets without rearrangements were matched to these treatment markets based on store characteristics.

Participating Markets

A convenience sample of three treatment supermarkets located in Northern Germany was paired with similar markets in terms of location, size, organic market share, and number of listed organic products.

	A		B		C	
	Treatment	Control	Treatment	Control	Treatment	Control
Region	Berlin	Berlin	Saxony-Anhalt	Saxony-Anhalt	Lower Saxony	Lower Saxony
Location	Urban	Urban	Suburban	Suburban	Suburban	Suburban
Size (m²)	900	800*	5,100	4,000	4,300	3,400
Organics share baseline (%)	9.0%	12.9%	2.4%	2.2%	4.8%	4.7%
Organic cereal share baseline (%)	29.7%	22.6%	31.9%	22.2%	32.1%	28.0%

* No data available – Estimated based on store visit.

Table 23: Treatment and control supermarkets characteristics

The data reveals significant variations in organic revenue shares from treatment market to treatment market. Control markets are matched to markets with similar organic revenue shares. The data also reveals that organic cereal shares (computed as the share of cereal revenue that is organic) are much higher than general grocery organic shares across all three markets. Apparently, consumers are more prone to buying organic cereal products than buying organic products in other categories.

The supermarkets were recruited into the study by the supermarket management. Two supermarkets were located in an urban environment and four were situated in smaller towns.

During the baseline period, organic cereals were placed on the lower half of the shelves to create a common baseline for all markets. During the treatment period, organic cereals were placed on the upper half of the shelves. The baseline period lasted from September 24, 2018, to November 25, 2018. The treatment period lasted from November 26, 2018, to February 17, 2019.

Intervention

The experiments manipulated the vertical position of organic cereals within the three treatment stores and analyzed the impact of these location changes on organic cereal sales. The entire organic cereal segment was targeted to avoid a boomerang effect of some organic products being substituted for other organic products as observed in Study 2.

Shelf #	Baseline Period	Intervention Period
6	Conventional	Organic
5	Conventional	Organic
4	Conventional	Organic
3	Organic	Conventional
2	Organic	Conventional
1	Organic	Conventional

Table 24: Shelf layouts during baseline and treatment periods

Within each shelf, the sequence of products and the number of facings were kept constant. Promotions, price changes, and shelf layout were monitored on a weekly basis during the experiments.

	Organic Cereal Products	Cereal Products Total
Treatment A	9	16
Treatment B	16	39
Treatment C	16	39

Table 25: Number of organic and conventional cereal products by treatment market

Since the three markets did not carry the same number and brands of products, layouts varied slightly from market to market. The larger treatment markets carried significantly more cereal products than the smaller markets. To maintain comparable layout changes, not all organic cereal products were re-sorted in all markets.

Scanner data was obtained for all six markets for both the baseline period and the intervention period. The data contained product-level information on the number of sold units and the price of the units during each week for each market in the treatment group and the control group.

Outcomes

The primary outcome of the study was the share of the re-sorted organic cereal products relative to the overall cereal products sold in the market.

Statistical Methods

Ordinary least squares regression was used to evaluate the effectiveness of the treatment. Both pre-post comparison and difference-in-difference specifications with controls were used in analyzing the data.

Baseline Comparisons

Difference-in-difference estimation relies on a common trend of the treatment group and the control group during the baseline period. These trends in the organic cereal share as a share of overall cereal revenue during the baseline period are illustrated in Figure 25.

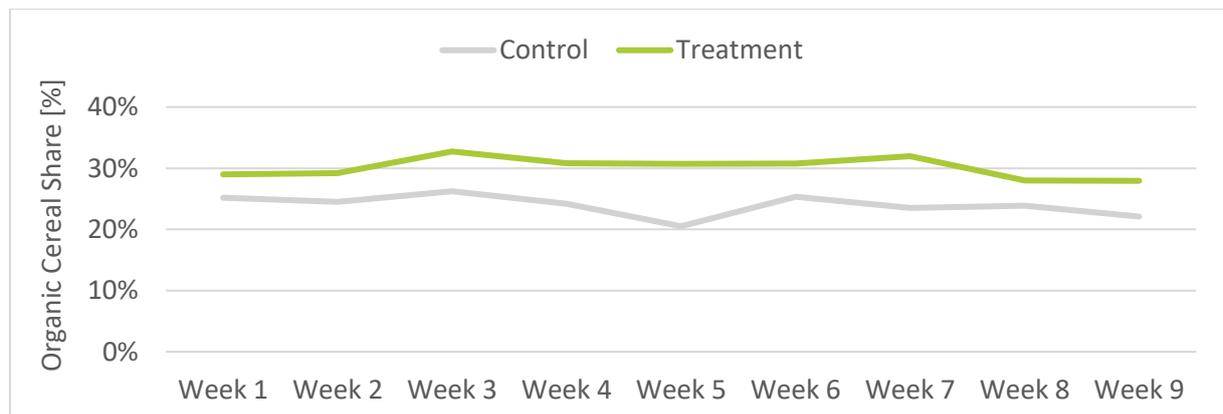


Figure 25: Baseline trends in organic cereal revenue as a share of overall cereal revenue

Visual inspection reveals a common trend of the control group and the treatment group organic cereal shares. Some deviations between the treatment and control group suggest that analyzing the robustness of results in additional non-difference-in-difference specifications could be helpful.

Representativity

The included sample of six supermarkets is too small to generalize to regional or national averages. But some data points indicate that the sample does not deviate much from German averages. The mix of urban and suburban supermarkets eliminates potential bias due to selecting only locations with high organic interest. The sample organic share of 6% is close to the overall German average of about 5%.

5.3.3 Results

Hypothesis 1

The first hypothesis posited that cereal products placed on the upper half of shelves would sell more than those placed on the lower half. This hypothesis was tested in several specifications. First, a simple pre-post-comparison was conducted.

$$\text{re-sorted_share}_k = \beta_0 + \beta_1 \text{post}_k + u_k \quad (19)$$

Second, a difference-in-difference specification was tested. This specification included data from the control markets to rule out that similar trends across all markets affected the result.

$$\text{re-sorted_share}_l = \beta_0 + \beta_1 \text{post}_l + \beta_2 \text{treat}_l + \beta_3 \text{post}_l * \text{treat}_l + u_l \quad (20)$$

Third, to absorb large inter-temporal and inter-market variance, dummy variables were included in the difference-in-difference specification. As noted when comparing supermarket data, markets are quite distinct in their organic shares, both overall and for cereals. Furthermore, organic shares vary over time. These trends are absorbed through the dummy variables in the following specification.

$$\begin{aligned} \text{re-sorted_share}_m = & \beta_0 + \beta_1 \text{post}_m * \text{treat}_m + \beta_2 \text{d_market}_m \\ & + \beta_3 \text{d_week}_m + u_m \end{aligned} \quad (21)$$

Data had to be aggregated to different levels for each specification. The first specification included only six observations of the re-sorted cereal share for each of the three supermarkets for the pre- and post-periods. The second specification also included observations for the control markets as well. The third specification was estimated with weekly data for each market. The *re-sorted_share* is computed as the ratio of the re-sorted organic cereal revenue and the overall cereal revenue.

Table 26 presents the results of these three specifications.

	<i>Dependent variable:</i>		
	re-sorted_share		
	(1)	(2)	(3)
post	0.007 (0.012)	0.001 (0.014)	
treat		0.040** (0.014)	
post:treat		0.006 (0.019)	0.006 (0.006)
Constant	0.098*** (0.008)	0.058*** (0.010)	0.118*** (0.008)
Market Dummy Variables	No	No	Yes
Weekly Dummy Variables	No	No	Yes
Observations	6	12	126
R ²	0.082	0.715	0.740
Adjusted R ²	-0.147	0.608	0.672
Residual Std. Error	0.014 (df = 4)	0.017 (df = 8)	0.018 (df = 99)
F Statistic	0.359 (df = 1; 4)	6.684** (df = 3; 8)	10.854*** (df = 26; 99)
Note:			* ** *** p < 0.01

Table 26: Regression results by shelf half

For easier interpretability, the results are graphically displayed in Figure 26.

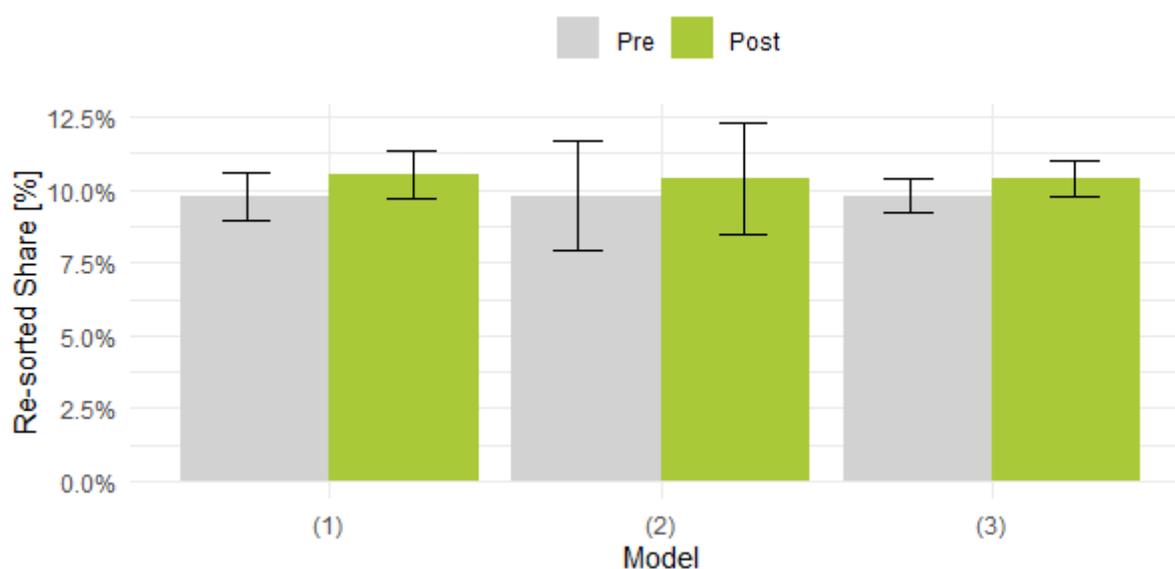


Figure 26: Regression results by shelf half

The regression results indicate that the share of the re-sorted organic cereals increased from 9.8% to 10.4% when comparing the baseline and the treatment periods for treatment markets. This effect is

not statistically significant at conventional levels. Still, the size of the effect is consistent across all three specifications.

Hypothesis 2

Hypothesis 2 posited that the re-sorting effects would vary depending on the exact shelf position. Based on product-level data on the re-sorting changes and sales, it was possible to compute changes in revenue share depending on the shelf position of the cereal products both before and after the intervention. For example, this allowed for computing the average effect for cereal products moved from shelf 1 (the bottom shelf) in the baseline period to shelf 4 (among the top half of the shelves) in the intervention period.

To estimate the effect of these changes, the shelf positions before and after the intervention were dummy coded in the *d_shelf_change_from_to* variable.

$$\begin{aligned} \text{re-sorted_share}_n = & \beta_0 + \beta_1 \text{treat} * \text{d_shelf_changed_from_to}_n \\ & + \beta_2 \text{d_shelf_change_from_to}_n + u_n \end{aligned} \quad (22)$$

The results from the regression are presented in Table 27.

	<i>Dependent variable:</i> re-sorted_share
post*shelf_changed_from_1_to_4	0.010 (0.020)
post*shelf_changed_from_1_to_5	-0.006 (0.034)
post*shelf_changed_from_2_to_3	0.005 (0.034)
post*shelf_changed_from_2_to_5	0.002 (0.024)
post*shelf_changed_from_3_to_4	-0.001 (0.034)
post*shelf_changed_from_3_to_6	-0.003 (0.024)
post*shelf_changed_from_4_to_1	-0.003 (0.020)
post*shelf_changed_from_4_to_2	-0.001 (0.034)
post*shelf_changed_from_4_to_3	0.001 (0.034)
post*shelf_changed_from_5_to_1	-0.009 (0.034)
post*shelf_changed_from_5_to_2	-0.006 (0.024)
post*shelf_changed_from_5_to_3	-0.002 (0.034)
post*shelf_changed_from_6_to_2	-0.010 (0.034)
post*shelf_changed_from_6_to_3	-0.004 (0.024)
Pre-Dummy Variables	Included
Observations	50
R ²	0.794
Adjusted R ²	0.429
Residual Std. Error	0.024 (df = 18)
F Statistic	2.174** (df = 32; 18)
<i>Note:</i>	* p ** p *** p < 0.01

Table 27: Regression results, shelf number

For easier interpretability, the results are graphically displayed in Figure 27.

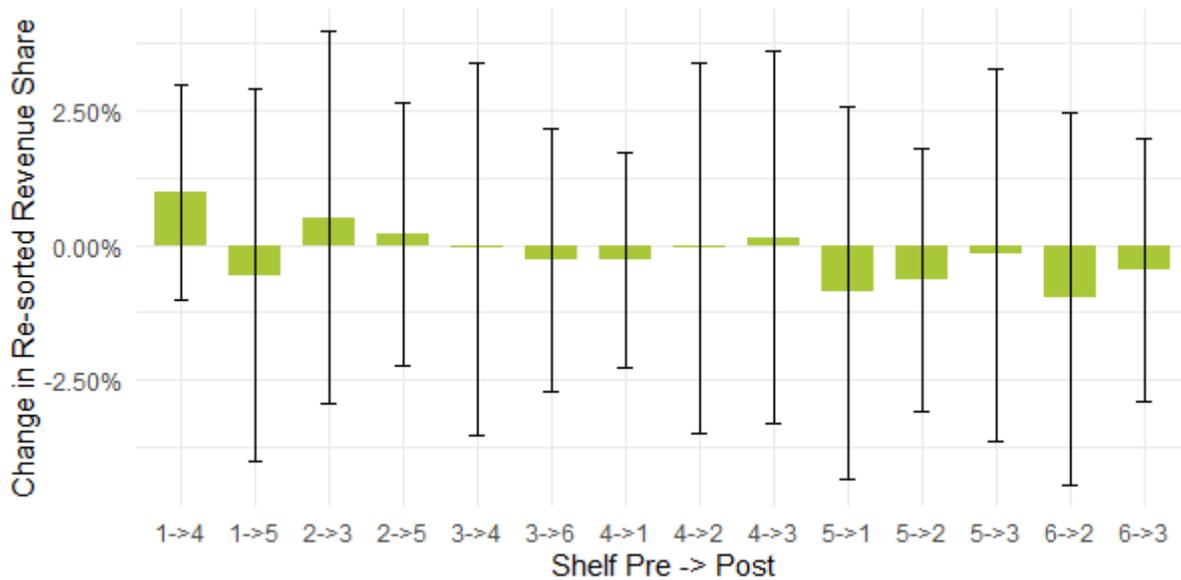


Figure 27: Regression results, shelf number

Again, the regression results do not reveal any statistically significant changes when analyzing the impact of resorting cereal products shelf by shelf.

5.3.4 Discussion

Main Findings

This study tested an often-mentioned but rarely tested nudging to increase the organic share in supermarkets: placing organic food at eye level in supermarkets. This change was implemented in an intervention that moved organic cereal products from a placement on the bottom half of the shelves to a placement on the top half of the shelves at three treatment supermarkets. No evidence of a significant sales impact of the eye-level placement intervention was detected either on a general level (top shelves vs. bottom shelves), on a shelf-by-shelf level, or when control supermarkets were added. Statistical power was sufficient to detect the major effects reported in non-experimental and laboratory studies, but no such effects were found. A small and statistically nonsignificant increase in the organic share was found to be consistent across three model specifications, but the lack of statistical significance eliminates this effect from further consideration.

Strengths

To the author's best knowledge, this study is the first published experiment studying the impact of eye-level placement for organic groceries. The approach tested in this study has several advantages over previous research: It tests the intervention in a realistic setting rather than in a laboratory, it examines actual purchases rather than self-reported data, and it targets multiple products at multiple supermarkets rather than just one category at one market, as some previous studies have done. As in

the previous studies, the tested intervention is a scalable, realistic, low-cost intervention that could be implemented on a large scale, if effective. As with Study 2 and in contrast to Study 1, this study tests an intervention that is influential at the precise time and place of the purchase decision. It is also one of few studies to include matched control stores to control for the bias of potential time trends. The average organic share matches the overall German organic share quite closely, even though the sample is relatively small.

Limitations

Although the results reported in this paper exceed previous experimental research, some limitations apply. The experiment evaluated one sorting change only and did not repeatedly change the sorting structure in an effort to avoid consumer confusion. Additionally, a sample of three supermarkets from one chain is relatively small and may be biased due to specific consumer segments with idiosyncratic behavior (though others have conducted studies with even smaller samples). High variance in the data, a condition typical for sales data, also may have contributed to obscuring smaller effects. Another limitation of this design was that stockouts were not controlled for and may have influenced results. Additionally, non-random introduction may have biased results. While a common trend of treatment and control markets was indicated by visual inspection, deviations from a common trend may have affected the concerned model specification. However, since effects were robust across specifications, this seems like a less likely scenario.

Generalizability

As with the other studies, this study tests one instance of an eye-level placement only, and other approaches to varying the vertical position may lead to different results. The results of the intervention at three markets are also not necessarily generalizable to other product categories, markets, supermarket chains, or geographies. While the markets did match the overall German organic share quite closely, they differed in other characteristics. Furthermore, the intervention was applied to one product category (cereals) only. It is possible that other product categories—for example, products that are frequently bought spontaneously—would react differently to a placement change.

Interpretation

This study is a reminder that even conventional wisdoms, such as the positive effect of eye-level placement, do not always hold true in real-life settings. While this study does not prove that eye-level placement has no effect on sales for organic groceries, it suggests that the magnitude and perhaps even the existence of eye-level placement effects for these products has been overestimated.

This research indicates that translating laboratory findings to actual settings is not always straightforward, and further research is needed to corroborate whether correlational and laboratory findings actually apply to realistic settings.

One can only speculate about the cause of such a null effect. Potentially, the intervention had no effect on sales and any differences are solely the result of random variations in sales. However, the results might also not achieve statistical significance because of the small effect of the intervention and the large random variations (“noise”) in the data. Nevertheless, the design had sufficient statistical power to detect the major effects reported in the literature, and no such effects were found.

Another explanation for this null effect could be the product category targeted in this experiment. It is possible that other, more hedonistic, products are more susceptible to sorting changes.

Recommendations

Future research should consider and address several limitations of this research. More products and product categories should be tested in larger samples with more statistical power. Treatment should be randomized. Stockouts should be controlled for. Future research should also consider that resorting can be quite work-intensive. Changing the vertical position of product could be done in conjunction with other changes to reduce the cost of this intervention.

5.4 Overall Discussion

Main Findings

The studies in this chapter evaluate the effectiveness of four nudging techniques—social norm messages, feedback messages, sorting, and vertical position—in increasing the share of organic purchases in a supermarket setting. None of the four techniques increased the overall organic share in the three tested interventions. For social norm and feedback messages, the coupons used to communicate the messages were redeemed more often when they conveyed a feedback or a social norm message, but no significant difference in the organic share was revealed by the regression analysis. For sorting, the intervention was effective in increasing the organic share for the re-sorted products by about 17%, but no change was detected in the overall organic revenue share. For vertical position, the regression analyses did not reveal any significant differences between eye-level and non-eye-level shelf positions for organic cereals. These results indicate that even plausibly effective nudging techniques from related domains of pro-environmental behavior may face significant challenges when implemented to increase organic food purchases in a supermarket setting.

Several more detailed hypotheses precluded that the overall result was non-significant due to countervailing sub-effects. For example, an intervention could have reduced consumption among high organic purchasers and increased it among low organic purchasers, thereby resulting in no overall effect. For the social norm and feedback messages, such differential effects for consumers depending on the level of prior consumption were tested and rejected (Study 1 – H5 and H6). Moreover, the existence of an effect for the first post-message purchase only was eliminated (Study 1 – H7 and H8). Additional hypotheses scrutinized the influence of certain message design components (Study 1 – H1 and H2). These results suggest that none of the employed treatment and control messages significantly changed the organic revenue share. For the sorting intervention, differential effects depending on prior organic purchases in the corresponding market were eliminated in the same manner (Study 2 – H3 and H4). For the eye-level placement study, differential effects by the exact shelf position were dismissed (Study 3 – H2). Table 28 summarizes these results for each hypothesis.

		Hypothesis	Accepted
Study 1	H1	A plain organic marketing message increases organic purchases compared to a control group without any message.	No
	H2	A plain conventional marketing message changes organic purchases compared to a control group without any message.	No
	H3	A social norm message increases organic purchases compared to a control group with a plain organic message.	No

	H4	A feedback message increases organic purchases compared to a control group with a plain organic message.	No
	H5	A social norm message increases organic purchases more for consumers with low prior organic purchases than those with high prior organic purchases.	No
	H6	A feedback message increases organic purchases more for consumers with low prior organic purchases than those with high prior organic purchases.	No
	H7	A social norm message increases organic purchases more for the purchase directly after it was communicated.	No
	H8	A feedback message increases organic purchases more for the purchase directly after it was communicated.	No
Study 2	H1	Placing a set of organic products next to their conventional alternative in addition to placement in a block increases the revenue share of the re-sorted products.	Yes
	H2	Placing a set of organic products next to their conventional alternatives in addition to placement in a block increases the revenue share of organic products overall.	No
	H3	The sorting intervention increases the purchases of re-sorted products more in those markets where they were previously sold less.	No
	H4	The sorting intervention increases the purchases of re-sorted products more in those markets where organic products were previously sold more.	No
Study 3	H1	Placing organic groceries on the top half of the shelves increases their share compared to placing them on the bottom half.	No
	H2	The increase in organic cereal sales varies depending on the precise shelf on which the organic cereals are placed.	No

Table 28: Summary of hypotheses results

Strengths and Limitations

In spite of this lack of overall findings, the three studies presented in this chapter share several strengths. The studies are each the first of their kind—the influence of the respective technique has, to the author’s best knowledge, not been academically studied with respect to increased purchases of organic food in supermarkets. Additionally, all of the studies implement a realistic, scalable, low-cost intervention that could be used on a large scale if it was successful. The measurement of objective behavior rather than self-reports or intentions is another feature that the three studies have in common. Further shared strengths of the three studies include the large and representative sample sizes, the focus on multiple products or the entire organic product category, and abundant longitudinal data. The studies also share that the reported effects are robust across multiple regression model specifications.

Nevertheless, the studies also differ in their designs and resulting strengths. Study 1 is notable for the randomized assignment of individual customers to five treatment and control groups. The careful variation of the message in the control groups allows for a more precise pinpointing of the source of effects and null effects in Study 1 compared to the other studies. Study 2 and Study 3 share the strength that they employ interventions that are targeted to the precise time and place when the customer makes a purchase decision. The large number of 101 test supermarkets in which the intervention was implemented in is another strength of Study 2.

The studies also share some limitations and generalizability considerations. All three studies had lower-than-expected statistical power due to high variance in sales data. This may have obscured smaller effects. The studies also share that they were conducted in one supermarket chain with a specific customer segment and only in one geographical region, Northern Germany. The effects may not generalize to other supermarket chains, geographies, or customer segments. Nevertheless, the available metrics from survey and consumption data suggest higher generalizability than in many comparable studies. The studies also share that they tested only one particular implementation of the respective technique. Therefore, their findings do not necessarily apply to the technique overall but may simply apply to the specific implementation.

Limitations and generalizability questions vary from study to study as well. Study 1 analyzed only loyalty card customers, and results may not apply to non-loyalty customers in the same fashion. Moreover, Study 1 limited participation to customers who used the loyalty card at least occasionally. The loyalty cards also may have been used by other shoppers in a household and were not necessarily used for each purchase. For Studies 2 and 3, the lack of randomization in the respective designs may introduce bias into the estimated effects, though steps have been taken to avoid such influence. Since the intervention in Study 2 entailed multiple components, it was not possible to pinpoint the source of the effect. In Study 3, the matching of test markets with control markets may have introduced bias into one model specification and the sample may have been too small to draw strong overall conclusions about the absence of an effect.

These different strengths and limitations are a result of the varying design from study to study. These designs are summarized in Table 29.

	Study 1		Study 2	Study 3
Description	Social norm messages distributed to customers at checkout	Feedback messages distributed to customers at checkout	Organic food items placed next to conventional alternative in addition to block placement	Organic cereals positioned at eye level
Sample	21,079 loyalty card users at 14 supermarkets		101 supermarkets	3 treatment supermarkets + 3 matched control supermarkets
Randomization	Individual randomization in 2 treatment and 3 control groups		No randomization – Staggered intervention in supermarkets	No randomization – Matched supermarkets as control
Dependent Variable	Overall organic revenue share		Re-sorted organic products revenue share and overall organic revenue share	Re-sorted organic products revenue share
Controls	3 control groups, Baseline time period		Non-re-sorted supermarkets, Baseline time period	Comparable supermarkets, Baseline time period

Table 29: Study design summaries

Interpretation

The four tested nudging techniques, though effective in other settings, did not fulfill their promise to increase the organic share in a realistic supermarket environment. Very tentatively, the tested placement changes seem to have more promise than the employed social norm and feedback messages. One significant increase in the targeted organic share in Study 2 and statistically nonsignificant but consistent increases in Study 3 suggest that further study of placement interventions could be fruitful, perhaps because they are closer in time and space to the targeted behavior and require less cognitive effort. Nevertheless, none of the interventions significantly increased the overall organic share. Any answer to why that is necessarily involves some speculation and is subject to inductive failure. Nevertheless, reasoning about the potential causes of these results might be important for further research and practitioners.

Supermarkets may be a more difficult settings in which to implement nudging techniques than other settings reported in the literature. Supermarkets subject consumers to hundreds of products vying for their attention, complex visual and aural clues, and meandering paths around the store that may

distract them from specific nudges. When compared to this setting, a social norm message in a hotel room may generate a more significant effect because it is not placed in a context of hundreds of other competing messages that vie for consumer attention.

Additionally, the particulars of the tested interventions may be more important than suggested by the theories. For example, physical and temporal distance between receipt of the norm message and execution of the decision may be an often-unmentioned yet potentially important factor for explaining the differing influence of social norm messages across publications.

Generally, the studies indicate that it can be challenging to transfer theories from the literature and the laboratory to realistic settings. Perhaps, this is an indicator for lower-than-expected generalizability of the underlying theories, but it could also point to the omission of relevant factors in the respective theories. The indications that some antecedent measure of an increasing overall organic share did demonstrate increases while the overall share did not change could also be a worrying sign for other research. Many studies report purchase intentions rather than actual purchases. The data suggests that the gap between the two might be larger than is sometimes suggested.

Finally, it cannot be dismissed that the tested techniques are less effective than the literature suggests. Perhaps, nonsignificant results are published less frequently than significant ones, leading to an overestimation of the effect in the literature, a so-called desk drawer bias. To dismiss the possibility that this is the case, more realistic studies, such as the ones reported in this chapter, are needed.

6 Conclusion

This dissertation set out to study the suitability of nudging to increase organic food purchases in supermarkets. The main result of this dissertation is that techniques found to be promising in the literature did not prove to be effective in a realistic purchasing setting to increase the overall organic share of food purchases. Since changes in realistic contexts are what is necessary to solve the sustainability crisis, this is a concerning finding for those seeking to solve the sustainability crisis of the food system by employing nudging techniques.

This chapter, the conclusion, develops and reiterates this overall finding from the theoretical-conceptual and empirical parts of this dissertation (6.1), critically reflects on the strength and limitations of this research endeavor (6.2.), and develops practical and theoretical implications as well as research recommendations (6.3). The outlook ends this chapter and this dissertation with a perspective on the state and future of this field (6.4.).

6.1 Main Findings

In undertaking this research, this dissertation proceeded in two parts: The first part of this dissertation, Chapters 1 through 4, laid the theoretical and practical foundations for applying nudging to organic food purchasing in supermarkets, by expanding on the need for a sustainability transformation of the food system, by studying the foundations and the applicability of a wide range of nudging techniques to sustainable food purchasing, and by conducting an in-depth literature review of three nudging techniques: social norms, feedback, and placement. The second part, Chapter 5, implemented and evaluated these nudging techniques in three large-scale field experiments in Northern Germany. Considering their respective findings in detail is helpful in deducing implications and developing recommendations.

6.1.1 Theoretical and Conceptual Findings

The review of theory- and practice-focused publications conducted in the first chapters identified nudging in general and three nudging techniques in particular as promising candidates for aiding the sustainability transformation of the global food system. Four themes support this argument:

- The importance of supermarkets for food purchases, and, hence, the impact of their decision environments, is growing globally (Chapter 1).

- The environmental footprint of the global food system is surpassing planetary ecosystem boundaries, resulting in an urgent need for a large-scale sustainability transformation (Chapter 2).
- Nudging techniques promise to contribute to this sustainability transformation by making supermarket purchases more sustainable (Chapter 3).
- Three nudging techniques to increase sustainable food purchasing are supported by abundant theoretical and practical evidence but need to be tested in a realistic purchasing environment (Chapter 4).

The details of each of these arguments are discussed in more detail in the following paragraphs.

First, the introductory chapter sketches out how the global shift to self-serve supermarkets has led to an increased focus on branded products and store environments, less informed consumers, and new environmental problems from food production over the past century. A historical view highlights the increasing importance of store settings for purchase decisions of consumers over the past century and emphasizes the ubiquity of situational influences on human environmental behavior. The continuing global expansion of supermarkets and the corresponding environmental problems underline the need for identifying new ways to increase the sustainability of supermarket purchases.

Second, the second chapter highlights the strain that global and regional ecosystems are already experiencing as a consequence of food production and the need for a rapid and large-scale sustainability transformation. Climate change may be the most-discussed of these strains, but other challenges such as high and growing land use, eutrophication of aquatic and terrestrial ecosystems, and biodiversity loss are also a cause of concern on the global scale. The scale, interconnectedness, and complexity of these challenges often remain invisible to consumers, even though shoppers wield substantial leverage over food production with the consumption decisions they make. A dietary shift to plant-based foods can more than halve a consumer's environmental footprint and could carry considerable health benefits as well. Organic food production can add to this reduction of environmental footprint, though it needs to be complemented with shifts in diet and grown crops. The case study of the German food system emphasizes that focusing on production within national boundaries is not enough. Germany imports food and feedstuff from an area that is larger than its own agricultural land. A focus on purchasing or consumption, as taken in this dissertation, may more completely capture such effects. The second chapter highlights that the sustainability of the global food system is indeed problematic and that major changes are needed. More policy tools to aid such a transformation that have not been traditionally used to regulate the food system are available. Nudging the purchases of organic food can be one element of such a transformation.

Third, the suitability of various nudging techniques to nudge organic food purchases in supermarkets is assessed after addressing frequent definitory and ethical issues of nudging. Since the original definition of nudging leaves open several important questions about the intentionality, falsifiability, and bias reliance of nudges, a new definition is developed. This definition characterizes nudges as interventions that aim to increase the well-being of individuals or society based on cognitive shortcuts that do not significantly alter incentives or the choice set. Frequent ethical concerns about the autonomy-reducing nature of nudges are rebutted by highlighting how the respective arguments often set an own standard (for instance, the maintenance of autonomy) as absolute in a way that would not hold true for other settings. For instance, autonomy reductions are accepted in many areas (e.g., speed limits) when the benefits seem to warrant such an approach. It is argued that a similar approach of balancing benefits and costs seems suitable for nudging if nudges can, in principle, be detected by the decision-maker. A synthesis of three nudging reviews for pro-environmental behavior supports the suitability of nudging for increasing organic food purchasing in supermarkets. Three nudging techniques are selected for further review based on their effectiveness in other comparable settings.

Fourth, three nudging techniques are considered in detail: social norms, feedback, and placement. The applicability, challenges, and opportunities in applying each technique to organic food purchases are discussed, with a particular view to the specifics that make or break the effectiveness of a particular technique. For social norms, the importance of basing a message on a close reference group and making it easily translatable into behavior are identified as the main criteria for success. The chapter also identifies a gap in research on social norm interventions that aim to increase organic food purchasing in supermarkets. For feedback, the direction of attention to the task level is identified as the main success criterion. Additionally, it emerges that feedback may be particularly effective for organic food since the discrepancy between the intention to buy organic food and the actual behavior is particularly large for organic food purchasing. Again, no studies on the effectiveness of feedback in supermarkets were encountered in the review. For placement techniques, the review identified a surprising gap in the experimental quantitative research on placement effects not just for organic purchases but also for purchases generally. Based on the correlational evidence, two strategies are identified as particularly promising for organic food purchases: changing the sorting strategy and placing organic products at eye level. Sorting strategies can be effective by making the sorting attribute more salient and by matching the decision sequence of consumers. Eye-level placements can increase sales, making products more noticeable when placing them close to the resting position of the eye. As for the previous strategies, no experimental studies that analyzed the effectiveness of placement strategies in increasing organic food purchasing were identified in the review.

The growing importance of supermarket purchases for the global food system, the need for a sustainability transformation of the food system, the apparent suitability of nudging for this setting, and the identified gaps in the literature provided the motivation for conducting experimental studies on the effectiveness of these techniques in increasing organic food purchasing in supermarkets.

6.1.2 Quantitative Findings

The four nudging techniques—social norm messages, feedback messages, sorting, and eye-level placement—were tested in three field experiments at 101 stores of a supermarket chain with more than 25,000 loyalty card holders in Northern Germany. An abbreviated version of the results is presented here; see Chapter 5.4 for a more extensive discussion. The three studies each aimed at increasing the organic revenue share. Toward this end, Study 1 tested the effectiveness of social norm and feedback messages distributed at checkout; Study 2 tested the effectiveness of changing the placement of a subsegment of organic products; and Study 3 tested the effectiveness of eye-level placement for organic cereals.

However, contrary to the hypothesized results, none of the tested techniques significantly increased the overall organic revenue share. In Study 1, some effects on antecedent measures—for instance, on the likelihood to redeem a social norm message coupon—were found, but these effects did not carry through to organic purchasing behavior. In Study 2, the intervention was effective at increasing the share of the re-sorted products by approximately 17% but failed to increase the overall organic share. This suggests that the intervention triggered a substitution within the organic segment only. In Study 3, no statistically significant effect of eye-level placement on the sales of organic cereals was found. Several more detailed hypotheses eliminated diverging sub-effects as an explanation for this result (see Chapter 5.4 for a more extensive discussion of these results). In summary, only 1 of the 14 tested hypotheses was accepted, and none of the four tested nudging techniques significantly raised the overall organic share in the test supermarkets. Table 30 summarizes these results of the most important hypotheses.

	Hypothesis	Accepted
Study 1	A social norm message increases organic purchases compared to a control group with a plain organic message.	No
	A feedback message increases organic purchases compared to a control group with a plain organic message.	No
Study 2	Placing a set of organic products next to their conventional alternative in addition to placement in a block increases the revenue share of the re-sorted products.	Yes

	Placing a set of organic products next to their conventional alternatives in addition to placement in a block increases the revenue share of organic products overall.	No
Study 3	Placing organic groceries on the top half of the shelves increases their share compared to placing them on the bottom half.	No

Table 30: Selected hypotheses results

Since the research designs varied from study to study, the results differ in explanatory power and are not strictly comparable. Study 1 is notable for randomized assignment of individual supermarket customers to various treatment and control groups. The 21,079 participants were randomly assigned to two treatment and three control groups that received varying messages through a checkout couponing system. This design allowed for disentangling the effects of various message components. Study 2 is notable for the large sample of 101 supermarkets. Such a large sample increases the external validity of results and provides evidence for how an intervention could perform at scale. Study 3 is notable for the matched control supermarkets design. This design allows for controlling time trends in sales by looking at supermarkets that had comparable sales patterns before any intervention was introduced. Table 31 reiterates the key design features for each of the three studies.

	Study 1		Study 2	Study 3
Description	Social norm messages distributed to customers at checkout	Feedback messages distributed to customers at checkout	Organic food items placed next to conventional alternatives in addition to block placement	Organic cereals positioned at eye level
Sample	21,079 loyalty card users at 14 supermarkets		101 supermarkets	3 treatment supermarkets + 3 matched control supermarkets
Randomization	Individual randomization in 2 treatment and 3 control groups		No randomization - Staggered intervention in supermarkets	No randomization – Matched supermarkets as control

Table 31: Selected study design features

Inherent in the study design, several strengths and limitations characterize this research effort overall as well as the respective studies. These are discussed in the next subchapter.

6.2 Strengths

As with the discussion of the results, the discussion of the strengths is split in two parts: The first part discusses the theoretical-conceptual chapters of this dissertation; the second discusses the intervention studies.

The genuine novelty of the theoretical-conceptual part of this dissertation is the application of the nudging concept to the purchase of organic food in supermarkets. To lay the groundwork for nudging organic food purchases in supermarkets, the first chapters proceed in three steps: First, they discuss specifics of the sustainability challenges of the food system. Second, they develop the theoretical and practical foundations of nudging in this context. Third, they provide a detailed discussion of three selected nudging techniques. The advantage of this approach is that it highlights elements that sometimes receive only cursory attention in less extensive works: the need to combine organic food production with more plant-based diets to meet planetary sustainability limits, the definitory and ethical issues of nudging, and the specifics of prior approaches to the selected nudging techniques. By addressing these issues, a more complete foundation for the subsequent experimental studies is assembled.

The main strength and novelty of the intervention part of the dissertation is the rigor of the experimental designs of the three studies. Some key features are worth highlighting (see Chapter 5.4 for a more complete discussion). The three studies evaluate the impact of the nudges quantitatively rather than inferring effectiveness from qualitative surveys or similar methods. The studies are intervention studies that test the effect of implementing changes in supermarkets rather than analyzing correlations in past data. Additionally, the studies observe actual purchase behavior rather than measuring purchasing intentions or self-reported purchase behavior in a survey (as suggested by, for instance, Lewandowski Jr & Strohmetz, 2009). Supermarkets allow for unobtrusively collecting purchase data from checkout scanners, which reduces the possibilities for biasing results by openly observing behavior. Purchase behavior is studied in the environment where it usually takes place (the supermarket) and not in a laboratory. This realistic setting may be quite different from the laboratory setups that have produced many findings in the literature. Moreover, while the samples were not fully generalizable to an overall German population, they did match important characteristics quite closely, such as the overall organic share of German supermarkets.

Specifically, the studies each are an advance of respective reference studies. Study 1 stands out as one of few experiments at supermarkets where subjects are randomly assigned to treatment and control groups. Additionally, the design with several control groups allows for pinpointing the source of any effect with greater precision than many other designs. Furthermore, the large sample of 21,079

customers is unprecedented in similar studies. Study 2 stands out for the large number of more 101 supermarkets that were included. Additionally, it is one of few studies that explicitly consider trends in comparable supermarkets as a potential source of an effect. Study 3 also explicitly considers the trends in matched control supermarkets. These strengths are considerable advancements over the methods employed to date in studying the tested intervention techniques because they are less prone to produce random effects.

6.3 Limitations and Generalizability

A brief discussion of the limitations of this dissertation supports the development of the future research agenda. The scope of this dissertation was limited in several dimensions to keep the analysis focused and manageable. However, these limitations may have also excluded some important sustainability levers from the scope of this dissertation. Only product acquisition was considered, and usage and disposal were excluded from the purview of this dissertation. Issues such as the footprint of preparing food or the recycling of nutrients are potentially important topics that are excluded by this limitation. This dissertation considered only food purchases and excluded other consumption categories, such as clothing or mobility. To meet planetary boundaries, these categories must be considered as well. Moreover, this dissertation considered only non-price factors but did not include product packaging and out-of-store factors. The higher price of many organic goods also plays a role in purchase decisions that should be considered. Only supermarkets with a choice between organic and conventional groceries were analyzed; organic-only or conventional-only markets were not considered. However, shopping for groceries at an organic-only market may be the least cognitively challenging way of increasing the organic share. In short, many other levers exist to increase the organic share in supermarkets and the sustainability of the food system.

A few additional limitations apply to the intervention part of this dissertation. First, it should be noted that this dissertation tested only one specific implementation for each employed nudging technique; many other implementations are conceivable. Even though the implementations were chosen to maximize their effectiveness, other, more effective, implementations could exist. To increase effectiveness, a combination of strategies could be promising even if the individual strategies are ineffective. This, however, would hamper the scientific value of the study in that internal validity would be low, and effects could not be traced back to specific intervention elements. Overall, any extrapolation from the particulars of the chosen implementation to the general effectiveness of the particular nudging technique is subject to induction errors.

The studies presented in this dissertation have large and more generalizable samples. Nevertheless, it is possible that the idiosyncrasies of the analyzed markets and their respective customers limit the

generalizability of the results of this dissertation. For a more extensive discussion of limitations and generalizability of the implementation studies, see Chapter 5.4.

6.4 Implications

The contrast between the reportedly effective nudging techniques in the literature review and the non-significant results in the three intervention studies has a range of theoretical, methodical, and practical implications. In this context, it can be useful to speculate about the reasons for the non-significant results, even though no definitive answers can be deduced, to crystallize the implications and provide the bases for future research recommendations.

6.4.1 Theoretical Implications

The results from the three intervention studies challenge literature findings about the effectiveness of the four nudging techniques. While the studies in this dissertation do not provide sufficient evidence to reject the respective theories on social norms, feedback, sorting, and vertical position, they can be read as evidence that questions the magnitude of effects from the respective nudging techniques, at least with respect to this particular setting. A potential file-drawer bias may lead to publications overestimating the effectiveness of these techniques because non-significant findings, in contrast to significant ones, are less likely to be published (Shrout & Rodgers, 2018). As Kluger and DeNisi (1996) point out, there is a danger of attributing nonsignificant effects to a failure of the specific intervention while interpreting significant findings as supporting the theory. Therefore, as is done in this dissertation, nonsignificant results should also be published and discussed critically. This would allow for a more complete picture of the effectiveness of the respective nudging techniques and nudging overall.

The findings from this dissertation also question the generalizability of the employed nudging techniques to new settings. The absence of effects in this dissertation's studies suggests that the techniques may not generalize as much as previously thought. Possibly, the theories do not account for important influences that mediate or moderate the effectiveness of the respective techniques in new settings. For example, social norm messaging may be effective for an easy behavior, such as recycling towels (e.g., Goldstein et al., 2008), but not for a comparatively difficult behavior, such as purchasing organic groceries. Characteristics of both the behavior and the situation likely explain the effectiveness in one but not the other setting, but theory to date is largely mute on what differentiates the two. One can easily conceive of many factors, ranging from size, location, and timing of the message to the ease of the targeted behavior. More theory must be developed and tested to ensure that techniques are applied to situations where they are effective.

Furthermore, the supermarket context may have played a role for the nonsignificant effects. Realizing effective interventions may be more difficult in supermarkets where many messages compete for consumer attention, and consumers are accustomed to tune out all but the most relevant stimuli. Including cognitive strain as an additional explanatory variable in the respective models on social norms, feedback, and position might yield relevant results.

The chosen implementations of the tested nudges and the supermarket setting may have lessened or eliminated their effects. It is possible that norm and feedback messages must be delivered closer in time and space to the relevant decision to make them salient factors in the decision process. A sorting intervention targeting the entire segment rather than simply some products may have affected the overall organic share. (For a similar argument, see Richter et al., 2018.) It is possible that an eye-level placement for a more hedonic product than cereals may have been effective. Including the temporal and spatial distance as additional explanatory variables in the respective theories could reveal the role of these for the effectiveness of the respective techniques. (For a similar argument regarding prompts, see Schultz, 2014, p. 112.)

6.4.2 Methodical Implications

The standard of evidence in this dissertation's experimental studies is an advance over several previous efforts. Randomization, adequate controls, large enough samples, realistic experimental environments, and adequate measures of actual behavior are some of the characteristics that distinguish this effort. Surprisingly, some prior experimental evidence for eye-level and placement effects seems to be based on brief, single-product studies in one supermarket conducted almost half a century ago. Several psychological consumption publications on social norms and feedback use self-reported intention measures and suggest that these are useful predictors of actual purchases. This dissertation's finding that some antecedent measures can reveal an influence while the actual behavior did not change suggests that this approach may overestimate the effectiveness of the respective interventions. Therefore, several of the reported effects in the literature potentially would not persist under more rigorous experimental conditions.

More careful quantitative experimentation, including randomization in realistic field experiments, may address such shortcomings. Properly randomized field experiments can address these flaws and should be employed more frequently. Recent developments in the field of development economics—marked by the 2019 Nobel Prize for Kremer, Duflo, and Banerjee—may serve as a methodical blueprint for sustainable purchasing. The trends toward collecting more and more digital data on consumer behavior should help such a shift and open a window for more natural experiments that could generate relevant results for aiding the sustainability transformation.

The high variation of sales in supermarkets makes it more difficult to detect effects. Supermarket sales in general, and organic sales in particular, fluctuate significantly from week to week, from market to market, and from individual to individual. These naturally occurring fluctuations may obscure relatively smaller effects of the tested interventions. In other words, the effects potentially exist but were too small to be detected.

From a methodical perspective, this dissertation also raises the question whether theory-inspiring studies are replicated enough. While the replication crisis has placed a focus on the value of replications, many theories have still not been replicated sufficiently (Shrout & Rodgers, 2018). More testing may also be required regarding the generalizations made and not just the specific context of the original study proposing a theory.

6.4.3 Practical Implications

The results of this dissertation suggest that nudges cannot easily be translated to any environment to aid pro-environmental decisions. Human behavior is complex, and while scientists understand the influences in some situations, these do not necessarily generalize to other settings.

The results also highlight the importance of quantitatively tracking the results of nudging interventions, since interventions do not always produce intuitive results. They also emphasize the context dependence of the tested nudging techniques and suggest that the tested nudges are not promising for increasing the sustainability of supermarket purchases.

For practitioners seeking to solve the sustainability crisis of the food system by changing supermarket purchases, the results of this dissertation provide a cautionary tale. Nudges are not always effective when applied to new environments, and even large-scale and carefully designed interventions fail.

The main result of this dissertation is that the tested nudges are not a panacea for increasing the organic share in supermarkets. While they are effective in some situations, they may not be in others, and it is still not entirely understood why that is the case. For the sustainability transformation to be successful, it must produce tangible and measurable outcomes in real-world settings. The nudging techniques employed in this dissertation did not achieve this goal.

6.5 Avenues for Future Research

Four broad directions for future research can be drawn from this discussion: expand randomized controlled quantitative research; transfer more survey, laboratory, and correlational findings to realistic intervention research; deepen the study of specific nudges; and incorporate more findings on environmental footprints.

This dissertation underlines the need for further methodologically sound quantitative research on nudges in supermarkets. Even conventional knowledge, such as the positive influence of eye-level placement on sales or the social influence on green purchasing behavior, could not be replicated in the experiments in this dissertation. These findings illustrate that even well-intentioned interventions based on sound theoretical and correlational research do not always result in effective interventions. Randomized controlled quantitative evaluation ensures that research and implementation efforts can be focused on effective interventions rather than wasting resources on scaling ineffective interventions.

Solving the sustainability crisis requires practical and scalable solutions that are effective in realistic settings. However, many findings, especially in the domain of environmental psychology, are based on correlational or laboratory research that is invaluable for developing theory but not always transferable to practical contexts. To advance in addressing the sustainability crisis, the identification and study of effective interventions for realistic settings is needed in addition to a deep understanding of the mechanisms guiding behavior. The lack of statistically significant results in this dissertation is an indication that more laboratory and correlational findings should be tested in realistic settings.

The specific nudging techniques examined in this dissertation also deserve more research attention.

Why is it that social norm messages are so frequently cited as effective but fail to produce any significant results in such a large-scale randomized study? (For similar arguments, see Dorn & Stöckli, 2018; Richter et al., 2018.) While a significant amount of research has been devoted to the exact phrasing of the message, much less attention has been devoted to other potentially important aspects of the setup. Do size, location, timing, and other characteristics of the message play a role? Do characteristics of the behavior and the decision environment influence the effectiveness of the social norm message? Are “easy” behaviors influenced more than difficult ones? How do habits interact with a social norm message? Are low-noise environments, such as hotel rooms more, conducive to social norm influence (e.g., Goldstein et al., 2008) than high-noise environments, such as supermarkets, where many visual and aural clues vie for the attention of consumers? These questions should be addressed in future research.

Feedback messages should be subjected to similar scrutiny. What factors other than the wording of the message influence its effectiveness? What characteristics of the targeted behavior and the decision environment influence the effectiveness of feedback nudges in altering behavior? Can feedback messages be effective if they relay only positive feedback standard discrepancies? Again, these questions should be addressed in future research.

Sorting seems to be an interesting field for further research based on the results of this dissertation. The results indicate that simply focusing on single products for a re-sorting intervention did not change the overall organic share, potentially because of a substitution of less prominently placed organic products with prominently placed ones. Relatively little theory exists to date exploring the mechanisms of sorting influence on purchase decisions.

Eye-level positioning provides another research opportunity. This dissertation did not discover significant effects of eye-level placement despite extensive literature citing their effectiveness and conventional wisdom supporting this claim. The original research on this topic traces back several decades, and surprisingly little experimental research has been done on this effect. This gap should be revisited.

Last, but not least, research must focus more on the environmental footprint of the targeted behaviors. This dissertation stopped short of evaluating the environmental footprint of the purchase decision nudges in the experiments. As the research on organic food production indicates, positive intentions do not suffice for making products more environmentally friendly. Future research should integrate life-cycle assessment findings to ensure that the nudges actually reduce environmental impact. This research potentially could be focused more on choosing plant-based food products over meat and dairy alternatives than on organic versus conventional groceries.

6.6 Outlook

The sustainability crisis is increasing in urgency. The year 2019 was the second hottest year on record, and each of the past five years has been warmer than any other in the past 140 years (National Aeronautics and Space Administration, 2020). While the environmental warning signs are increasing, a large gap remains to be bridged for environmental policy to effectively address these sustainability problems. Recent mass protests by farmers against pro-environmental regulation on fertilizer use in the Netherlands and Germany indicate that crafting effective and publicly acceptable policy is challenging.

Nudges are often highlighted as an important part of the policy suite to address the sustainability crisis. However, a cautionary tale is offered in this dissertation for those who believe that nudging will solve the sustainability crisis. Even plausibly effective nudges can fail to have any impact for some decisions and environments. This failure highlights the need for employing the entire policy portfolio, ranging from bans over incentives and disincentives to providing information to help the global ecosystem stay within planetary boundaries. These measures must be complemented by research on their design and effectiveness to ensure that they deliver on the promises they make.

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Appendix

Survey Items

The survey is provided in German, the language it was administered in. Some of the items are not discussed in this dissertation and were part of other research endeavors. They are still presented here to provide a complete context for all questions. References to the supermarket chain were replaced by "Supermarkt".

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Altglas bringe ich zum Sammelcontainer.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Beim Waschen verzichte ich auf den Vorwaschgang.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Für den Arbeits- bzw. Schulweg benutze ich das Fahrrad, öffentliche Verkehrsmittel oder gehe zu Fuss.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Für Fahrten in die umliegende Gegend (bis 30 km) benutze ich öffentliche Nahverkehrsmittel oder das Fahrrad.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft

- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Für längere Reisen (6 Stunden Autofahrt und länger) nehme ich das Flugzeug.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich benutze einen Wäschetrockner.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich besorge mir Bücher, Informationsschriften oder andere Materialien, die sich mit Umweltproblemen befassen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich boykottiere Produkte von Firmen, die sich nachweislich umweltschädigend verhalten.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich dusche (statt zu baden).

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich fahre auf der Autobahn höchstens 100 km/h.

- Keine Angabe

- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich fahre mit dem Auto in die Stadt bzw. ich fahre in der Stadt Auto.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Artikel in Nachfüllpackungen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Fertiggerichte.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe gebleichtes und gefärbtes Toilettenpapier.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Getränke in Dosen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Lebensmittel aus kontrolliert biologischem Anbau.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Mehrweg- statt Einwegflaschen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich kaufe Obst und Gemüse der Jahreszeit entsprechend.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich mache jemanden, der / die sich umweltschädigend verhält, darauf aufmerksam.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich sammle altes Papier und gebe es zum Recycling.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich spende Geld für Umweltschutzorganisationen.

- Keine Angabe

- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich unterhalte mich mit Bekannten über Probleme der Umweltverschmutzung.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Ich warte, bis ich eine volle Wäschetrommel habe, bevor ich wasche.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Im Winter drehe ich meine Heizung herunter, wenn ich meine Wohnung für mehr als 4 Stunden verlasse.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Insekten bekämpfe ich mit chemischen Mitteln.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Vor geschlossenen Bahnschranken lasse ich den Motor laufen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich

- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Vor roten Ampeln lasse ich den Motor laufen.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Wenn ich in den Urlaub fahre, schalte ich den Kühlschrank aus.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Wenn ich in einem Geschäft eine Plastiktüte bekomme, nehme ich sie.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Zum Reinigen des Backofens verwende ich ein Spray.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bitte geben Sie an, wie häufig Sie diese Handlungen ausführen. Zum Spaziergehen fahre ich mit dem Auto an den Ausgangspunkt des Spazierganges.

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Breiige Essensreste leere ich in die Toilette.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Durch mein Fahrverhalten versuche ich, den Kraftstoffverbrauch so niedrig wie möglich zu halten.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich benutze beim Waschen einen Weichspüler.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich besitze ein verbrauchsreduziertes Auto (weniger als 6 Liter Treibstoff pro 100 km).

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich besitze eine Geschirrspülmaschine der Effizienzklasse A+ oder besser.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich beziehe Strom aus erneuerbarer Energie.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich bin in einem „Car-Sharing“-Pool.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich bin Mitglied in einer Umweltschutzorganisation.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich ernähre mich vegetarisch.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich habe eine Solaranlage zur Energie- bzw. Wärmeerzeugung angeschafft.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich habe mich über Vor- und Nachteile einer Solaranlage informiert.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich verlasse nach einem Picknick den Platz genauso, wie ich ihn vorgefunden habe.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich verwende Einkaufstüten oder -taschen mehrfach.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Ich verzichte auf ein Auto.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Im Hotel lasse ich täglich die Handtücher wechseln.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. In der Toilette benutze ich chemische Duftsteine für den guten Geruch.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. In meiner Wohnung ist es im Winter so warm, dass man ohne Pullover nicht friert.

- Keine Angabe
- Nein
- Ja

Bei den folgenden Handlungen ist nicht die Häufigkeit gefragt; es geht vielmehr darum, was eher für Sie zutrifft. Leere Batterien werfe ich in den Hausmüll.

- Keine Angabe
- Nein
- Ja

Wie alt sind Sie?

- Textfeld

Was ist Ihr Geschlecht?

- Keine Angabe
- Frau
- Mann

Wie hoch ist das monatliche Nettoeinkommen Ihres Haushalts?

- Keine Angabe
- unter 1000€
- 1000 – 2000€
- 2000 – 3000€
- 3000 – 4000€
- 4000 – 5000€
- über 5000€

Welches ist Ihre höchste abgeschlossene Ausbildung?

- Keine Angabe
- kein Schulabschluss
- Hauptschulabschluss
- Realschulabschluss
- Abitur
- (Fach-) Hochschulabschluss

Wie viele Personen leben in Ihrem Haushalt?

- Keine Angabe
- Ein-Personenhaushalt
- Zwei-Personenhaushalt
- Drei-Personenhaushalt
- Vier-Personenhaushalt
- mehr als 4 Personen im Haushalt

Wie häufig, glauben Sie, kaufen andere Edekkunden Bioprodukte?

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft

- Immer

Wie häufig kaufen Sie selbst Bioprodukte?

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Wie häufig planen Sie, in der Zukunft Bioprodukte zu kaufen?

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Günstiger Preis

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Guter Geschmack

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Hohe Qualität

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Wenig bzw. umweltfreundliche Verpackung

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig

- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Biosiegel

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Fairtradesiegel

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Dass es regional ist

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Dass es saisonal ist

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Dass es vegetarisch ist

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig
- Ziemlich
- Sehr

Auf folgende Produkteigenschaften achte ich beim Lebensmitteleinkauf: Dass es vegan ist

- Keine Angabe
- Nicht
- Wenig
- Mittelmäßig

- Ziemlich
- Sehr

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen (Mehrfachantworten möglich): Discounter

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen (Mehrfachantworten möglich): Andere Supermärkte außer "Supermarkt"

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen (Mehrfachantworten möglich): Drogeriemärkte

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen (Mehrfachantworten möglich): Bio-Supermärkte

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen (Mehrfachantworten möglich): Naturkostfachmärkte

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen
(Mehrfachantworten möglich): Wochenmarkt/Bauer

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen
(Mehrfachantworten möglich): Bäcker/Metzger

- Keine Angabe
- Nie
- Selten
- Gelegentlich
- Oft
- Immer

Außer bei "Supermarkt" gehe ich regelmäßig an folgenden Orten Lebensmittel einkaufen
(Mehrfachantworten möglich): Sonstige:

- Textfeld