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Essays on Behavioral Interventions for Consumer Food Waste Reduction

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Summary

Around a third of all food produced is wasted. With increasing food prices and a growing population that needs to be fed, wasting food is unacceptable. In industrialized countries, most food waste is generated at the end of the supply chain, i.e., in private households. Therefore, reducing consumer food waste is indispensable to achieving the United Nations' Sustainable Development Goal 12.3, which calls for a significant reduction of per capita food waste at the retail and consumer levels. This thesis aims to contribute to this goal by examining how different behavioral interventions can help reduce consumer food waste.

Previous research has started to evaluate several approaches (e.g., providing information about food waste, technology-based solutions such as smart fridges, or policy/system changes such as new dietary guidelines). However, the effect of different information contents and their interrelation with psychological factors as well as the role of unconscious processes, remain underexplored. This thesis adds to the current body of research by testing the effect of two types of interventions (i.e., providing information and priming) in combination with several conscious and unconscious food waste-influencing factors (e.g., explicit and implicit attitudes). First, the effect of providing information is investigated. Therefore, information treatments are employed targeting different types of knowledge (i.e., system versus action-related) and product perceptions (i.e., safety versus health). Second, a priming experiment investigates whether recalling previous behavior can nudge consumer behavior. The effect of interventions is first tested in a more general consumer food waste context and next in the specific context of suboptimal food products (i.e., products that deviate from the standard and are, therefore, often wasted).

Results are obtained through online surveys with experimental treatments. The findings show that providing information can reduce consumer food waste behavior. However, the type of information is essential. Providing information targeted at action-related knowledge increases consumers' intention to reduce food waste significantly, while information targeted at system knowledge has no such effect. In the case of suboptimal food, information targeting safety and health perception of the respective products increases the willingness to consume them significantly. The priming experiment was only partly effective. While recalling previous frugal behavior had no effect, recalling previous wasteful behavior leads to a backfire effect, meaning consumers evaluate suboptimal products less favorably. The results highlight essential theoretical and practical implications for consumer food waste reduction.

Zusammenfassung

Etwa ein Drittel aller produzierten Lebensmittel wird weggeworfen. Angesichts steigender Lebensmittelpreise und einer wachsenden Bevölkerung, die ernährt werden muss, ist die Verschwendung von Lebensmitteln nicht tragbar. In Industrieländern entsteht der Großteil der Lebensmittelverschwendung am Ende der Lieferkette, d. h. in privaten Haushalten. Die Reduzierung der Lebensmittelverschwendung von Verbrauchern ist daher unerlässlich, um das *Sustainable Development Goal* 12.3 der Vereinten Nationen zu erreichen, welches eine deutliche Reduzierung der Pro-Kopf-Lebensmittelverschwendung auf der Ebene des Einzelhandels und der Verbraucher fordert. Diese Dissertation soll einen Beitrag zu diesem Ziel leisten, indem sie untersucht, wie verschiedene Verhaltensinterventionen zur Reduzierung der Lebensmittelverschwendung beim Verbraucher beitragen können.

In der bisherigen Forschung wurden bereits mehrere Ansätze untersucht (z.B. Informationen über Lebensmittelverschwendung, technologiebasierte Lösungen wie intelligente Kühlschränke oder politische bzw. systemische Veränderungen wie neue Ernährungsrichtlinien). Die Wirkung verschiedener Informationsinhalte und ihre Wechselbeziehung mit psychologischen Faktoren sowie die Rolle unbewusster Prozesse ist jedoch noch nicht ausreichend erforscht. Diese Dissertation ergänzt den derzeitigen Forschungsstand, indem sie die Wirkung von zwei Arten von Interventionen (Bereitstellung von Informationen und Priming) in Kombination mit verschiedenen bewussten und unbewussten Faktoren, die die Lebensmittelverschwendung beeinflussen (z.B. explizite und implizite Einstellungen), untersucht. Als Erstes wird die Wirkung der Bereitstellung von Informationen untersucht. Dazu werden Informationstreatments eingesetzt, die auf unterschiedliche Arten von Wissen (system- versus handlungsbezogen) und Produktwahrnehmungen (Sicherheit versus Gesundheit) abzielen. Als Zweites wird in einem Priming-Experiment untersucht, ob die Erinnerung an früheres Verhalten eine Änderung des Verbraucherverhaltens bewirken kann. Die Wirkung von Interventionen wird zunächst in einem allgemeinen Kontext der Lebensmittelverschwendung und anschließend im spezifischen Kontext suboptimaler Lebensmittelprodukte (Produkte, die von der Norm abweichen und daher häufig verschwendet werden) getestet.

Die Ergebnisse werden durch online Befragungen mit experimentellen Treatments erlangt. Die Ergebnisse zeigen, dass die Bereitstellung von Informationen das Verbraucherverhalten bezüglich Lebensmittelverschwendung positiv beeinflussen kann. Allerdings ist die Art der

Information entscheidend. Die Bereitstellung von Informationen, die auf handlungsbezogenes Wissen abzielen, erhöht die Intention der Verbraucher, Lebensmittelverschwendung zu reduzieren signifikant, während Informationen, die auf Systemwissen abzielen, keine solche Wirkung haben. Im Fall der suboptimalen Lebensmittelprodukte zeigt sich, dass Informationen, die auf die Sicherheits- und Gesundheitswahrnehmung der jeweiligen Produkte abzielen, die Bereitschaft, diese zu konsumieren, erheblich erhöhen. Das Priming-Experiment war nur teilweise wirksam. Während die Erinnerung an früheres sparsames Verhalten keine Auswirkungen hatte, führte die Erinnerung an früheres verschwenderisches Verhalten zu einem Backfire-Effekt, das heißt Verbraucher bewerteten suboptimale Produkte weniger positiv. Die Ergebnisse liefern wichtige theoretische und praktische Implikationen zur Reduzierung von Lebensmittelverschwendung durch Verbraucher.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ANOVA   Analysis of Variance

e.g.   Exempli Gratia [for example]

EU   European Union

FAO   Food and Agriculture Organization of the United Nations

IAT   Implicit Association Test

i.e.   Id est [that is]

NGO   Non-governmental Organization

PBC   Perceived Behavioral Control

PW   Premeditated Waste

SDG   Sustainable Development Goals

TPB   Theory of Planned Behavior

UK   United Kingdom

UNEP   United Nations Environment Programme

USA   United States of America

WTC   Willingness to Consume

WTP   Willingness to Pay

WTW   Willingness to Waste

Publication and Submission Record

The present thesis is submitted as a cumulative dissertation based on the following three publications:

- Neubig, C. M., Vranken, L., Roosen, J., Grasso, S., Hieke, S., Knoepfle, S., Macready, A. L., & Masento, N. A. (2020). Action-related information trumps system information: Influencing consumers' intention to reduce food waste. *Journal of Cleaner Production, 261*, 121126. https://doi.org/10.1016/j.jclepro.2020.121126.

- Neubig, C. M., Roosen, J., Karg, C. A., & Moser, S. (2022). It's safe and healthy! Increasing consumers' willingness to consume aging produce. *Food Quality and Preference, 101*(3), 104608. https://doi.org/10.1016/j.foodqual.2022.104608.

- Neubig, C. M., & Roosen, J. (2023). *Can I still eat this? Using implicit and explicit measures to explore consumer behavior towards food products with date labels.* Paper presented at the European Marketing Academy (EMAC) Annual Conference, May 23-26, 2023, Odense, Denmark.

1 Introduction and Objective

Food waste and how to reduce it remains a pressing issue. According to the Food and Agriculture Organization of the United Nations (FAO) (2011), around a third of food intended for human consumption is lost or gets wasted along the food supply chain. More recent estimates by the United Nations Environment Programme (UNEP) (2021) suggest that 931 million tons of food waste originated from households, food service, and retail in 2019, which equals to wastage of 17% of all food produced. When considering food waste numbers, it is crucial to keep in mind that there is no commonly agreed definition of food waste yet (FAO, 2019). The UNEP (2021) defines food waste as "food [...] and associated inedible parts removed from the human food supply chain in the following sectors: manufacturing of food products (under certain circumstances); food/grocery retail; food service; and households" (p. 19), while food that exits the supply chain from post-harvest to before the retail stage is termed *food loss*. In contrast to the UNEP's definition above, the food waste definition provided by the FAO (2011, 2019) excludes the inedible parts of food waste and food waste directed to other uses, such as animal feed. These two examples illustrate how different definitions and inclusion criteria regarding food waste measurement make comparing food waste quantities reported in different studies difficult.

It is important to note that food waste occurring in the later stages of the supply chain is primarily relevant in developed regions, such as Europe, North America, Oceania, and industrialized Asia. In contrast, in sub-Saharan Africa and South/Southeast Asia, the amount of consumer food waste is marginal, and the major proportion of food is lost in earlier supply chain stages (FAO, 2011). In Europe, it is estimated that private households account for 53% of all food waste (Stenmarck et al., 2016). Similar numbers are reported for Germany, where Schmidt et al. (2019) suggest that from the total of around 12 million tons of food waste in Germany, about 6 million tons stem from households.

However, not all food waste is avoidable. Most studies that aim at quantifying food waste distinguish between *unavoidable food waste* (sometimes also referred to as *inedible or non-edible parts of food waste*), i.e., the parts of food that are not edible under normal circumstances, such as bones or pits, and *avoidable food waste* (sometimes also referred to as *edible parts of food waste*), i.e., food that was still edible at the time of disposal or would have been edible if used in time, such as food past the best-before date, moldy foods, or leftovers from a meal

(Schmidt et al., 2019; UNEP, 2021). In their baseline study investigating food waste in Germany, Schmidt et al. (2019) also inspect the amount of avoidable food waste and state that among the 6 million tons of household food waste in Germany, 2.69 million tons can be categorized as avoidable.

The high amounts of food waste, especially the avoidable portion of wasted food, are very concerning. First of all, food waste has high environmental impacts, as all the resources used to produce the food are wasted when food gets discarded, resulting in environmental impacts such as increased carbon and water footprints, land degradation, unnecessary land and energy use, and threats to biodiversity (Roka, 2019). Scherhaufer et al. (2018) estimate that, in total, food waste is responsible for 15.7% of the global warming potential of food consumption. In addition, the later food is wasted in the supply chain, the higher its environmental impact. Food waste at the end of the supply chain (e.g., in private households) is the most harmful because the impacts created in all previous supply chain stages add up. Next to environmental impacts, food waste is also an economic problem. In Europe, food that is never consumed has an estimated monetary value of 143 billion Euros (Stenmarck et al., 2016). Finally, the social impacts of food waste must be taken into account. Considering the pressing issue of food security, with between 702 and 828 million people in the world affected by hunger in 2021 and the inflation of food prices resulting in almost 3.1 billion people who were not able to afford a healthy diet in 2020 (FAO et al. 2022), wasting food is detrimental. The Sustainable Development Goals (SDG) conveyed by the United Nations in 2015 have also laid down the importance of reducing food waste: SDG target 12.3 aims to halve per capita food waste at the retail and consumer level (and reduce food losses along the supply chain).

In summary, food waste poses considerable environmental, economic, and social threats; most food waste in Germany and Europe is created at the household level, and a significant portion of this food waste is avoidable. Therefore, the questions of what drives consumers to waste this substantial amount of food (see Principato et al., 2021 and Roodhuyzen et al., 2017 for an overview) and what levers can make consumers waste less food (see Vittuari et al., 2023 for an overview) have caught much attention in recent years.

This thesis aims to contribute to these streams of literature. It builds on studies asking what drives consumer food waste, the potential barriers to reducing food waste, and what interventions can help reduce it. It addresses research gaps regarding what interventions work and what other conscious and unconscious factors influence consumer food waste behavior.

This thesis uses the cases of information-based interventions and priming to alter consumer food waste behavior. Results from a literature review by Reynolds et al. (2019) and a meta-analysis by Tian et al. (2022) suggest that information-based interventions have great potential to reduce consumer food waste. However, not all information-based interventions were equally effective. Therefore, this thesis investigates different message contents and other potential influencing and mediating factors. In addition, the concept of priming (i.e., exposure to a stimulus that may influence the response to a subsequent stimulus without the individual's awareness) is tested. Priming has not yet received much attention in the consumer food waste literature. However, results from related fields such as sustainable food choice (e.g., Danner & Thøgersen, 2022; Panzone et al., 2021; Tate et al., 2014) show promising results. This thesis tackles the following primary research questions:

(1) How can increasing consumers' food waste-related knowledge using educational measures (i.e., information treatments) affect consumer food waste behavior?

    a. What are the effects of providing information targeting different types of knowledge (i.e., system versus action-related)?

    b. What are the effects of providing information targeting different product perceptions (i.e., safety versus health perception)?

(2) What factors apart from educational measures can be used to nudge food waste reduction?

    a. How do unconscious and conscious processes determine behavior towards suboptimal food products?

    b. Can priming change consumers' perception and increase their willingness to consume suboptimal food products?

These questions are examined in three papers on which this thesis is based. The first paper explores whether consumers' intention to reduce food waste can be increased by providing information targeting either system or action-related knowledge. The second and third papers look into the case of suboptimal food products. Suboptimal food products are foods that diverge from the standard, for instance, due to differences in visual appearance (Aschemann-Witzel et al., 2015). They are often wasted even though they would be safe to consume. The second paper aims to increase consumers' willingness to consume suboptimal food products by providing information to change consumers' beliefs about the suboptimal foods' safety and healthfulness. The third paper focuses on unconscious processes influencing suboptimal food consumption. It

examines implicit attitudes and tests whether priming can motivate consumers to consume suboptimal food products. Table 1 gives an overview of the three papers and provides their research questions, methodology, key findings, and contributions.

The remainder of the thesis is structured as follows: Chapter 2 describes the background of the thesis. First, consumer food waste behavior and how to reduce it is discussed. Next, the theoretical background of consumer behavior change toward more sustainable consumption choices is conferred, and an overview of how previous research has measured consumer food waste behavior is provided. Chapter 3 explains the research methods used in the three papers. The subchapters provide details on the data and methods of every individual study, including the research design and data analysis. Chapter 4 provides an overview of the three papers this dissertation is based on, including a statement on the individual contributions of the doctoral candidate to each of them. Finally, Chapter 5 summarizes the main findings of the three papers and discusses the overarching results.

Table 1. Overview of the Papers, their Research Questions, Methodology, Key Findings, and Contributions

|	Paper I	Paper II	Paper III
Title	Action-related information trumps system information: Influencing consumers' intention to reduce food waste	It's safe and healthy! Increasing consumers' willingness to consume aging produce	Can I still eat this? Using implicit and explicit measures to explore consumer behavior towards food products with date labels
Major Research Questions	(1) How does additional information affect consumers' intention to reduce food waste and their attitudes, norms, and perceived behavioral control? Which information (system vs. action-related) is more effective in increasing intention to reduce food waste? (2) Is an adaptation of the theory of planned behavior a suitable theoretical model to reflect consumer food waste behavior, and do its constructs mediate the hypothesized information effect on the intention to reduce food waste?	(1) Does providing information regarding the safety and healthfulness of aging produce increase consumers' safety and health perception and prolong their willingness to consume it? (2) Do safety and health perceptions predict willingness to consume aging produce? What other factors contribute to the prediction of willingness to consume aging produce?	(1) How do unconscious and conscious processes determine behavior toward expired food products? (2) How can a prime asking to recall past wasteful versus past frugal behavior change consumers' perception of expired food products and increase their willingness to consume them? (3) What other factors contribute to the prediction of willingness to consume expired food products?
Methodology	• Online survey including an information experiment with a between-subjects design • Information was provided using a food waste quiz • Four conditions: system information, action-related information, control 1 (quiz but no information), control 2 (no quiz) • Analyses of variance, structural equation modeling	• Online survey including an information experiment with a between-subjects design • Information was provided using a time-lapse video and information text • Three conditions: safety information, healthfulness information, control information • Analyses of variance, stepwise multiple regression analyses, mediation analysis	• Online survey including an implicit association test and a priming experiment with a between-subjects design • Three conditions: frugal priming, wasteful priming, control priming • Analyses of variance, structural equation modeling
Key Findings & Contributions	• Providing action-related information increases respondents' intention to reduce food waste significantly, which is attributed to greater personal norm activation, more favorable attitudes toward reducing food waste, and a higher perceived behavioral control • System information has no significant effect on food waste intentions but results in more favorable attitudes toward reducing food waste • These findings stress the importance of providing action-related information in food waste reduction campaigns	• Providing information on safety or healthfulness results in increased safety and health perception, which in turn increases willingness to consume aging produce • Consumers with lower food disgust sensitivity, a decision style characterized by less reliance on expiration dates, and a preference for vegetarian dishes are more willing to consume aging produce • These findings imply that informing consumers about safety and healthfulness can be a viable path to increase the consumption of aging produce at home	• Consumers have negative implicit associations toward expired food products • Reduced health and safety perceptions, consumers' strategies to determine edibility, and general risk perception of expired products predict consumption of expired products • While frugal priming has no significant effect, wasteful priming decreases the perceived safety and healthfulness of expired products • These findings indicate that careful consideration should be given to how to communicate the food waste problem to consumers

5

2 Background

The general food provisioning process includes acquisition, preparation, cooking, eating, and disposal (Marshall, 1995). Previous research (Principato et al., 2021; Roodhuyzen et al., 2017) has tailored this process toward consumer food waste behavior. While the *household food waste journey* (Principato et al., 2021) consists of five *phases*, namely, planning, in-store, pre-consumption (storage and cooking), consumption, and disposal, Roodhuyzen et al. (2017) distinguish between five *practices*, namely planning and organizational practices, shopping practices, storing practices, preparation and serving practices, and consumption practices. Different reasons and behavioral practices can contribute to consumers generating food waste in each phase. For instance, in the in-store phase, the practice of impulsive buying can result in food waste (see Figure 1). It is important to note that all phases are connected; for example, impulsive buying could result from a lack of planning meals in advance (planning phase/practices). In the scope of this thesis, when referring to *consumer food waste behavior*, this entails actions carried out by consumers that result in the disposal of food items in their household. The terms *consumer food waste* and *household food waste* are used synonymously in this thesis.

2.1 Consumer Food Waste Drivers and Reduction Opportunities

Previous research on household food waste has uncovered various determinants affecting consumer food waste behavior. These determinants range from sociodemographic factors such as gender, age, and household size (e.g., Gaiani et al., 2018; Jörissen et al., 2015; Koivupuro et al., 2012; Visschers et al., 2016) over situational factors such as the geographical and economic environment (e.g., Secondi et al., 2015) to norms and psychological factors such as attitudes, emotions, and knowledge (e.g., Richter, 2017; Russell et al., 2017; Stancu et al., 2016).[1] Discussing all potential drivers of consumer food waste behavior is out of the scope of this thesis. However, Figure 1 provides a conceptual framework showing the interrelations of different behaviors and behavioral antecedents contributing to consumer food waste behavior.

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[1] However, findings lack consensus, and factors that are shown to significantly influence consumer food waste behavior in one study may turn out to be insignificant in subsequent studies, and vice versa. This could be because food waste behavior is not a single behavior, but it stems from multiple behaviors (Quested et al., 2013), which in turn are influenced by a variety of factors.

Figure 1. Conceptual Framework of Consumer Food Waste Behavior
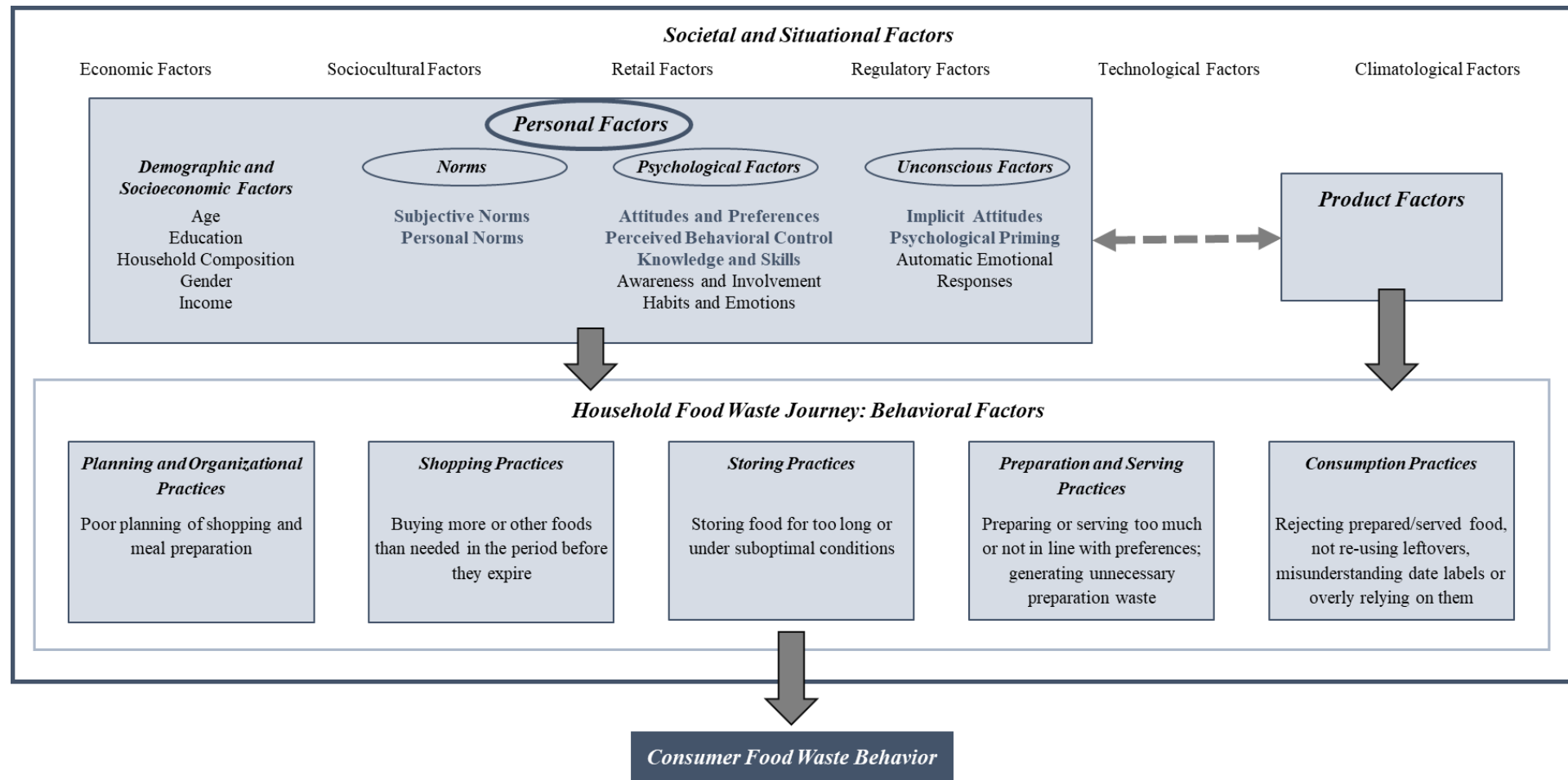
Source: Own depiction condensed from Principato et al. (2021) and Roodhuyzen et al. (2017).
Notes. The category 'unconscious factors' was not part of previous frameworks and was added by the author of this thesis. The highlighted aspects present the focus of this thesis.

Within this framework, the present thesis focuses on personal factors. More precisely, norms (Paper I) and psychological factors, i.e., perceived behavioral control (PBC) (Paper I), attitudes, and preferences (Papers I, II, III), play an important role. Papers I and II additionally focus on knowledge and how to increase it through educational measures. Paper III includes unconscious factors, i.e., implicit attitudes and priming.[2]

Next to uncovering the drivers of consumer food waste behavior, a body of research has worked on finding and testing different behavioral interventions to reduce consumer food waste. Previous studies in this area have examined the effect of interventions such as education campaigns (e.g., Liz Martins et al., 2016) and nudging (e.g., Kallbekken & Sælen, 2013). In their literature review, Reynolds et al. (2019) cluster applied food waste interventions at the consumption stage into three categories: (1) *Information-based*, meaning any type of information was provided. This includes information campaigns but also more practical information or teaching methods such as cooking classes. (2) *Technology-based*, meaning new technologies or objects were introduced, or present technologies or objects were changed in a way to help reduce food waste. Examples of technology-based interventions include changes in plate or portion sizes, food-sharing apps, and fridge cameras. (3) *Policy/system/practice change*, meaning the introduction or change of policies or systems, for example, dietary guideline changes. While within all categories, effective interventions were found, the success of these interventions varied widely. Moreover, the authors criticize that for some interventions (e.g., cooking classes, fridge cameras, information sharing), there is little or no robust evidence across studies. A more recent meta-analysis by Tian et al. (2022) looks at 58 studies that used intervention experiments to reduce food waste. They use a more detailed clustering of previous interventions (as compared to Reynolds et al., 2019) and divide them into seven different types: (1) *prompts*, meaning information-based interventions using posters and similar measures but only focusing on declarative information; (2) *education*, meaning educational programs that provide systematic and comprehensive information; (3) *tips*, meaning practical knowledge focusing on procedural information; (4) *consequence*, meaning information that evokes emotions such as guilt or shame; (5) *feedback*, meaning providing information on consumers'

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[2] It is important to note that there may be overlaps between unconscious and conscious psychological constructs. For instance, habits and emotions can be both, conscious and unconscious. While people are usually aware of their emotional state (e.g., "I am happy") they are not always aware of the reasons nor do they always have control over the emotional state they are in. Even though implicit attitudes are generally viewed as unconscious constructs, people may be aware of their implicit attitudes (Fazio & Olson, 2003), for instance, they may know that they have prejudices or stereotypical beliefs.

previous behavior; (6) *incentive*, meaning giving financial incentives; and (7) *environmental alteration*, meaning a nudge-type intervention in the external environment such as changing plate sizes. The authors state that, in general, behavioral interventions are an effective tool in helping consumers reduce their food waste. More precisely, they find that structured education programs are most effective. Still, incentives, environmental alterations, and most other information/knowledge-based interventions (i.e., prompt and consequence-based messages, tips with practical knowledge) achieve significant food waste reduction. Informational feedback, however, was found to have no significant effect in this meta-analysis. The fact that education performs best is attributed to the many different messages used in structured education programs compared to a single message in many other cases. Tian et al. (2022) also consider additional factors influencing the intervention effect. However, they only find marginal effects of, for instance, the setting (e.g., within a school, hotel, lab) or region in which the experiment was performed.

2.2   Behavior Change Toward More Sustainable Choices

The question of how to make consumers behave more sustainably has been of broad interest in the marketing and behavioral sciences literature. Several consumer behavior theories are used and adapted to fit sustainable consumption behavior. This thesis focuses on the Theory of Planned Behavior (TPB) (Ajzen, 1991). The TPB is especially useful in predicting behavior that is primarily under volitional control, as is the case with consumer food waste behavior (Visschers et al., 2016). It also provides flexibility to add factors not included in the original model (Stefan et al., 2013) and is the most commonly utilized theoretical framework for explaining consumer food waste behavior (Schmidt, 2019).

2.2.1   The Theory of Planned Behavior in Consumer Food Waste Research

The TPB (Ajzen, 1991, see Figure 2) posits that behavior can be predicted by behavioral intention, which can be understood as the motivation to engage in a specific behavior. Behavioral intention, in turn, is predicted by attitudes, subjective norms, and PBC. Attitudes towards a specific behavior can be understood as evaluative beliefs, i.e., a favorable versus unfavorable appraisal of the behavior; subjective norms reflect the perceived social pressure to engage (or not) in a specific behavior; and PBC describes how capable a person feels of executing the behavior. Generally, more favorable attitudes, higher social norms, and greater PBC are expected to increase the intention to engage in a specific behavior. However, it should

be noted that the relative importance of the predictors can vary depending on the type of behavior that is investigated and the corresponding situation (Ajzen, 1991).

Figure 2. The Theory of Planned Behavior (TPB) Model
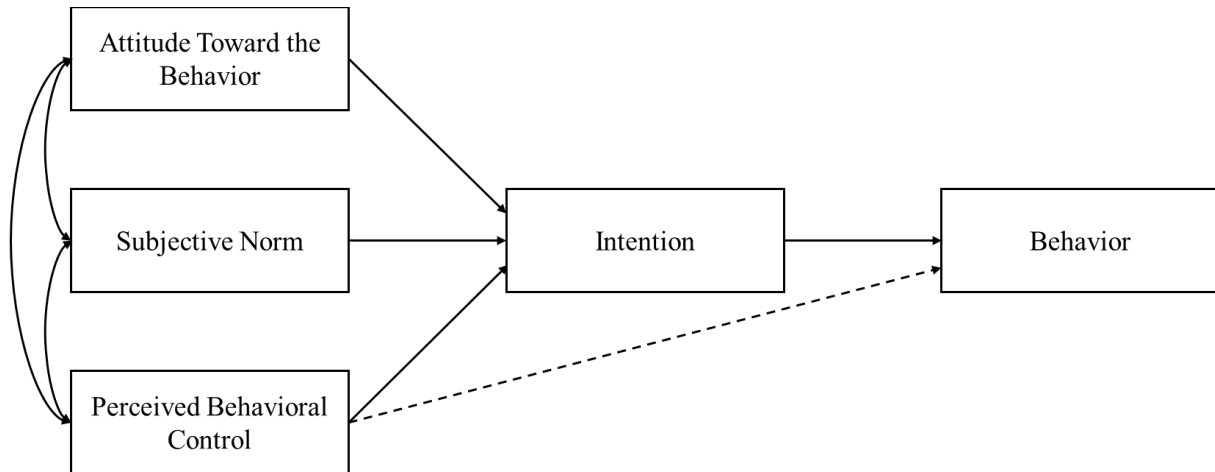
In the field of consumer food waste behavior, multiple studies that have used the TPB confirm that attitudes, subjective norms, and PBC are significant predictors of intention to reduce food waste (e.g., Graham-Rowe et al., 2015; Schmidt, 2019). However, in some studies, attitudes (e.g., Russell et al., 2017), social norms (e.g., Visschers et al., 2016), or PBC (e.g., Stancu et al., 2016) have no significant influence on behavioral intention to reduce food waste. In addition, the explained variance varies widely between studies, which could be evidence that the conventional TPB constructs may not suffice to predict food waste behavior accurately.

Therefore, food waste researchers have added additional constructs with the aim of explaining food waste intention and behavior more comprehensively. Personal norm is one of the constructs frequently connected to the TPB model by researchers (e.g., Schmidt, 2019; Stancu et al., 2016; Stefan et al., 2013).[3] Personal norm can be defined as the "moral obligation felt by the individual to follow the line of behavior in question" (Schwartz, 1973, p. 353). Personal norms describe the expectations people set for themselves, as opposed to subjective norms, where behavior is motivated by the perceived expectations of other people. In previous research on consumer food waste behavior, personal norms were regularly reported to influence behavioral intention significantly (e.g., Pakpour et al., 2014; van der Werf et al., 2019b;

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[3] The term personal norm is used interchangeably in the literature with other related terms such as moral attitude or (personal) moral norm.

Visschers et al., 2016). Examples of other constructs that have been found to significantly influence behavioral intention and/or behavior in the area of consumer food waste reduction include the perceived taste of food (Lorenz, Hartmann, Hirsch et al., 2017), portion size and palatability of food (Lorenz, Hartmann, & Langen, 2017), the good provider identity[4] (Visschers et al., 2016), routines regarding shopping, leftover use, planning (Stancu et al., 2016), habits, and emotions (Russell et al., 2017).

The TPB provides the basis for the theoretical model in Paper I, which uses an adaptation of the TPB, including personal norms, and investigates attitudes, norms, PBC, and behavioral intention toward food waste reduction in three European countries. Moreover, Paper I investigates how food waste information interventions affect attitudes, norms, PBC, and behavioral intention.

2.2.2 The Role of Knowledge and Education in Food Waste Reduction Efforts

Another relevant factor in consumer food waste reduction behavior is food waste-related knowledge. Food waste-related knowledge can comprise knowledge of food waste amounts and impacts, as well as more practical knowledge, such as knowledge regarding food storage or date labels. It is, therefore, important to distinguish different types of knowledge before further discussing their role in consumer food waste behavior. First, it can be distinguished between subjective knowledge (i.e., what people think they know) and objective knowledge (i.e., what people *actually* know; what is stored in memory) (Brucks, 1985).

Frick et al. (2004) further divide objective environmental knowledge into three dimensions, i.e., system knowledge (*knowing what*), action-related knowledge (*knowing how*), and effectiveness knowledge (*knowing when and why*). System knowledge (similarly defined as *declarative knowledge* in Kaiser & Fuhrer, 2003) refers to knowledge about environmental systems and the corresponding environmental issues. A typical example is knowing the effect of carbon dioxide on the atmosphere (Kaiser & Frick, 2002). Regarding food waste, system knowledge can include knowing about the environmental, economic, and social impacts of food waste. Action-related knowledge refers to knowing how to act and address an environmental problem.

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[4] The good provider identity refers to the goal of being a good parent/partner/host and therefore buying and cooking plenty of food to avoid failing the expectations of other people in the household and/or guests (Graham-Rowe et al., 2014).

Regarding food waste, action-related knowledge can include knowing possible actions to reduce food waste, such as planning meals in advance or storing food correctly. Finally, effectiveness knowledge refers to the effectiveness of environmental actions, i.e., the benefit of alternative courses of action. Regarding food waste, effectiveness knowledge can include knowing which actions are most effective in reducing food waste at home.[5] To help consumers perform the behavior with the most pro-environmental impact, all types of knowledge must work together. It is crucial to have knowledge about environmental systems and environmental issues (system knowledge), be knowledgeable about how to respond to these issues (action-related knowledge), and know which actions will maximize environmental benefits (effectiveness knowledge) (Frick et al., 2004; Kaiser & Fuhrer, 2003).

Research on how knowledge influences consumer food waste behavior is somewhat limited, with a lack of consensus across different studies. In a recent study, Gabriel et al. (2021) report that German university students' food waste knowledge did not significantly influence their food waste behavior. Visschers et al. (2016) find no significant effect of knowledge regarding food storage and use-by dates on food waste behavior or behavioral intention. Meanwhile, McCarthy and Liu (2017) show that perceived knowledge regarding the difference between best-before and use-by dates can reduce food waste behavior. Results from a qualitative study by Graham-Rowe et al. (2014) indicate that consumers who felt knowledgeable about food management felt more confident that they could reduce food waste in their homes.

Previous interventions that aim for consumer behavior change in the food waste area focus on increasing knowledge by using educational measures such as information provision (see Chapter 2.1). One example is van der Werf et al. (2019a), who provided an educational package, including informational messages focusing on the financial aspects of food waste and practical tips on how to reduce food waste to a treatment group of households in Ontario, Canada. They find that total food waste (measured using curbside garbage samples) in the treatment households decreased by 31% after the intervention, while the amounts in control households remained relatively stable. Another recent example is Wharton et al. (2021), who provided treatment households in Arizona, USA, with food waste education via a specifically created

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[5] Providing examples here is difficult, since a systematic ranking of behaviors regarding their effectiveness in food waste reduction does not exist. The effectiveness of different behaviors in this area might also be very individual. For instance, some households may benefit greatly from meal planning, while for others, incorrect food storage is the main issue to be solved.

website. The information on the website was presented in different formats (e.g., videos, podcasts, text-based) and included content on recipes, shopping tips, food storage, expiration dates, and freezer usage. The treatment lasted five weeks. Results show that the households reduced food waste by around 28% after the intervention. Next to the aforementioned studies, which provided more elaborate food waste information and education, studies using single messages have also been shown to be effective in previous research. For instance, Bretter et al. (2023) show in two experiments that environmental messages increased respondents' intention to reduce food waste and interest in engaging in food waste reduction efforts. Zhang et al. (2023) investigate the effectiveness of food waste avoidance messages in the context of food near the expiration date. They find that messaging increases consumers' willingness to buy products near the expiration date. However, previous research also shows that the message content is critical. Nisa et al. (2022) test combinations of different messages, for instance, simple prompts such as "Reduce Food Waste!", messages focusing on the economic, environmental, or social consequences of food waste, and more elaborate information focusing on different aspects of food waste. They find that the messaging can lead to reactance, especially when more imperative prompts are used. Milder persuasive messages, however, were shown to be effective. Moreover, Nisa et al. (2022) find that messages should be easy to understand and not focus on many different components. Regarding the content, social and environmental messages were the most effective. Still, they also report that, generally, the effect sizes of their messaging interventions were small.

Knowing what messages to provide is crucial when designing food waste reduction campaigns. Therefore, Papers I and II add to the research on education/information contents. While Paper I tests information that targets different types of knowledge (system vs. action-related), Paper II focuses on messages tailored to a specific food product (suboptimal produce).

2.2.3 The Role of Explicit and Implicit Attitudes

Since previous studies focusing on (primarily conscious) psychological constructs (see Figure 1) often find small effect sizes of their interventions, the question of what other constructs may influence consumer food waste behavior remains. Consumer psychologists generally advocate that conscious information processing only affects a limited amount of our choices and that unconscious processes play an essential role in consumer decision-making in many everyday situations (Dijksterhuis et al., 2005). Therefore, next to conscious psychological constructs such as knowledge, explicit attitudes, and preferences, unconscious factors such as implicit attitudes

may influence food waste behavior. Generally, attitudes describe an evaluation of an object (e.g., positive or negative) that subsists over time (Wilson et al., 2000). In contrast to explicit attitudes that are conscious and can be self-reported, implicit attitudes "are manifest as actions or judgments that are under the control of automatically activated evaluation, without the performer's awareness of that causation" (Greenwald et al., 1998, p. 1464). Implicit and explicit attitudes can diverge from each other, and consumers can hold dual attitudes (i.e., implicit and explicit) towards the same object (Wilson et al., 2000). One reason is that implicit and explicit attitudes can stem from different sources. Implicit attitudes are more likely to be formed from distant experiences, for instance, childhood events and memories that may even be forgotten, while explicit attitudes are more likely to reflect recent experiences (Greenwald & Banaji, 1995; Rudman et al., 2007). In situations where people hold dual attitudes toward an object, the implicit attitude is activated automatically, but it can be overridden by the explicit attitude if people have the cognitive capacity and motivation to retrieve it (Wilson et al., 2000).

The unconscious nature of implicit attitudes demands different methods for data collection, such as the Implicit Association Test (IAT) (Greenwald et al., 1998). The IAT originated in psychological research and has been used, for instance, to investigate ethnic stereotypes and prejudices (Greenwald et al., 1998). Still, it has meanwhile also found its way into consumer research. For example, using an IAT and explicit attitude scales, Govind et al. (2019) show that consumers hold dual attitudes, but only implicit attitudes influence behavior and preferences in the context of ethical consumption. In the field of sustainable food consumption, previous studies found that implicit attitudes can provide additional explanatory value (e.g., Richetin et al., 2016; Verneau et al., 2016). In contrast, Panzone et al. (2016) report that implicit attitudes only influence consumer choice in one of their tested product categories (i.e., bottled water), while there are no significant effects in the other product categories.

The presence of dual attitudes can help explain the attitude-behavior gap in sustainable consumption. When directly asked about their attitude, for example, concerning the consumption of suboptimal foods, consumers may state a positive attitude. This positive explicit attitude, however, does not necessarily translate into behavior because there might be conflicting implicit attitudes that will be activated under cognitive load or in situations where consumers do not reflect upon it (Wilson et al., 2000).

The effect of implicit attitudes has rarely been studied in terms of consumer food waste behavior. In the context of suboptimal food products, Bolos et al. (2019) use an IAT and explicit

attitude measures to investigate consumer choices of optimal versus suboptimal apples. They find that both implicit and explicit attitudes predict purchase likelihood. However, the effect of explicit attitudes was stronger. Since implicit attitudes add to the explanation of suboptimal product choice, Bolos et al. (2019) advocate for including them to explain variability in consumer behavior towards suboptimal foods. Moreover, in contrast to Govind et al. (2019), Bolos et al. (2019) recommend focusing on changing explicit attitudes rather than implicit ones to achieve behavior change. Since implicit attitudes have been shown to be stable (Bolos et al., 2019; Govind et al., 2019), they may not be easily affected by interventions, especially by single messages.

Drawing upon the importance of implicit and explicit attitudes in other domains, Paper III investigates consumers' implicit and explicit attitudes towards suboptimal food products. Moreover, Paper III uses a priming experiment aiming at changing the willingness to consume suboptimal food products.

2.3   Measurements of Consumer Food Waste Behavior

One of the critical questions for consumer food waste researchers is how to measure consumer food waste behavior. There are several methods ranging from food waste surveys, diaries, kitchen caddies, and photographic coding to waste composition analysis. Since this thesis is based on survey work, the following paragraphs will focus on how consumer food waste behavior can be operationalized in questionnaires.

Previous food waste questionnaires employ several dependent variables, such as intention to reduce food waste (e.g., Elhoushy & Jang, 2021; Lorenz, Hartmann, Hirsch et al., 2017; Stancu et al., 2016), food waste concerns (e.g., Principato et al., 2015; Stefan et al., 2013), consume versus discard decisions (e.g., Ellison & Lusk, 2018), willingness to consume (WTC) (e.g., Gong et al., 2022; Thompson et al., 2018), willingness to waste (WTW) (e.g., Wilson et al., 2017), reported food waste in the past week (e.g., van Herpen, van Geffen et al., 2019) or in a regular week (e.g., Stefan et al., 2013).

General food waste (reduction) intention and concern are usually measured on Likert-scale items, such as "I intend not to throw food away" (Stancu et al., 2016) or "I do not really worry about the amount of food that I throw away" (Stefan et al., 2013). The advantage of using survey items like this is that there are pre-existing scales available and that survey respondents can

answer these scales without effort. However, intention and concern may not always translate into actual behavior. For instance, in their TPB-based study, Stefan et al. (2013) show that while a lack of concern influences food waste intention, food waste intention does not affect reported food waste. Consequently, these measures are not necessarily a reliable proxy for consumer food waste behavior. Still, for intervention studies, it can be relevant to capture the effects of, for instance, information campaigns on intention and concern as well.

Another group of food waste measures associated with behavioral intention are consume versus discard decisions and the related WTC and WTW. These measures are primarily used in cases where one is interested in the disposal or consumption of specific food items. For instance, in their vignette study, Ellison and Lusk (2018) showed respondents different vignettes to investigate which factors influence discard decisions of leftovers and milk. They asked respondents first to indicate whether they would throw away or save/consume the respective products. Next, they asked on a five-point Likert scale how likely they would save versus discard the products. Similarly, WTC has been measured by asking respondents how likely it is that they would consume a food product that is one day past its expiration date (Gong et al., 2022) or until when they would be willing to consume products relative to the expiration date (Thompson et al., 2018). For WTW, Wilson et al. (2017) use a more elaborate measure, which refers to the cost of discarded food. The WTW is derived by asking survey respondents how much percent of a food product they expect to consume and taking the remaining percentage as a measure for what they refer to as premeditated waste (PW). Respondents were also asked to state their willingness to pay (WTP). The final WTW measure for each subject and product is then calculated by multiplying PW with the maximum WTP for the respective product. Other studies have also used the PW measure as a dependent variable (e.g., Buttlar et al., 2021). The advantage of consume versus discard decisions, WTC, and WTW measures is that they use a more concrete scenario than the rather general and abstract measures of food waste intention or concern. Even so, it is important to note that these are still hypothetical measures, and it is unclear if stated WTW or WTC translates into actual behavior. Since consumers tend to be over-optimistic, these measures may also be biased (Wilson et al., 2017).

Therefore, measures aiming to capture the amount of food wasted in the household directly are also used. These range from simpler scales asking respondents to estimate the fraction of food in total and/or of specific food items going to waste (e.g., Graham-Rowe et al., 2015; Stefan et al., 2013) to more extensive questionnaires asking consumers first to indicate the types of food thrown away in the past seven days and then for each product type report the respective food

waste category (e.g., meal leftovers, unused foods) and estimate the amount wasted (e.g., two tablespoons, one glass), which can later be translated to a food waste quantity in grams (van Herpen, van Geffen et al., 2019). While more general food waste questions are often only weakly correlated to other non-survey measurement methods (e.g., food waste diaries, kitchen caddies, photographic coding), van Herpen, van der Lans et al. (2019) show that the more elaborative questionnaires asking to report food waste of the past week correlate strongly with other measurement methods. Still, the authors state that questionnaires underestimate the amount of food waste. One reason for the underestimation of food waste can be social desirability bias, meaning that respondents answer the questionnaire according to what they believe other people would view as favorable. In addition, the accuracy of reported food waste depends on respondents' memory and ability to estimate food waste amounts correctly. Still, those measures can help determine relative food waste amounts (e.g., between different demographics or treatment groups in an experiment). The accuracy of food waste questionnaires can also be increased using simple measures. When using questionnaires about food waste amounts, it is recommended to provide a preannouncement, meaning an advance notice to survey respondents asking them to pay attention to their food waste in the upcoming week (van Herpen, van der Lans et al., 2019), which can increase accuracy in reporting food waste amounts. In addition, using measurement units related to the product category that are easy for respondents to understand can assist respondents in reporting their food waste amounts more precisely (van Herpen, van der Lans et al., 2019).

Ultimately, it remains an issue that – even when only considering survey research – there is no standard measurement method of consumer food waste, making it challenging to compare the results of different studies.

3 Methodological Approach

This thesis is based on data collected using online surveys and online experiments. This data collection method comes with several advantages. For instance, the costs of (online) surveys for the researcher and the effort for respondents to participate are low (van Herpen, van der Lans et al., 2019). Moreover, it is possible to set specific quotas (e.g., regarding age, gender, income, education) to ensure samples capture a diverse population group, which increases the study's external validity. Still, using self-reported measures also comes with several disadvantages. For instance, survey responses can be biased towards social desirability (e.g., respondents might report that food waste avoidance is very important to them, even if this is not the case in reality). Social desirability bias can be reduced using anonymous self-administered online questionnaires without a human interviewer present (Nederhof, 1985). Another risk of survey research is hypothetical bias, meaning that respondents state that they are willing to do something (e.g., buy suboptimal food products or consume food items past the expiration date) when asked in a survey, but they would act differently in reality. To overcome this bias, previous research has employed so-called "cheap talk" designs (Cummings & Taylor, 1999) that, before asking the hypothetical question, remind respondents about the hypothetical nature of the study and that they may tend to overestimate their willingness to pay/buy/consume. The goal is to make respondents aware of their potential bias and make them answer more truthfully.

Multiple food waste measures and proxies are used in this thesis. Intention to reduce food waste is the dependent variable in Paper I, while Papers II and III use WTC as the dependent variable. While these cannot be regarded as measures for absolute food waste amounts, they are helpful in the scope of this thesis, which tests the effect of different interventions. The above-discussed biases are (presumably) independent of any experimental treatment/intervention respondents receive. Since this thesis focuses on investigating differences between treatment and control conditions and the *relative* changes in reported intention and WTC, not the *absolute* food waste numbers, these self-reported measures were deemed appropriate. In the following, the experimental designs and measurements of the three papers are introduced. In addition, an overview of the sample for each study will be provided.

3.1 Methodological Approach for Paper I

The first paper investigates how different types of information (system versus action-related) affect consumer food waste. It uses intention to reduce food waste as a dependent variable. The theoretical background of this study is the TPB; therefore, attitude, subjective norm, and PBC are measured additionally. Moreover, in line with similar studies (e.g., Stancu et al., 2016), personal norm was included. The TPB constructs were measured on multi-item scales adapted from previous research (i.e., Russell et al., 2017; Stancu et al., 2016; Thøgersen, 2006). The experimental treatment in this study was provided to respondents in the form of a food waste knowledge quiz. This quiz consisted of 13 questions in total with three different types of questions: (1) general food waste questions, such as questions regarding food waste statistics; (2) system knowledge questions, such as questions regarding food waste's environmental, financial, and social impacts; and (3) action-related questions, such as questions regarding behavioral practices that help reduce food waste, for instance, correct food storage.

Respondents were assigned to one of four conditions, including two control and two treatment conditions. Respondents in both treatment conditions answered the general food waste questions and either the system (treatment 1) or the action-related (treatment 2) questions. Additionally, after each question, respondents in the treatment conditions received feedback on whether their answer was correct. All treatment condition respondents received additional information about the respective question topic, independent of whether their answer was correct. Respondents in the control conditions also answered the food waste quiz but did not receive feedback or additional information. The difference between the control conditions was that respondents in the first control condition answered the food waste quiz mid-survey (same as the treatment conditions) to test for a mere awareness/quiz effect. Respondents in the second control condition did not answer the food waste quiz mid-survey but only completed the quiz at the very end of the survey. The quiz was still included in their survey flow in order to compare the share of correct answers between all conditions.

Figure 3 shows a flowchart of the survey and experimental design in Paper I. First, respondents were asked about their socio-demographic information and responded to general questions related to food and food waste. Next, respondents in the treatment conditions and the first control condition completed the food waste quiz. Finally, all respondents answered the multi-item scales measuring the TPB constructs. While for the other conditions, this marked the end

of the survey, respondents in the second control condition still had to complete the food waste quiz after the TPB questions.

Figure 3. Flowchart of the Experimental Design in Paper I
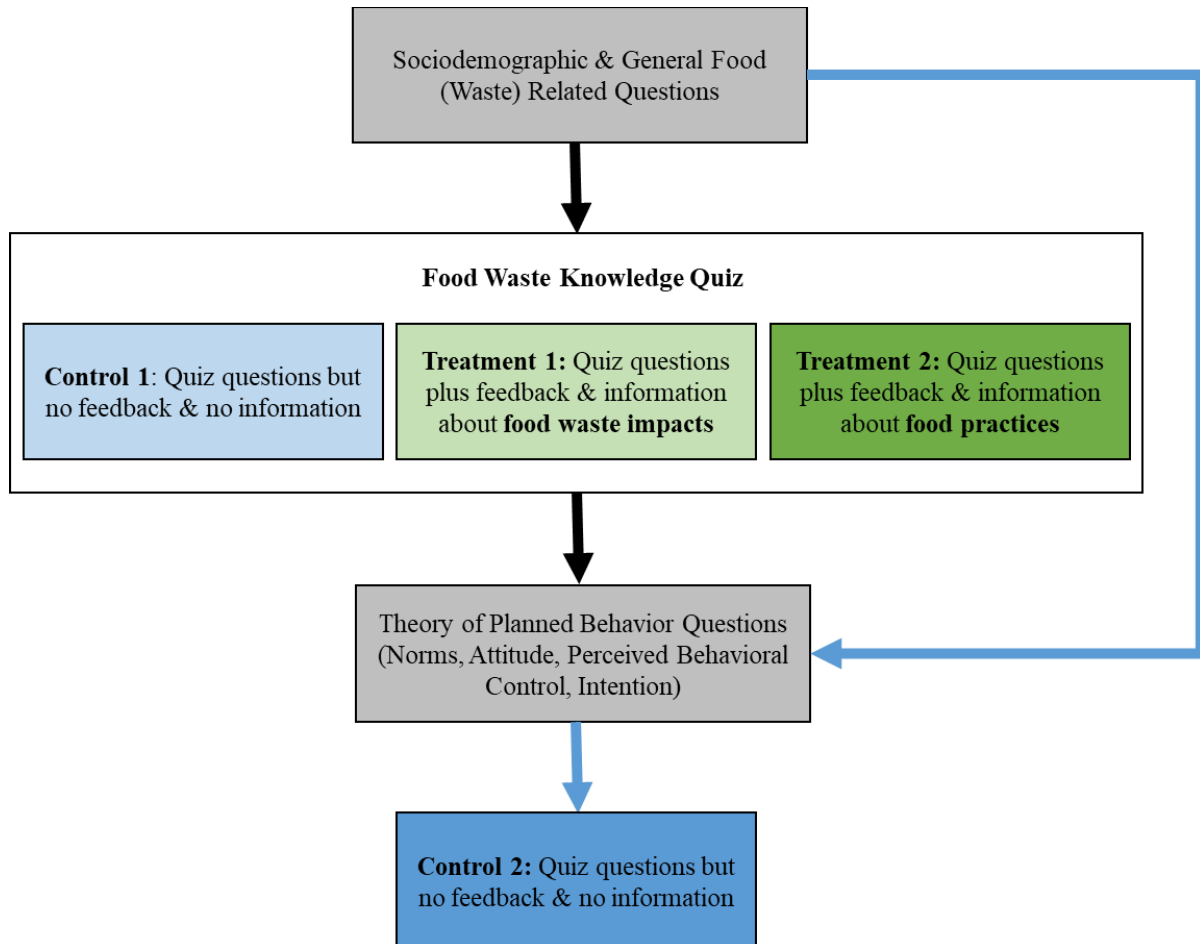
Notes. Blue arrows represent the survey flow for 'Control 2', black arrows represent the survey flow for all other conditions.

Data was analyzed using IBM SPSS 25 and SPSS Amos 25. First, t-tests and One-way Analyses of Variance (ANOVA) were used to examine differences between the control and treatment conditions. Afterward, covariance-based structural equation modeling (SEM) was used to estimate the hypothesized adapted TPB model (using maximum likelihood estimation) and investigate how attitude, norms, and PBC influence intention to reduce food waste. Lastly, multiple group analyses were performed to examine differences in the hypothesized model between treatment and control conditions. For the comparison of path coefficients, the factor loadings across groups were held constant and χ^2 tests were used to determine the significance of the path coefficient differences between conditions.

Data for Paper I was collected in June and July 2018 through an online survey. The survey was administered in three countries: Belgium (Flanders), Germany, and the UK, with 750 respondents from each country. Randomization into the treatment and control conditions was performed by country to ensure each country was represented evenly in all four conditions. Two respondents were excluded from the analyses because they reported randomly clicking through the survey, resulting in a final sample of 2,248 respondents. Table 2 shows the sociodemographic characteristics of the sample in total, by country, and by condition. The sample is representative of the respective countries regarding age, gender, income, employment status, and household size. However, respondents in the sample had a higher education than the general population in the respective countries.

Table 2. Socio-Demographic Characteristics of the Sample in Paper I

	Total	BEL	GER	UK	C1	C2	T1	T2
N	2,248	748	750	750	561	561	563	563
Gender in %								
Female	51.0	51.1	50.9	50.9	51.0	50.8	51.0	51.2
Male	49.0	48.9	49.1	49.1	49.0	49.2	49.0	48.8
Age in %								
18 – 35	27.7	27.9	25.1	30.0	27.6	27.6	27.9	27.5
36 – 45	15.7	17.1	14.0	16.0	15.9	15.7	15.6	15.6
46 – 55	18.0	17.0	18.9	18.0	17.8	18.2	17.8	18.1
56 – 65	16.0	16.0	16.9	14.9	16.0	15.9	16.0	16.0
66+	22.7	21.9	25.1	21.1	22.6	22.6	22.7	22.7
Higher Education in %[1]	59.6	53.2	69.1	56.4	61.7	55.7	60.8	60.1
Household Size								
1	27.8	21.4	36.7	25.5	28.2	26.4	30.2	26.6
2	41.2	43.6	42.1	37.9	39.8	42.2	40.5	42.3
3	15.9	16.4	12.5	18.7	15.9	16.9	15.6	15.1
4	10.3	12.3	6.4	12.1	11.1	8.7	9.6	11.7
5	3.2	4.1	1.5	4.1	3.6	3.0	3.0	3.4
6 or more	1.6	2.1	.8	1.7	1.6	2.7	1.1	.9
Monthly Net Income in %[2]								
Less than 1,000£/€	11.2	2.9	13.3	16.5	11.6	11.5	11.1	10.5
1,001 – 2,000£/€	30.4	27.0	30.1	33.9	27.7	33.1	30.6	30.2
2,001 – 3,000£/€	27.4	30.9	29.5	22.1	32.4	25.1	26.9	25.2
3,001 – 4,000£/€	16.9	24.0	14.3	13.3	14.1	16.8	17.0	19.7
4,001 – 5,000£/€	7.9	8.8	8.8	6.2	7.3	7.6	7.6	9.3
5,001 – 6,000£/€	3.7	5.0	2.5	3.8	4.3	3.3	4.3	3.0
More than 6,000£/€	2.4	1.4	1.5	4.3	2.6	2.5	2.5	2.2

Notes. BEL = Belgium, GER = Germany, C1/2 = Control 1/2, T1/2 = Treatment 1/2
[1]Higher education refers to a university, vocation, or technical degree; 18 missing values. [2]232 missing values.

3.2 Methodological Approach for Paper II

The second paper investigates the factors predicting WTC aging produce and whether providing different information (safety versus healthfulness) increases WTC. The dependent variable used in this study is WTC aging produce. WTC was measured in days. The paper uses the example of iceberg lettuce aging over one week. Starting with day one, respondents were presented with one picture at a time for each day the lettuce was aging. For each picture, respondents were asked to indicate whether they would still be willing to consume the lettuce (yes/no/don't know). If they ticked "yes" or "don't know", they were shown a picture from the next day. Once they indicated that they were no longer willing to consume the lettuce, no more pictures from subsequent days were shown. Moreover, respondents' safety and health perception of the lettuce were measured by asking them for every picture and day how safe and healthy they expected the lettuce to be using a 5-point Likert scale.

The experimental treatment in this study was provided to respondents using a time-lapse video of an iceberg lettuce head aging over a week and an informational text. There were three conditions: two treatments (safety versus health) and one control. Respondents in the safety condition received information regarding the safety of the aging lettuce and were informed that seven-day-old lettuce is still safe to consume. Respondents in the health condition received information regarding the potential health benefits of aging lettuce and were informed that aging lettuce produces potent antioxidants. Respondents in the control condition received general information about the green pigment in plants (chlorophyll) and photosynthesis. The information treatments were based on findings of a biochemical study investigating the aging process of lettuce and cucumber (Karg et al., 2021).

Additional influencing factors on WTC included in this research were food disgust sensitivity, which was measured using the food disgust picture scale (Ammann et al., 2018), and food waste propensity. Food waste propensity was operationalized as previous food waste behavior and measured by asking respondents how often they throw away (parts of) food products from five different categories. Respondents answered on a 5-point Likert scale ranging from never to always. The measurement of food waste propensity was based on scales from Stefan et al. (2013) and Russell et al. (2017), but the wording and answer options were adapted. In addition, respondents were asked how they determine the edibility of food items, i.e., whether they use objectification strategies, such as relying on the expiration date, or internalization strategies, such as using their own sense (e.g., smell, taste) (Blichfeldt et al., 2015). The scales to measure

objectification and internalization were self-developed and comprised four items. Moreover, self-developed measures for vegetarian preference (three items) and vegetable liking (three items) were used. Respondents answered all self-developed scales on a 7-point Likert scale from strongly disagree to strongly agree.

Figure 4 shows a flowchart of the survey and experimental design in Paper II. First, respondents provided sociodemographic information and answered the scales regarding additional influencing factors on WTC. Next, they were randomly assigned to one of the three conditions and received the corresponding information treatment. After passing an attention check (i.e., questions about the content of the information treatments), they saw the one-by-one pictures of the aging lettuce and indicated safety and health perception as well as WTC for each picture/day.

Figure 4. Flowchart of the Experimental Design in Paper II
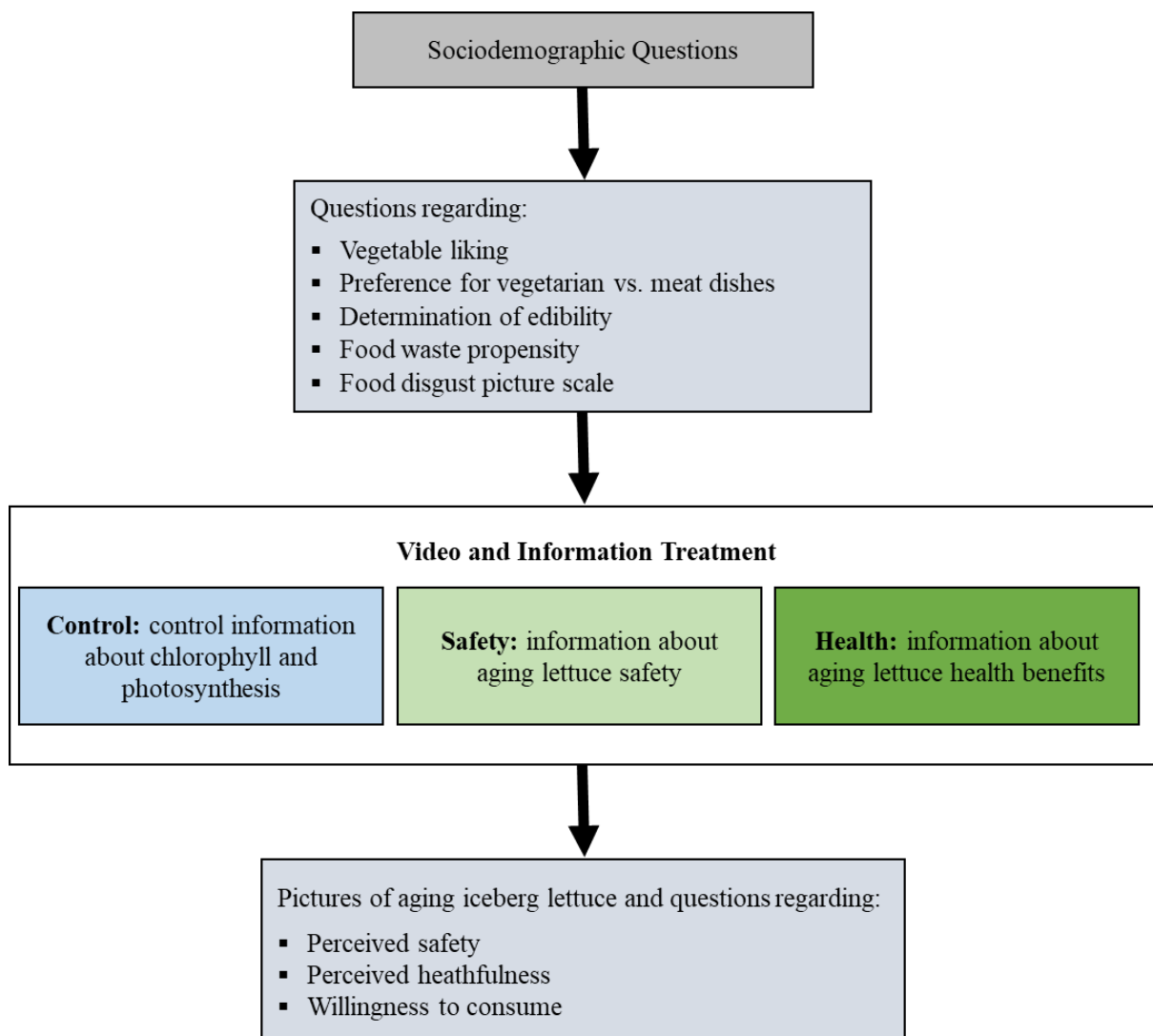
Data was analyzed using IBM SPSS Statistics 28. First, ANOVAs were used to examine differences between the experimental conditions. Afterward, stepwise multiple regression analyses were performed to investigate the influence of the information treatments and the additional factors on WTC aging lettuce. Lastly, a mediation analysis with the experimental treatments as independent variables, safety and health perception as mediators, and WTC as the dependent variable was performed using the PROCESS macro (Hayes, 2022).

Data for Paper II was collected in July 2020 in Germany using an online survey with 1,103 respondents. Only respondents who stated to be at least partly responsible for grocery shopping and cooking in their household were considered. Table 3 shows the sociodemographic characteristics of the sample in total and by condition. The sample is representative of the German population regarding age, gender, education, and region.

Table 3. Socio-Demographic Characteristics of the Sample in Paper II

	Total	Control	Safety	Health
N	1,103	367	376	360
Gender in %				
Female	50.6	49.0	50.5	52.2
Male	49.3	51.0	49.5	47.5
Other	0.1	0.0	0.0	0.3
Age in %				
18 – 22	4.9	5.2	5.1	4.4
23 – 35	19.4	19.1	18.1	21.2
36 – 55	37.0	37.3	38.8	34.7
56+	38.7	38.4	38.0	39.7
Education in % [1]				
No education completed (yet)	1.7	1.7	1.6	1.7
General secondary education certificate	32.4	31.0	32.3	33.8
Intermediate secondary education certificate	32.0	31.9	32.1	32.1
University entrance qualification	33.9	35.5	34.0	32.4
Household Size in %				
1	33.1	33.8	32.2	33.3
2	39.8	37.3	38.6	43.6
3	14.0	15.3	15.2	11.4
4 or more	13.1	13.6	14.1	11.7
Monthly Net Income in % [2]				
Less than 1,500€	27.4	24.6	29.7	27.9
1,500 – 2,500€	28.5	30.3	24.1	31.1
2,500 – 3,500€	19.5	17.6	22.7	18.0
3,500 – 4,500€	14.8	16.5	14.0	14.0
4,500 – 5,500€	6.2	6.9	5.9	5.8
More than 5,500€	3.6	4.0	3.6	3.2

Notes. [1] 19 missing values, [2] 56 missing values.

3.3 Methodological Approach for Paper III

The third paper investigates if and how implicit attitudes can predict WTC suboptimal food, using the example of dairy products past the best-before date (from here on 'expired dairy products'). Moreover, an experimental treatment tests whether priming past frugal versus wasteful behavior can change WTC. The dependent variable used in this study is WTC expired dairy products. WTC was measured separately for four different dairy products, i.e., milk, yogurt, cream cheese, and curd. Respondents saw pictures of the respective product, including a printed best-before date that – depending on when the respondents responded to the survey invitation – was between one and twelve days in the past. For each product, they were then asked to imagine the product at home in their fridge and to indicate how likely they would consume it on a 5-point Likert scale plus an opt-put option ("I generally don't eat/drink this product"). Since answers between the different dairy products were highly correlated, they were combined, and the mean value of the WTC of all four products was used as the final WTC variable.

Moreover, explicit product perceptions were measured. These were operationalized as safety and health perceptions of the expired versus non-expired dairy products, aiming at detecting how best-before dates influence safety and health perceptions. To compare the safety and health perception of expired and non-expired products, respondents saw pictures of expired dairy products and also of a non-expired version of the same products (depending on when the respondents responded to the survey invitation, the best-before date was between two and four weeks in the future). They were then asked how safe and healthy they expected the respective dairy products to be using a 5-point Likert scale. To reduce mental load, they were only asked questions for two of the four products, i.e., milk and yogurt.

The experimental treatment in this study was provided to respondents using a writing task. Specifically, respondents were asked to think about a particular scenario and describe it in a text box as detailed as possible. There were three conditions: two treatments (frugal versus wasteful) and one control. Respondents in the frugal condition were asked to think of and describe a situation where they wanted to throw something away but decided to use, recycle, or donate it. Respondents in the wasteful condition were asked to think of and describe a situation where they had thrown something away that was still good or could have been (re-)used. Respondents in the control condition were asked to think of a typical (work) day and describe the first thing they do when they get up in the morning.

Other influencing factors on WTC included in this research were the determination of edibility, food disgust sensitivity, and risk perception of expired dairy. Determination of edibility and food disgust sensitivity were measured using the same scales as in Paper II. Risk perception of expired dairy was measured using the items from the perceived health risks scale in Visschers et al. (2016) that were adapted to the context of expired dairy products.

Besides the questionnaire and the priming experiment, a substantial part of the data collection for Paper III included an IAT to measure respondents' implicit attitudes toward expired dairy products. During the IAT, respondents had to assign four types of stimuli to different category pairings. They were instructed to act as quickly as possible. The following stimuli were used: (1) pictures of expired dairy products, (2) pictures of non-expired dairy products, (3) negative words (e.g., moldy, damaged), and (4) positive words (e.g., fresh, healthy). The positive and negative word stimuli were adapted from Bolos et al. (2019). The picture stimuli were created using photographs of the four different dairy products under study (i.e., milk, yogurt, cream cheese, curd) and manipulating them using an image editing software only to show the product name, graphical elements such as pictures of the content, and a best-before date. For half of the products, the best-before date was set to have recently expired (between 1 and 12 days ago), while the other half was allocated a best-before date in the near future (between two and four weeks). The IAT consisted of two different category pairings. One was expected to be congruent to respondents' unconscious beliefs, whereas the other one was expected to be incongruent. In the congruent condition, respondents had to assign stimuli to the categories 'expired dairy products or negative' versus 'non-expired dairy products or positive'. In the incongruent condition, respondents had to assign stimuli to the categories 'non-expired dairy products or negative' versus 'expired dairy products or positive'. The idea behind this setup is that if respondents associate expired dairy products with negative words, they will answer more quickly in the congruent condition. Respondents completed seven rounds in total, of which three were practice rounds. The measurement rounds included two rounds with congruent and two rounds with incongruent category pairings for each respondent. To reduce left-right biases and counterbalance starting positions (Nosek et al., 2005), respondents were randomly assigned to one of four permutations.

Figure 5 shows a flowchart of the survey and experimental design in Paper III. First, respondents provided sociodemographic information. Next, they performed the IAT. Afterward, they answered the scales regarding additional influencing factors on WTC. Subsequently, respondents were randomly assigned to one of the three conditions for the writing

task in the priming experiment. Finally, they were shown the product pictures and indicated their safety and health perceptions and WTC for the respective products.

Figure 5. Flowchart of the Experimental Design in Paper III
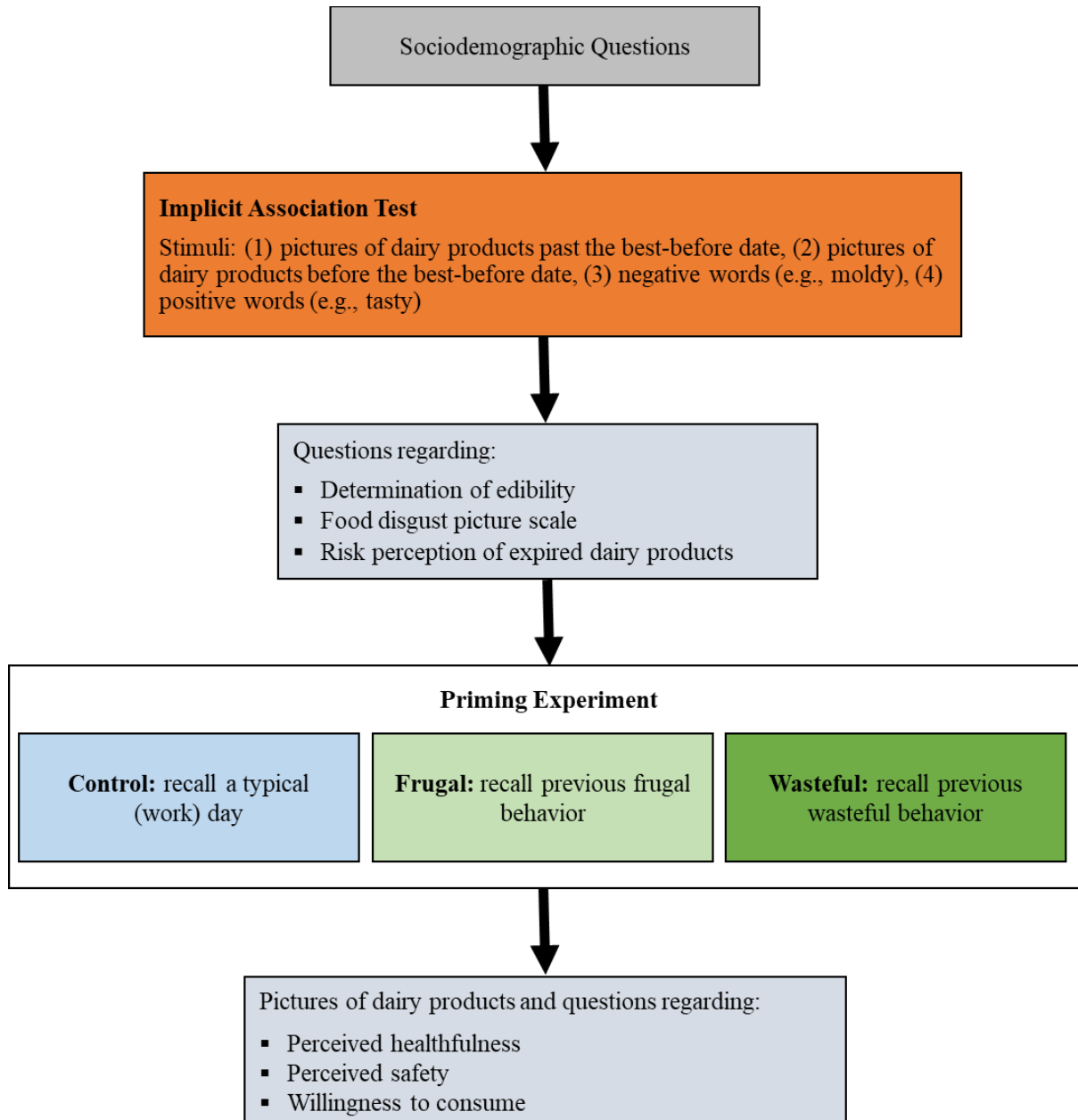
Data was analyzed using IBM SPSS 28 and SPSS Amos 28. First, the D-score (Greenwald et al., 2003) was calculated to analyze the results from the IAT. The D-score is a standardized difference score based on the respondents' reaction times in the congruent versus incongruent IAT conditions. It indicates the presence and strength of implicit preferences of – in this case – non-expired dairy products over expired dairy products. Next, dependent sample t-tests were performed to examine whether there are differences in the explicit product perceptions

regarding safety and health. Since safety and health perception were highly correlated, they were combined into one construct. For the following analyses, a measure of the reduction in safety and health perception after expiration was created by subtracting safety and health perception ratings of expired products from those of non-expired products. Lastly, confirmatory factor analysis and SEM with maximum likelihood estimation were performed to examine the interdependencies of implicit and explicit product attitudes, WTC expired dairy products, treatment effects, and additional influencing factors.

Table 4. Socio-Demographic Characteristics of the Sample in Paper III

	Total	Control	Frugal	Wasteful
N	1,135	275	489	371
Gender in %				
Female	49.3	49.5	48.1	50.7
Male	50.3	49.8	51.7	48.8
Other	0.4	0.7	0.2	0.5
Age in %				
18 – 29	12.8	10.2	11.0	17.0
30 – 39	15.4	16.4	14.9	15.4
40 – 49	13.9	14.2	14.3	13.2
50 – 59	19.7	18.2	22.1	17.8
60+	38.1	41.1	37.6	36.7
Education in %[1]				
No education completed (yet)	0.8	0.0	1.2	0.8
General secondary education certificate	23.5	25.1	23.9	21.8
Intermediate secondary education certificate	34.7	38.9	33.3	33.4
University entrance qualification	34.6	31.6	34.2	37.5
Prefer not to say	6.3	4.4	7.4	6.5
Household Size in %				
1	17.3	16.4	17.6	17.5
2	46.0	48.0	45.4	45.3
3	18.9	18.5	18.6	19.4
4 or more	17.9	17.1	18.4	17.8
Monthly Net Income in %				
Less than 1,500€	7.1	8.4	7.2	6.2
1,500 – 2,500€	17.3	16.7	16.6	18.6
2,501 – 3,500€	22.7	21.8	23.1	22.9
3,501 – 4,500€	19.7	21.5	17.8	21.0
4,501 – 5,500€	15.9	12.4	17.6	16.4
More than 5,500€	11.5	13.1	11.2	10.5
Prefer not to say	5.7	6.2	6.5	4.3

Data for Paper III was collected in December 2021 in Germany using an online survey with 1,135 respondents. Only respondents who stated to be at least partly responsible for grocery shopping and food preparation in their household were considered. Moreover, it was required that respondents consume milk and yogurt regularly (at least once a month). There were no

screening criteria for cream cheese and curd consumption. Still, only 2.2% and 3.7% of the sample indicated to never consume these products, respectively. Table 4 shows the sociodemographic characteristics of the sample in total and by treatment condition. The sample was quota-sampled and is representative of the German population regarding age, gender, and education.

4 Results

This chapter summarizes the three papers on which this dissertation is based. In addition, each subchapter contains a statement on the individual contributions of the doctoral candidate to the respective paper.

4.1 Paper I: Action-related information trumps system information: Influencing consumers' intention to reduce food waste

Extended Abstract:

Because consumers are significant contributors to the food waste problem, finding ways to reduce food waste at the household level remains critical. Therefore, consumer behavior regarding food consumption at home must be significantly altered. Several intervention studies have been conducted in recent years to address this issue (see Reynolds et al., 2019, for an overview), and it has been demonstrated that educating consumers about the problem of food waste can encourage them to engage in food waste reduction behavior. However, what type of information is most likely to result in behavior change has yet to be determined. Furthermore, from a theoretical standpoint, how and through which factors information may influence food waste-related consumption behavior has yet to be established.

Therefore, this study extends the findings from previous literature on information and consumer food waste reduction (e.g., Jagau & Vyrastekova, 2017; Liz Martins et al., 2016). We test how information based on two types of knowledge affects consumer food waste intentions and which type of information is most promising in reducing it. The types of knowledge considered are (1) system knowledge (i.e., knowing *what*, for instance, knowing about the food waste problem and the related environmental impacts) and (2) action-related knowledge (i.e., knowing *how*, for instance, knowing how to take action to reduce food waste at home). As a behavioral-distal factor, knowledge is not expected to influence behavior directly but to be mediated by factors such as attitudes, norms, and intention (Kaiser & Fuhrer, 2003). Consequently, we assess additional factors using an adaption of the TPB (Ajzen, 1991) to assess consumers' attitudes, norms, and PBC and relate these constructs to behavioral intention toward food waste reduction.

Data was collected in June and July 2018 using an online survey with 2,248 respondents from three European countries (Belgium, Germany, and the UK). The survey included an information

experiment with a between-subjects design and four conditions, two treatments (system vs. action-related knowledge), and two controls (quiz effect vs. mere control).

Results show that respondents generally report a favorable attitude towards food waste reduction, high personal norms, and PBC. Food waste knowledge is relatively poor, with action-related knowledge questions being answered correctly by about half of the respondents and system and general knowledge questions being answered correctly by about a third of the sample. Respondents who received action-related information reported a significantly higher intention to reduce food waste than those in the mere control condition. In contrast, the intention to reduce food waste of the respondents who received system information does not differ significantly from any other condition. The increased intention to reduce food waste of the action-related information condition can be attributed to greater personal norm activation, more favorable attitudes towards food waste reduction, and higher PBC of food waste behaviors. Even though respondents in the system information condition do not report an increased intention to reduce food waste, they hold more favorable attitudes toward food waste reduction than respondents in the mere control condition. Finally, the adapted TPB model used in our study proves to be a good fit for the collected data. However, there are no significant differences in the path model coefficients between the four conditions, meaning that we cannot conclude that system and action-related information influence intention in the TPB model differently.

The findings of this study can advise policymakers and non-governmental organizations (NGOs) on the types of information to consider when developing effective food waste reduction campaigns aimed at consumers. Providing action-related information appears to be a promising approach to nudge consumers to reduce food waste in their homes.

CRediT authorship contribution statement

Christina M. Neubig: Writing – original draft, Data curation, Formal analysis, Methodology, Conceptualization. Liesbet Vranken: Conceptualization, Writing – review & editing. Jutta Roosen: Conceptualization, Writing – review & editing. Simona Grasso: Conceptualization. Sophie Hieke: Conceptualization, Writing – review & editing. Sandra Knoepfle: Data curation, Formal analysis. Anna L. Macready: Conceptualization, Writing – review & editing. Natalie A. Masento: Conceptualization, Writing – review & editing.

Neubig, C. M., Vranken, L., Roosen, J., Grasso, S., Hieke, S., Knoepfle, S., Macready, A. L., & Masento, N. A. (2020). Action-related information trumps system information: Influencing consumers' intention to reduce food waste. *Journal of Cleaner Production, 261,* 121126. https://doi.org/10.1016/j.jclepro.2020.121126.

4.2 Paper II: It's safe and healthy! Increasing consumers' willingness to consume aging produce

Extended Abstract:

Being among the food items that are most often wasted by consumers (Bräutigam et al., 2014), reducing fruit and vegetable waste is highly relevant. Fruits and vegetables go to waste for various reasons, often even when they are still safe to consume. Being classified as 'suboptimal foods' (Aschemann-Witzel et al., 2015) due to cosmetic issues, such as signs of aging, can be among these reasons. When it comes to suboptimal food products, consumers frequently encounter a conflict between their goal to avoid food waste and their concern for food safety (Watson & Meah, 2012). Additionally, consumers' acceptance of a (suboptimal) food product can be influenced by its perceived freshness and healthfulness (Wansink & Wright, 2006). Consequently, these factors may lead to the decision to (no longer) consume products approaching their expiration date or whose natural aging process has started. However, recent research by Karg et al. (2021) has shown that the aging of green produce can bring health benefits and that even seven days old lettuce can usually be consumed without hesitation. Increasing consumers' health and safety perception of aging produce has a high potential to help reduce the waste of these foods.

Our study uses the example of iceberg lettuce and investigates whether informing consumers about the safety and healthfulness of aging lettuce can extend their WTC. Moreover, we explore what other factors can increase or decrease WTC aging lettuce. Next to safety and health perception, potentially relevant factors are consumers' strategies to determine the edibility of food items, food disgust sensitivity, food waste propensity, vegetable liking, and vegetarian preference.

Data was collected in July 2020 through an online survey with 1,103 respondents from Germany. The survey included an information experiment with a between-subjects design and

three conditions: two treatments (information about safety vs. health benefits of aging lettuce) and one control (control information about chlorophyll).

Results show that respondents will typically eat iceberg lettuce for four days. However, information about the safety or healthfulness of aging lettuce increases WTC. There is no significant difference between respondents in the safety and health treatment conditions regarding WTC and safety and health perception of lettuce. Further results were obtained from four regression models with WTC aging lettuce as the dependent variable and an increasing number of predictors. Model 1 uses the information treatments as sole predictors and shows that both, safety and health information, prolong WTC aging lettuce. Model 2 adds safety and health perception, both of which are significantly positively associated with WTC aging lettuce. Models 3 and 4 add the remaining predictors. Food disgust sensitivity and objectification of edibility (i.e., relying on expiration dates) decrease WTC aging lettuce, while a preference for vegetarian dishes increases WTC aging lettuce. Food waste propensity, internalization of edibility (i.e., relying on one's own senses), and vegetable liking do not predict WTC aging lettuce. Finally, a parallel mediation analysis shows that safety and health perception fully mediate the relationship between the information treatments and WTC aging lettuce.

This study adds to the literature on suboptimal foods and provides insights about how to increase consumer acceptance and WTC suboptimal products using the example of aging produce. Our results suggest that an increase in the consumption of aging produce at home can be accomplished by educating consumers about its safety and/or healthfulness. Policymakers and marketers can use these results to create effective information campaigns.

CRediT authorship contribution statement

Christina M. Neubig: Conceptualization, Methodology, Formal analysis, Writing – original draft, Investigation, Writing – review & editing. Jutta Roosen: Conceptualization, Methodology, Writing – review & editing, Supervision. Cornelia A. Karg: Conceptualization, Writing – review & editing. Simone Moser: Conceptualization, Writing – review & editing.

Current status: Published

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4.3 Paper III: Can I still eat this? Using implicit and explicit measures to explore consumer behavior towards food products with date labels

Extended Abstract:

Date labels (e.g., use-by or best-before dates) are widely employed by the food industry, even though they have been shown to be a cause of (unnecessary) household food waste (Newsome et al., 2014). According to the European Commission, Directorate-General for Health and Food Safety (2018), date labels account for 10% of the 88 million tons of food thrown away annually in the EU. As a result, it is critical to investigate the reasons and mechanisms underlying consumers' habit of tossing out food as soon as the expiration date has passed. Many customers mistakenly believe that expiration dates indicate product safety. As a result, they discard products that might still be edible (Patra et al., 2022). In addition to safety concerns, expiration dates may also influence other product inferences, such as health perception, which in turn might drive consumers to discard expired food.

To date, there are few studies investigating consumer behavior towards expired food items, and current research around expired food tends to be concerned with conscious constructs, such as explicit attitudes or norms. In contrast, implicit associations, i.e., unconscious attitudes or biases, remain underexplored. We aim to contribute to the literature by further exploring how unconscious and conscious processes influence behavior toward food products before and past the best-before date. We also examine the influence of additional factors such as consumers' strategies to determine the edibility of food items (i.e., relying on external cues such as expiration dates vs. relying on one's senses), risk perception of expired food products, and food disgust sensitivity. Next to understanding what makes consumers throw out expired food, we also aim to investigate if priming past behavior related to sustainable consumption can encourage consumers to consume products past the best-before date (but still safe to eat) to reduce food waste at home. In this study, we use the example of dairy products past the best-before date.

Data was collected in December 2021 through an online survey with 1,135 respondents from Germany. The survey included an IAT (Greenwald et al., 1998) and an experimental manipulation, i.e., a priming task with a between-subjects design and three conditions: two treatments (recalling a frugal behavior vs. recalling a wasteful behavior) and one control (recalling an unrelated behavior).

Results

Results show that respondents have negative implicit attitudes toward expired dairy products. On the explicit level, respondents rate expired products significantly less safe and healthy than fresh products. Reduced safety and health perception are negatively associated with WTC expired dairy products. Moreover, risk perception of expired dairy and consumers' strategies to determine edibility predict consumption of expired products: A higher risk perception and a tendency to rely on external cues is negatively associated with the WTC expired dairy products. A tendency to rely on one's senses, however, increases the WTC expired products. Disgust sensitivity and implicit attitudes are not directly related to the WTC expired dairy, but the reduction in safety and health perception mediates their effect. Similarly, both priming treatments do not directly influence the WTC expired dairy products. However, recalling past wasteful behavior before evaluating products past the best-before date reduces the perceived safety and healthfulness of expired products, negatively affecting the WTC expired products. Recalling past frugal behavior does not have a significant effect.

This study adds to the literature on date labels and food waste, as well as implicit and explicit attitudes. The findings can advise marketers and policymakers about which factors to consider when aiming to increase consumption of expired but still safe-to-eat food products. Finally, our results suggest that, to avoid unexpected consequences on consumer food waste behavior, careful consideration should be given to how to communicate the food waste problem to consumers.

CRediT authorship contribution statement

Christina M. Neubig: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. Jutta Roosen: Conceptualization, Writing – review & editing, Supervision.

Current status: Presented at the European Marketing Academy Annual Conference 2023

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5 Discussion and Conclusion

By implementing behavioral interventions in online surveys, this thesis shows that providing information and priming tasks can help tackle consumer food waste behavior. This chapter connects the main findings of the three papers this thesis is based on and discusses the overarching results. Moreover, implications for research and practice will be provided.

5.1 Use and Effectiveness of Behavioral Interventions in Online Studies

This thesis uses online surveys and experiments to investigate how behavioral interventions affect consumer food waste behavior. All three surveys include an experimental treatment, i.e., a behavioral intervention to be tested. Papers I and II look at the effect of providing information with the aim of generating, activating, and/or strengthening knowledge about food (waste). The information was provided in different formats. While Paper I uses a food waste quiz to activate respondents and increase interest in the written information subsequently provided, Paper II uses a time-lapse video to increase respondents' attention and make them more interested in reading the provided information text. Paper II also included a manipulation check in the form of three quiz questions to ensure respondents understood the information text. In terms of content, the information provided in Paper I focused on general information about and knowledge of food waste impacts (treatment 1) or food waste-related practices (treatment 2). The information provided in Paper II focused on specific information about and knowledge of safety (treatment 1) or healthfulness (treatment 2) of aging produce.

Both papers show that providing the respective information is an effective tool to help consumers waste less food. Still, when looking at the effect of the single information treatments, results from Paper I demonstrate that only the action-related information effectively increased consumers' intention to reduce food waste. In contrast, the impact information had no such effect. While respondents' intention to reduce food waste was relatively high in all conditions, respondents receiving action-related information reported higher intentions to reduce food waste than all other conditions.[6] In addition, the reported attitude toward food waste reduction

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[6] However, the differences are only significant between the action-related information condition and the control condition with the food waste quiz at the end of the survey (i.e., mere control; p = .019); and marginally significant between the action-related information condition and the control condition with the food waste quiz mid-survey (i.e., quiz effect control; p = .065). There is no significant difference between the two treatment conditions.

was significantly higher for both the treatment conditions as well as the control condition with the quiz mid-survey. The fact that the attitude also increased for respondents in the control condition who answered quiz questions but received no feedback or additional information points to the conclusion that when it comes to attitude, it is not necessarily about providing information or increasing knowledge. The mere activation of a topic, in this case, food waste reduction, can already influence consumers' attitudes toward it. Moreover, respondents in the action-related information condition report the highest personal norm, which is somewhat surprising since the action-related information provided was not aimed at influencing personal norms. Still, being told they have the necessary means or learning that there are easy ways to reduce food waste at home may make consumers feel guiltier when wasting food, knowing they could easily avoid it. Finally, the results of Paper I also show that PBC is higher for respondents who received the action-related information compared to the control conditions.[7]

Contrary to Paper I, both information treatments employed in Paper II resulted in a significantly increased WTC aging produce. While respondents in the control condition were willing to consume the aging produce only for an average of 3.62 days, respondents in the safety condition were willing to consume the aging produce for an average of 4.15 days, and respondents in the health condition were willing to consume the aging produce for an average of 4.19 days. The average WTC across conditions was 3.99 days. Both information treatments significantly increased the safety and health perception of the aging produce. Respondents who received the health information reported the highest safety and health perception, which was unexpected since the safety of the aging produce was not emphasized in the health information treatment. This points to the conclusion that for consumers, there might not be a difference between the healthfulness and safety of aging produce or that these factors influence each other. A subsequent mediation analysis further shows that the effect of safety and health information treatments is fully mediated by safety and health perception.

Paper III approaches the issues on a slightly different path. Instead of providing information to influence food waste behavior, the intervention (i.e., priming) used in Paper III aims to increase consumers' attention toward and the salience of food waste reduction by activating desired

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[7] The effect is significant (p = .025) between the action-related information condition and the control condition with the food waste quiz at the end of the survey (mere control); and marginally significant (p = .087) between the action-related information condition and the control condition with the food waste quiz mid-survey (quiz effect control).

goals, such as behaving frugally. In line with previous studies (e.g., Panzone et al., 2021), this is achieved by asking respondents to recall past pro-environmental behavior. The past pro-environmental behavior to be recalled in the context of this paper was an instance where the respondents behaved frugally and saved something intended for discard. Respondents were asked to write a few lines and describe the recalled instance as detailed as possible to make the recalled behavior more salient. Additionally, Paper III takes an interest in the reverse effect: Using a second priming treatment that asked respondents to recall an instance where they behaved wastefully and threw away something that could have been used or repurposed, it was investigated whether this wasteful priming can lead to a decrease in WTC expired dairy products. This direction is essential considering current information campaigns in the context of food waste that tend to call out consumers' food waste behavior and emphasize the amount of food thrown away by consumers.

The results show that recalling past wasteful behavior significantly negatively affected the perception of expired dairy products, which in turn decreased WTC expired dairy products. Recalling past frugal behavior, however, had no effect. A reason could be that recalling past frugal behavior may have triggered negative or positive memories. For instance, some respondents recalled consuming expired food products and felt good for not wasting them. Others might have recalled an incident where the consumption of expired food made them sick and consequently felt bad when recalling the memory.

These results emphasize the importance of finding the best way to communicate the food waste issue to consumers. When communication focuses on food waste amounts and impacts, this may trigger memories of previous waste and reasons for wasting in consumers. Consequently, a backfire effect can occur where consumers do not change their food waste behavior or even waste more after receiving the information. This could also be due to social norm activation. Communication emphasizing the high amount of consumer food waste can make consumers feel that wasting food is the norm. Consequently, they will not be motivated to change their behavior, as previous research on related pro-environmental behaviors has shown (Cialdini, 2003). Therefore, communication should not only focus on descriptive norms (i.e., what most people do) but also injunctive norms (i.e., whether this behavior is acceptable or not). Moreover, in line with the findings of Paper I, action-related information should be provided to give consumers the means to change their behavior.

To measure consumer food waste behavior, the three papers of this thesis employ different but related measures inspired by previous research in the food waste field (see Chapter 2.3). The various outcome measures were chosen based on the respective paper topics and research questions. While Paper I focuses on the intention to reduce food waste, Papers II and III use WTC (aging lettuce and expired dairy products, respectively). WTC is either measured as a binary variable (yes/no) for several days in a row, which, when added up, results in a WTC measure in days (Paper II) or on a Likert scale to result in a WTC likelihood (Paper III). Intention to reduce food waste was also measured on a Likert scale. Measuring food waste behavior, in general, poses numerous challenges, and each method – be it an online survey or a waste audit – comes with its caveats. It is, therefore, important to note that the measures used in this thesis cannot be interpreted as absolute values. This thesis aimed to test behavioral interventions and investigate their effectiveness. As an effect measure, the used measures provided adequate: As the results show, all outcome measures reflected the employed interventions, meaning respondents who received interventions scored higher in the respective outcome measure. However, the present work does not allow conclusions regarding the generalizability of the results into other settings (e.g., outside of an online environment, for different products) and especially, the effect sizes in other settings and on other outcome variables (e.g., consumption-versus-discard decisions in real life). Still, the samples collected for Papers II and III were representative of the German population, and the sample for Paper I was representative of the population of three European countries (Belgium, Germany, and the UK), which means results obtained in these papers are transferrable to the respective populations.

5.2 Additional Influencers of Food Waste Behavior

While the focus of this thesis is to explore how different behavioral interventions affect consumer food waste behavior, another aim is to explore additional factors that contribute to consumer food waste behavior. In the course of this thesis, conscious psychological factors such as explicit attitudes and preferences (Paper I, II, and III), affective processes such as disgust (Paper II and III), and unconscious factors such as implicit attitudes (Paper III) were considered.

Concerning the conscious psychological factors influencing food waste behavior, Paper I looks at the attitudes, norms, and PBC of consumers in relation to food waste. It finds that respondents have an overall favorable attitude toward food waste reduction. The personal norm is high among respondents, meaning they tend to feel guilty when wasting food. The level of subjective

norm, however, is relatively low, meaning respondents feel little social pressure to engage in food waste reduction behaviors. Respondents also report an overall high PBC of food waste reduction. Looking at the extended TPB model, it becomes evident that attitude and subjective as well as personal norms have a far more considerable influence on the intention to reduce food waste than PBC. The previously stated findings of this paper show increased PBC for respondents in the action-related information condition. However, given its small influence on behavioral intention, the question arises whether increasing PBC is very effective or if increasing attitudes and norms might be a more viable path. In this context, it is important to note that Paper I only includes behavioral intention, not actual behavior, as a dependent variable. In the original TPB model (Ajzen, 1991), PBC is also assumed to affect behavior directly and not only via behavioral intention. Therefore, increasing consumers' PBC regarding food waste reduction can still be an effective way to reduce food waste and should be investigated further in studies of actual behavior.

Papers II and III investigate a range of psychological factors. In contrast to Paper I, they do not consider general attitudes, norms, and PBC toward food waste reduction. Papers II and III focus on the specific case of suboptimal foods and their contribution to unnecessary food waste, using the examples of aging produce (Paper II) and expired dairy products (Paper II). They consider explicit perceptions of the products under study. Both papers deal with suboptimal foods. Because consumers tend to be concerned about the safety and healthfulness of suboptimal food products (Neff et al., 2019; Schmidt, 2019; Stangherlin et al., 2019), product perceptions were operationalized as safety and health perceptions. Even though the concepts are analyzed differently in the two studies (see Chapter 3), both find that explicit product perceptions play the most prominent role in the decision to consume suboptimal foods. In addition, Papers II and III include explanatory variables such as consumers' strategies to determine edibility (i.e., objectification versus internalization). Paper II finds that respondents who stated to use objectification strategies when determining the edibility of food items, such as relying on expiration dates, report a significantly lower WTC aging produce. These results were replicated in Paper III for the case of expired dairy. Additionally, internalization of edibility (e.g., using one's senses) positively influenced WTC expired dairy. This effect was not found in Paper II for aging produce.

Moreover, Paper II considers previous food waste behavior and eating preferences regarding vegetables and vegetarian meals. While previous food waste and vegetable liking did not influence WTC aging produce, a preference for vegetarian meals increased WTC significantly.

This could be due to vegetarians being more acquainted with the preparation of vegetables and having more action-related knowledge of them (e.g., how lettuce looks and smells once it is no longer edible). Paper III includes risk perception of expired dairy products, i.e., a measure that describes how risky consumers feel the consumption of expired dairy products is in general. As expected, the general risk perception of expired dairy products significantly influenced WTC and explicit product perceptions. Papers II and III both look at the effect of disgust sensitivity on WTC suboptimal foods and thereby include an affective process, too. Results indicate that disgust sensitivity plays a significant role in WTC aging produce. In line with expectations, being easily disgusted leads to a lower WTC aging produce. In the case of expired dairy products, disgust sensitivity did not directly affect WTC but was fully mediated by explicit product perceptions regarding safety and health.

Finally, the effect of implicit attitudes was studied in Paper III. Interestingly, results show that implicit attitudes do not directly affect WTC expired dairy. However, implicit attitudes significantly influence explicit product perceptions. Even though previous research classified explicit and implicit attitudes as distinct processes (Govind et al., 2019), this finding aligns with previous research that reports implicit and explicit attitudes are often correlated (e.g., Hofmann et al., 2005).

In summary, this thesis shows that several factors contribute to food waste behavior. While some of these factors have been widely recognized (e.g., attitudes, norms, PBC), others have only rarely (e.g., food disgust sensitivity, eating preferences) or – to the best of the author's knowledge – not at all been considered in previous studies in the respective context (e.g., implicit attitudes, strategies to determine edibility).

5.3 Research Implications

This thesis provides important implications for future research. First, the three studies carried out in this thesis's scope contribute to the field of research dealing with how to use behavioral interventions to reduce consumer food waste. The studies show some promising results, specifically regarding comparing educational interventions and providing information focusing on different aspects of the food waste problem. Still, more work needs to be done. There are numerous possibilities for educational content that could be tested. To name one example, take the concept of determination of edibility. This concept was included in Papers II and III, and results show that it is a relevant predictor of consumer food waste behavior. Therefore, future

intervention studies could target this concept and develop and test interventions that teach consumers how to use their senses when determining edibility and how to interpret expiration dates correctly. Other factors to be targeted might be personal and subjective norms since these were shown to be important influencing factors of the intention to reduce food waste in Paper I. Since respondents in the study in Paper I reported comparatively low levels of subjective norms, meaning they do not feel a high social pressure to engage in food waste reduction efforts, there is potential to increase subjective norms using behavioral interventions. Future research could add value by incorporating norms into educational messages. In the field of suboptimal food, safety and health perceptions play a crucial role. Future research should, therefore, focus on these constructs and test ways to influence them.

This thesis did not include combinations of different message contents, for example, action-related *and* system information or safety *and* health information. A combination of messages, however, might lead to additional insights and should therefore be tested. Recent research on food waste and message framing also shows that gain versus loss framing (Khalil et al., 2021), as well as climate versus frugal versus taste framing (Aschemann-Witzel et al., 2022) of messages, can significantly influence results. More research is needed in this area, especially to identify the most relevant frames. Additionally, future research should focus on identifying situations and/or target groups for whom specific frames are more or less effective and develop targeted communication material for diverse audiences.

This thesis sheds some light on the role of implicit attitudes in consumer food waste behavior and shows that consumers unconsciously devalue expired products. However, the IAT for Paper II only included one product category (dairy products) and one expiration date type (best-before date). It would be interesting to replicate the findings using other expired food products (e.g., canned food, frozen food, meat, and fish) and different expiration date types (e.g., use-by, sell-by) to test the robustness of the findings. In addition, behavioral interventions targeted at changing implicit attitudes should be tested to explore if and how this might be possible. A possibility would be using self-referencing tasks (i.e., making consumers associate the respective products with the self), which has been shown to influence implicit attitudes toward green vegetables (Mattavelli et al., 2017) and organic food (Richetin et al., 2016).

Additionally, multiple explanatory factors were included in this thesis. However, studying their interrelations was out of scope. It would be worthwhile for future research to address these interrelations (e.g., between constructs such as vegetarian preference and food waste-related

knowledge or health/safety perception and norms) to better understand how different aspects work together regarding consumer food waste behavior.

In terms of methods, there is generally a lack of field experiments that investigate the effectiveness of behavioral interventions in a real-world setting. Additionally, only a few studies measure food waste behavior more extensively, for instance, by using food waste diaries or elaborate questionnaires (e.g., van Herpen, van Geffen et al., 2019). Moreover, longitudinal studies that test the stability of intervention effects are still rare. This is problematic because to target household food waste effectively, consumers need to change their behavior permanently and not just in the short run after they receive *one* educational measure.

5.4   Managerial and Policy Implications

This thesis also provides implications that (marketing) managers, policymakers, or NGOs can employ to address the food waste problem.

Motivated by the positive findings of this thesis regarding information provision, policymakers and NGOs that want to reduce food waste should launch education campaigns and provide information to consumers. Concerning content, action-related information should be preferred over system information. Moreover, reminding consumers of their previous food waste accounts should be avoided. Informational messages should instead focus on tips for preventing food waste in the future. Regarding suboptimal products, information should focus on safety and healthfulness. More precisely, NGOs and policymakers should strengthen the safety and health perception of suboptimal foods. For instance, in the case of expired foods, explaining the meaning of date labels, i.e., that they are mainly a quality index and not a measure of product safety, could be worthwhile. For all suboptimal foods, strengthening internalization strategies when it comes to determining edibility, i.e., teaching consumers how to use their senses to determine whether food products are still edible, is recommended. Such information could be provided via national or local print and social media information campaigns or even at the point of sale. Producers and manufacturers who want to reduce household food waste could also provide information regarding expiration dates and ways to determine whether a product is still safe to eat on the product packaging. The first attempts to do so have already been made. For instance, German retailer Aldi Süd recently tested printing a "smell me, taste me" claim next to

the best-before date on dairy products to encourage consumers to consider consuming products past this date.[8] Labels like this can help make consumers reconsider expiration dates.

Technological innovations such as food safety scanners that measure the bacterial load on aged or expired products or smart packaging that can give information regarding potential interruptions of the cold chain or, more generally, the safety of its contents could also be a way to help make consumers feel safer about (suboptimal) foods. Especially consumers who focus on the objectification of edibility strategies could be responsive to this approach.

Finally, this thesis shows that suboptimal foods are also implicitly perceived as unfavorable. As discussed above, it is challenging to change implicit attitudes and associations. Still, it is crucial to attempt because implicit attitudes can play an important role, especially in habitual and everyday consumption decisions. Previous research recommended a repeated and constant pairing of suboptimal products with positive stimuli to change implicit attitudes (Bolos et al., 2019). Since explicit attitudes can override implicit ones if people have the required motivation and capacity (Wilson et al., 2000), another approach could be to trigger elaborate instead of habitual decision-making, thereby decreasing the influence of implicit attitudes. One attempt could be to provide more information on expiration dates and internalization strategies at the point of sale or the product packaging in a conspicuous way to increase consumers' awareness. Lastly, increasing consumers' understanding and valuation of the whole food production system could be worthwhile. For instance, by teaching children early on about food production and getting them used to handling fresh produce, they could learn that not every apple looks as perfect as the ones in the supermarket, and negative attitudes towards suboptimal produce could be reduced. Still, more research is needed to put this to the test.

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[8] This project was carried out in Bavaria, as part of a campaign by the Bavarian State Ministry of Food, Agriculture, and Forestry and the alliance "We save food!" For more information, please refer to: https://www.zugutfuerdietonne.de/jetzt-engagieren/projekte-aus-der-praxis/aktion-riech-mich-probier-mich-ich-bin-haeufig-laenger-gut/

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Appendices

Appendix 1. Paper I: Action-related information trumps system information: Influencing consumers' intention to reduce food waste

Appendix 2. Paper II: It's safe and healthy! Increasing consumers' willingness to consume aging produce

Appendix 3. Paper III: Can I still eat this? Using Implicit and Explicit Measures to Explore Consumer Behavior towards Food Products with Date Labels