Call for Testing Interventions to Prevent Consumer Food Waste

Sabrina Stöckli,[a]
Eva Niklaus,[a]
Michael Dorn[a]

[a] University of Bern, Institute of Marketing and Management, Department Consumer Behavior

Author Note

Correspondence about this article should be addressed to: Sabrina Stöckli, University of Bern, Institute of Marketing and Management, Department Consumer Behavior, Engehaldenstrasse 4, 3012 Bern, Switzerland, Email: Sabrina.Stoeckli@imu.unibe.ch

Abstract

Over the last decade, practitioners have implemented various interventions against consumer food waste. In contrast, academics have only just started to examine how to prevent consumer food waste. This review synthesizes practical and academic evidence on anti-consumer-food-waste interventions. The basis for this synthesis was a systematic framework of antecedent interventions (informational intervention, prompts, modeling (social norms), commitment) and consequence interventions (feedback, rewards, penalties) that we have drawn from general behavioral change and intervention research. This review shows that (1) informational interventions are the most commonly used intervention type even though evidence indicates that this intervention type is relatively ineffective, and (2) there is a lack of evidence of the effectiveness of anti-consumer-food-waste interventions. With reference to general behavioral change and intervention literature, we suggest that (1) intervention types other than informational interventions should be considered, and (2) anti-consumer-food-waste interventions should be evaluated in a systematic manner; that is, by using a framework with standardized definitions and measurement methods that addresses specific behaviors and change processes and that allows accurate identification of short-term and long-term effects. Overall, this review outlines current conceptual and methodological challenges and sets an agenda for implementing effective anti-consumer-food-waste interventions.

Keywords: Consumer Food Waste; Green Consumption; Behavioral Change; Behavioral Intervention; Social Marketing

1 Introduction

Food waste is an urgent environmental, social, and economic issue. It causes greenhouse gas production and soil depletion (Knipe, 2005; Quested, Ingle, & Parry, 2012; Ventour, 2008), compromises global food security (Godfray et al., 2010), and adds to food price inflation (FAO, 2015). In developed countries, consumers are the single biggest producer of food waste (Beretta, Stoessel, Baier, & Hellweg, 2013; Priefer, Jörissen, & Bräutigam, 2016). In the US, for instance, a consumer wastes 0.28 kg of food per day (Thyberg, Tonjes, & Gurevitch, 2015; for a review of food waste estimates across various developed countries, see Thyberg & Tonjes, 2016). Considering that 65% of this waste could be avoided with more sustainable consumer behavior (Farr-Wharton, Choi, & Foth, 2014a), the urgent need to change behavior is evident.

"Food waste" has become a media buzzword over the last decade[1]. There are more organizations (e.g., WRAP, FAO) and campaigns (e.g., Love Food Hate Waste) which aim to make consumers aware of food waste and to foster more sustainable food consumption. In contrast to this practical effort, academics have only recently begun to examine anti-consumer-food-waste interventions. So far, academics concerned with consumer food waste have mainly (1) measured the environmental impact (for a review, see e.g., Bernstad & Cánovas, 2016), (2) identified causes, most notably by applying the *Theory of Planned Behavior* (TPB) (e.g., Graham-Rowe, Jessop, & Sparks, 2015; Russel, Young, Unsworth, & Robinson, 2017; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016), and (3) proposed policies as well as prevention by calling for awareness campaigns, informational interventions, and education (for a review, see e.g., Hebrok and Boks, 2017; Priefer, Jörissen, & Bräutigam, 2016; Thyberg & Tonjes, 2016). Moreover, some academics have outlined detailed research agendas to better understand the mechanisms underlying consumer food

[1] See Google Trends: https://trends.google.com/trends/explore?q=foodwaste

waste (for a review, see e.g., Block et al., 2016; Porpino, 2016). Few studies have evaluated concrete interventions to examine to what extent consumer food waste can be reduced or prevented (for exceptions see, e.g., Kallbekken & Sælen, 2013; Whitehair, Shanklin, & Brannon, 2013).

Considering the urgent need to reduce food waste, it is important to understand the current state of knowledge on behavioral interventions against consumer food waste in order to implement effective interventions in the future. This review considers both practical and academic insights in order to provide a systematic assessment of anti-consumer-food-waste interventions with the help of general behavioral change literature (e.g., McKenzie-Mohr, 2013; Schultz, 2014; Steg, Buunk, & Rothengatter, 2008). So far, the interdisciplinary behavioral change literature has identified many intervention types (e.g., information, prompts) and contextual factors that effectively lead to behavioral change (Schultz, 2014). Although behavioral change studies and campaigns are mostly separated by issue (e.g., littering) and focus on specific behaviors, they apply the same or similar theories, concepts, methodologies, and procedures (Mick, Pettigrew, Pechmann, & Ozanne, 2012).

Overall, this synthesis of practical and academic evidence on general and food-waste-specific interventions reveals two key challenges: First, informational interventions are predominant and it is necessary to conduct other intervention types. Second, there is a general deficiency in evaluating anti-consumer-food-waste interventions, and therefore a need for more systematic evaluation.

The structure of this review is as follows: First, we introduce a systematic framework of established types of behavioral change intervention used to promote sustainable consumer behavior. Second, we review practical and academic evidence on anti-consumer-food-waste interventions and link it to evidence from general behavioral change research. Finally, we discuss key findings and suggest future directions for effective anti-consumer-food-waste interventions for both practitioners and academics.

2 A Framework of Behavioral Change Interventions

There is substantial interdisciplinary research on behavioral change interventions which are intended to foster sustainable consumption. Reviews of the behavioral change literature often adopt a wide-ranging classification framework to sketch the variety of intervention types and the contextual factors that determine whether an intervention is effective (e.g., Geller et al., 1990; McKenzie-Mohr, 2013; Michie, West, Campbell, Brown, & Gainforth, 2014; Schultz, 2014; Steg et al., 2008). Typically, intervention types are categorized as *antecedent* or *consequence*: antecedent interventions alter (the salience of) the context that precedes the target behavior. The most prominent antecedent intervention types are informational interventions, prompts, modeling, and commitment. Consequence interventions alter (the salience of) the consequences of the target behavior. The most prominent consequence interventions are feedback, rewards, and penalties.

Although this general twofold classification is said to be simplistic (e.g., Mosler & Tobias, 2007), it meets our requirement for a simple framework within which to systematically review a broad range of intervention types (against consumer food waste). For an overview of this framework and definitions of its intervention types, see Table 1. Comprehensive reviews of these intervention types, including findings on their effectiveness, underlying mechanisms and the role of contextual factors, can be found elsewhere (e.g., Abrahamse & Matthies, 2012; Abrahamse, Steg, Vlek, & Rothengatter, 2005; Homburg & Matthies, 1998; Osbaldiston & Schott, 2012; Schultz, 2014).

Table 1

A Systematic Framework of Behavioral Change Interventions

Intervention		Description	Example	Effect Size (*g*)
Antecedent	Informational	Strategies that aim to increase knowledge and skills	Education, training	.31
	Prompts	Verbal or written messages designed to remind people to perform a target behavior	Signs, stickers	.62
	Modeling	Demonstration of a desired target behavior, often building on the influence of social norms	Video portraying certain practices	.63
	Commitment	Asking people to agree to perform a target behavior	Signing pledges, promise cards	.40
Consequence	Feedback	Providing information about the frequency and/or consequences of a target behavior	Printed sheet with statistics of one's resource consumption	.31
	Rewards	Applying positive consequences for a target behavior	Money, special privileges, praise	.46
	Penalties	Applying negative consequences for a target behavior	Monetary penalties	.46

Note. Systematic framework of antecedent and consequence interventions with descriptions of intervention types and effect sizes (Hedges' g) from Osbaldiston and Schott's (2012) meta-analysis. Note that several of the meta-analyzed studies confound multiple intervention types.

3 A Systematic Review of Antecedent and Consequence Interventions Against Consumer Food Waste

We used the framework of antecedent and consequence interventions (see Table 1) to collect, group, and analyze practical and academic evidence on anti-consumer-food-waste interventions. The range and nature of this literature strongly determined our search methodology.

3.1 Search Methodology

For the literature search of practical evidence of anti-consumer-food-waste interventions, we adopted a case study research approach. Between October 2016 and September 2017, we searched for current gray literature — that is, reports and website information from governments and non-governmental organizations — using the Google search engine. In view of the vast amount of gray literature, we did not intend to obtain a complete inventory of practical anti-consumer-food-waste interventions. We used the search

criteria that the gray literature should address anti-consumer-food-waste interventions that were carried out in developed countries and that reached a high degree of popularity. Further, we only used grey literature that was available in English, German, and/or French. The first author of this paper conducted a content analysis of the collected online information. Based on this, the campaigns and interventions were assigned to one of the intervention types in the framework in Table 1.

To find academic evidence of anti-consumer-food-waste interventions, we conducted a systematic literature search between October 2016 and January 2018 using Google Scholar (https://scholar.google.ch/) and Peerus (https://peer.us/). We used a predefined set of search terms[2]. For all search terms, we screened the first ten Google Scholar search pages and all search results from Peerus. In that way, we collected all articles published in academic journals that qualitatively or quantitatively examined effects of anti-consumer-food-waste interventions in developed countries. Only articles in English were considered. No further search criteria (e.g., date restriction) were set. The literature search resulted in an academic intervention inventory with articles between 2012 and 2018.

Within our literature search we limited our focus to anti-consumer-food-waste interventions in developed countries, using the United Nations classifications of *developed countries*, *countries in transition*, and *developing countries*[3]. The rationale for this geographical focus is that there are only a few studies of consumer food waste in countries in transition or developing countries (e.g., Abdelradi, 2018). Furthermore, the percentage of food waste by households is substantially larger in developed countries than in countries in transition or developing countries (for a detailed overview see Lipinski et al., 2013) and

[2] The search terms used in Google Scholar were: "consumer food waste", "household food waste", "food waste"+intervention", "food waste"+information+intervention, "food waste"+education+intervention, "food waste"+modeling+intervention, "food waste"+commitment+intervention, "food waste"+feedback+intervention, "food waste"+reward+intervention, "food waste"+penalties+intervention, "food waste"+incentive+intervention The search terms used for Peerus were: "consumer food waste", "household food waste"

[3] See http://unctadstat.unctad.org/EN/Classifications.html

psychological drivers (e.g., attitudes, habits) seem to differ in developed versus other countries (e.g., Calvo-Porral, Medin, & Losada-Lopez, 2017; Alamar, Falagán, Aktas, & Terry, 2018; Ramukhwatho, du Plessis, & Oelofse, 2017). This suggests that effective anti-consumer-food-waste interventions would need to address different specific behaviors and psychological drivers for developed and other countries.

Table 2 provides an overview of all analyzed practical and academic anti-consumer-food-waste interventions. The subsequent general and food-waste-specific descriptions of all intervention types and their assessments provide a basis for discussing patterns of effective anti-consumer-food-waste interventions. This, in turn, raises a number of questions that will help to develop a research agenda to better understand how consumer food waste can be effectively reduced.

Table 2

An Overview of Analyzed Anti-Consumer-Food-Waste Interventions

Intervention		Number of Practical Interventions	Number of Academic Interventions	Total Number of Interventions
Antecedent	Informational	17 (81%)	3 (30%)	20 (65%)
	Prompts	1 (5%)	2 (20%)	3 (10%)
	Modeling	1 (5%)	1 (10%)	2 (6%)
	Commitment	2 (10%)	1 (10%)	3 (10%)
Consequence	Feedback, Rewards and Penalties	-	3 (30%)	3 (10%)
Total		21 (100%)	10 (100%)	31 (100%)

Note. Systematic overview of the number of all analyzed practical and academic anti-consumer-food-waste interventions according to the taxonomy of intervention types in Table 1. The percentages in brackets represent the proportion of the analyzed intervention types within all (practical and/or academic) interventions. (Percentages do not add up to 100% due to rounding.)

3.2 Informational Intervention

In general, informational interventions are the intervention type most frequently applied to promote sustainable behavior. Informational interventions aim to increase knowledge and skills, and are based on the assumption that providing information about the negative consequences of an undesired behavior (e.g., wasted resources) and the positive consequences of a desired behavior (e.g., saved resources) creates problem awareness and changes behavior. However, information alone seldom changes behavior, but has often been successful in combination with other intervention types (Kollmuss & Agyeman, 2002; McKenzie-Mohr, 2013; Steg et al., 2008). Osbaldiston and Schott (2012) meta-analyzed the effects of common intervention types (see Table 1) and substantiated this by showing that informational interventions are less effective than other intervention types (i.e., relatively low average effect size; g = .31).

Our review of practical informational interventions in the domain of consumer food waste reveals that there are three noteworthy peculiarities (see Table 3). First, real-world campaigns almost exclusively implement informational interventions rather than other intervention types such as prompts or commitment (see Table 2). General intervention research shows that campaigns are more successful when informational interventions are complemented with other intervention types (e.g., prompts or commitment; Abrahamse & Matthies, 2012; Steg et al., 2008).

Second, most practical campaigns employ multiple non-personal and personal communication channels to convey diverse types of information (see Table 3). Frequently used channels include informative videos, websites, social networks (e.g., Facebook), brochures, workshops, and events that inform consumers about the issue of food waste and its link to food sustainability and environmental consequences (i.e., declarative knowledge), as well as tips for household practices (i.e., procedural knowledge). In general, the extensive use of diverse communication channels is beneficial as it increases the likelihood of reaching a

wide audience. However, no evaluation or comparison of the effectiveness of these communication channels exists for the field of consumer food waste (see Table 3). The general social marketing literature urges communicators to match communication channels to the target group and to message content (e.g., Lee & Kotler, 2015). The effectiveness of a communication channel depends on whether personal contact is made, on its medium (i.e., visual, auditory, print, electronic), and on its ability to transmit complex information (Friedman & Shepeard, 2007; Kotler & Zaltman, 1971; Kreuter & Wray, 2003; Myhre & Flora, 2000). Although the diverse communication channels available for interventions against consumer food waste have not yet been evaluated, it seems that practitioners orient themselves toward general intervention research. The “KiNa" campaign (see Table 3), for instance, uses multiple (non-)personal communication channels and adopts evidence on the importance of harmonizing communication channels with the target group and information type. Specifically, this target-group-oriented campaign aims to educate kindergarten children with trained mentors and provides educational material such as films and websites that are suitable for children.

Third, our review reveals that, although informational interventions are popular among practitioners, there is a lack of evidence for their effectiveness. As shown in Table 3, practitioners have seldom evaluated their campaigns and have even more seldom used a systematic evaluation scheme. Related to this is the problem that it is not yet known which are the most valid and practicable variables with which to measure consumer food waste. Such variables are required to measure the effect of interventions. Another methodological problem is that it is often impossible to distinguish between the effect of a campaign as a whole and the effects of single (informational) interventions.

In sum, it is evident that informational intervention is the most popular intervention amongst practitioners. Evaluation measures are needed in order to overcome numerous

methodological challenges and to ensure a systematic, unconfounded comparison of individual informational interventions.

Unlike practitioners, academics have not often examined informational interventions against consumer food waste, but repeatedly recommend this intervention type. An empirical test that examined the impact of informational interventions on different communication channels (Facebook page and e-newsletter) from a national retailer over time did find reductions in self-reported food waste behavior (Young, Russel, Robinson, & Barkemeyer, 2017). However, the effect was also found for people that did not remember the informational intervention (i.e., the control group) and the reported effect size (0.01) induced a controversy over its behavioral significance (see Grainger & Stewart, 2017; Young, Russel, & Barkemeyer, 2017).

It seems that some academics recommend informational interventions (e.g., Garrone, Melacini, & Perego, 2014; Gruber, Holweg, & Teller, 2016; Kantor, Lipton, Manchester, & Oliveira, 1997; Lorek & Spangenberg, 2001; Parfitt et al., 2010) without discussing the evidence that informational interventions are often not sufficient to change behavior. Stancu, Haugaard and Lähteenmäki (2016), for instance, recommended informational interventions to improve household routines and thus reduce food waste. Other studies (e.g., Carlsson-Kanyama, 2004; Jörissen, Priefer, & Bräutigam, 2015; Priefer, Jörissen, & Bräutigam, 2016) discussed the need to educate consumers and recommended or acknowledged addressing food waste issues in school curricula with material such as factsheets and lesson plans.

In sum, the few reviewed academic studies on informational interventions against consumer food waste point towards promising implementations of informational campaigns (see Table 3). Yet, the small effect size and possible rebound effects (e.g., when additionally informing consumers about composting effects and opportunities) accentuate the need for further evaluation (see Qi & Roe, 2017; Romani, Grappi, Bagozzi & Barone, 2017; Young, Russel, Robinson, & Barkemeyer, 2017).

Overall, informational interventions are the most frequently used intervention type in practice and are commonly recommended within the academic food waste literature. This is troublesome, as there is evidence that informational interventions alone are ineffective in changing consumer behavior. Thus, practitioners as well as academics are urged to redouble their efforts to evaluate the effectiveness of informational interventions.

Table 3

Informational Interventions Against Consumer Food Waste

Practical Interventions			
Campaign (Origin, Start), Initiator	Description	Aim	Evaluation
Love Food Hate Waste (UK, 2007), NGO (WRAP)[a]	Comprehensive awareness campaign[4], many communication channels: digital/online (e.g., TV, app, website, Facebook, YouTube), print (e.g., brochures), and audio (e.g., radio), personal (e.g., PR, events)	Provision of declarative knowledge (e.g., food waste consequences) and procedural knowledge (e.g., how to avoid impulse buying with shopping lists)	24% food waste decrease in UK households from 2007 to 2012 (from 210 kg to 160 kg per household per year)[5] Limitations: Most comprehensively evaluated campaign; no independent evaluation, no evaluation of individual interventions, methodological bias (e.g., social desirability due to self-report)
Stop Spild Af Mad (DNK, 2008), non-profit consumer movement[a]	Comprehensive awareness campaign[6] many communication channels (similar to the previous campaign)	Provision of declarative knowledge and procedural knowledge	Food waste decrease and food waste awareness increase in 2005-2014 Limitations: No independent evaluation, no evaluation of individual interventions, methodological bias (e.g., social desirability due to self-report)
Zu gut für die Tonne (DE), national authority[a]	Comprehensive awareness campaign[7], many communication channels with a focus on educational material (e.g., brochures and flyers) for schools or exhibitions, public cooperation with diverse stakeholders (e.g., branded takeaway boxes for restaurant leftovers)	Provision of declarative knowledge and procedural knowledge	No evaluation

[4] http://www.lovefoodhatewaste.com/

[5] Note that this decrease could be biased by the financial crisis in 2008 and may be (partially) explained by consumers' diminishing financial situation. (We thank an anonymous reviewer for this insight.)

[6] http://www.stopspildafmad.dk/

[7] https://www.zugutfuerdietonne.de/

Qui jette un oeuf, jette un boeuf (FR), national authority[a]	Comprehensive awareness campaign[8], many communication channels (similar to the "Love Food Hate Waste" campaign)	Provision of declarative knowledge and procedural knowledge	No evaluation
De menjar, no en llencemni mica (SPAN), national authority/NGO[a]	Comprehensive awareness campaign[9], many communication channels (similar to the "Love Food Hate Waste" campaign)	Provision of declarative knowledge and procedural knowledge	No evaluation
Foodwise (AU, 2009), NGO[a]	Comprehensive awareness campaign[10], many communication channels with a focus on social media (e.g., Facebook, Twitter, Pinterest, Instagram, blogs)	Provision of declarative knowledge and procedural knowledge	No evaluation
Reduisons nos dechets (FR, 2009), national authority[a]	Comprehensive awareness campaign[11], many communication channels (similar to the "Love Food Hate Waste" campaign)	Provision of declarative knowledge and procedural knowledge	No evaluation
Foodwaste TV (DE, 2010), NGO[a]	Awareness campaign, video-based information (YouTube channel[12])	Provision of declarative knowledge and procedural knowledge	Various videos with more than 165,000 views; no further evaluation Limitations: No systematic/empirical evidence of the intervention's effect
GreenCook (EU), NGO[a]	Comprehensive awareness campaign[13], many communication channels (similar to the "Love Food Hate Waste" campaign)	Provision of declarative knowledge and procedural knowledge	No evaluation

[8] http://agriculture.gouv.fr/anti-gaspi/anti-gaspi
[9] https://nollencemnimica.wordpress.com/
[10] http://www.foodwise.com.au/
[11] http://www.casuffitlegachis.fr/
[12] https://www.youtube.com/user/foodwastetv
[13] http://www.green-cook.org/-The-project-.html

Food Cycle (UK, 2009), NGO[a]	Awareness campaign[14], many communication channels (similar to the "Love Food Hate Waste" campaign), distribution of meals to needy people to use up surplus food	Provision of declarative knowledge and procedural knowledge, use of surplus food	No evaluation
Taste the Waste (DE, 2011), NGO[a]	Film about food waste[15] that raises awareness of food waste and its global consequences	Provision of declarative knowledge	No evaluation
Feeding the 5000 (UK, 2009), NGO[a]	Event to raise awareness of global food waste by serving up a feast for 5,000 people made from surplus food	Provision of declarative knowledge	No evaluation
Appetite for Action (IRL/UK, 2009), NGO[a]	Website for schools[16] that offers free educational material (e.g., lesson plans, fact sheets, and films)	Provision of declarative knowledge and procedural knowledge	No evaluation
This is Rubbish (UK, 2009), NGO[a, b]	Awareness campaign[17], many communication channels	Provision of declarative knowledge and procedural knowledge	No evaluation
Stop Food Waste (IRL, 2009), national authority[a, b]	Comprehensive awareness campaign[18], many communication channels (similar to the "Love Food Hate Waste" campaign)	Provision of declarative knowledge and procedural knowledge	No evaluation
KiNa (DE, 2009), local authority[c]	Educational project for kindergartens[19] that provides educational material, trains mentors, and offers workshops	Provision of declarative knowledge and procedural knowledge	No evaluation

Academic Interventions

Reference	Description	Theoretical Basis	Effect Measurement	Limitations

[14] http://foodcycle.org.uk/
[15] http://tastethewaste.com/
[16] http://appetiteforaction.org.uk/ [no longer active]
[17] http://www.thisisrubbish.org.uk/projects/
[18] http://www.stopfoodwaste.ie/
[19] http://www.nachhaltigkeit-im-kindergarten.de/kina.aspx

Young, Russel, Robinson, & Barkemeyer (2017)	Examination of retailer magazine/e-newsletter/Facebook pages as sources for messages to encourage food waste reduction. National survey measured self-reported food waste behavior prior and post intervention (two weeks after and five months after intervention)	Social influence theory was used to develop and implement intervention	Reduction of self-reported food waste over time for treatment group (retailer e-newsletter/Facebook pages) and the control group	Small effect size of 0.01 questions its behavioral significance (see Grainger & Stewart, 2017)
Romani, Grappi, Bagozzi, & Barone (2018)	Field experiment testing educational intervention in the form of an educational article on how to organize menus (aiming to increase food preparation skills)	TPB and its extensions was used to develop and implement intervention	Reduction of self-reported food waste, effect mediated by improvement of perceived skills	Mediation is marginally significant, methodological bias (e.g., social desirability due to self-report)
Qi & Roe (2017)	Examination of informational intervention in a laboratory-dining situation with a 2x2 factorial design (*information about food waste consequences and mitigating composting effects* [*yes vs. no*] vs. *information about handling with unconsumed food of tasting study* [*waste vs. compost*])	-	Food waste reduction due to food waste/composting information; additional information about composting the unconsumed study food increased food waste	Artificial dining situation

Note. Overview of practical and academic informational interventions against consumer food waste.
Categories for practical interventions: Campaign = name of the campaign; Origin = geographical location; Start = year of launch; Initiator = organization or type of organization running the campaign; Description = design and communication of the campaign; Aim = intended effect on the target population and details of the procedure; Evaluation = effect of the campaign (if available) and limitations of available evaluation results.
Categories for academic interventions: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.
Target (population addressed by the campaign): [a]Broad consumer population; [b]Businesses (e.g., restaurants) and policy makers; [c]Children.

3.3 Prompts

In general, prompts are visual or auditory messages that are intended to remind people to perform a desired behavior. Prompts are most effective when they address a clearly defined behavior that is easy to perform (e.g., repetitive rather than one-time), when they are placed where the target behavior occurs, and when they are worded politely (vs. in a demanding manner) (Steg et al., 2008). Prompts are a relatively effective intervention type (g = .62; Osbaldiston & Schott, 2012) and can substantially change behavior on a large scale (Schultz, 2014; Steg et al., 2008).

Our analysis shows that there are only a few practical implementations of prompts against consumer food waste (see Table 4). These implementations were exclusively written messages reminding consumers about food waste and/or requesting a specific behavior such as taking second helpings or not serving too much. As is most suitable for prompts, practitioners placed them near the point where the target behavior occurs (e.g., on the buffet). As shown in Table 4, the application of prompts has been limited to public places. Though consumer food waste largely occurs in private spheres (e.g., consumers' kitchens), we do not know of any practical intervention that asks consumers to place prompts in private places. Further, practitioners did not systematically evaluate the effect of prompts on consumer food waste.

From an academic perspective, prompts were repeatedly shown to reduce food waste (Kallbekken & Sælen, 2013; Whitehair et al., 2013). There is experimental evidence for the behavioral effect of prompts in public places, but there is no insight into the underlying mechanisms (see Table 4). One study (Whitehair et al., 2013) looked at the influence of prompts on beliefs concerning food waste, and found no effect. Future research needs to address the underlying mechanisms of prompts and examine which psychological constructs explain the effect. As with practical implementations, academic examination of prompts

293 against consumer food waste has been limited to those in public spaces. Thus, the question of
294 whether prompts work in private spaces such as consumers' kitchens remains unanswered.

Table 4

Prompts Against Consumer Food Waste

Practical Interventions			
Campaign (Origin, Start), Initiator	Description	Aim	Evaluation
Love Food Hate Waste (UK), NGO (WRAP)/restaurants/hotels[a]	Messages/signs at buffets or on napkins (e.g., asking people to only take what is needed)	Providing information at the point of behavior	No evaluation

Academic Interventions				
Reference	Description	Theoretical Basis	Effect Measurement	Limitations
Whitehair, Shanklin, & Brannon (2013)	Field experiment testing simple print message (‘All Taste No Waste - Eat What You Take, Don't Waste Food’) addressing students in an university dining facility	Elaboration Likelihood Model of Persuasion was used to develop and implement intervention	15% food waste reduction, no significant influence on beliefs concerning food waste	Insufficient evidence of the underlying processes of the intervention, no direct examination of theoretical basis
Kallbekken & Sælen (2013)	Field experiment testing a social norm sign at the buffet encouraging restaurant guests to help themselves more than once (‘Welcome back! Again! And again! Visit our buffet many times. That’s better than taking a lot once. ’)	Nudging Literature	20% food waste reduction	Insufficient evidence of the underlying processes of the intervention

Note. Overview of practical and academic prompts against consumer food waste.
Categories for practical interventions: Campaign = name of the campaign; Origin = geographical location; Start = year of launch; Initiator = organization or type of organization running the campaign; Description = design and communication of the campaign; Aim = intended effect on the target population and details of the procedure; Evaluation = effect of the campaign (if available) and limitations of available evaluation results.
Categories for academic interventions: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.
Target (population addressed by the campaign): [a]Restaurant/hotel guests.

3.4 Modeling

In general, *modeling* is the demonstration of desired behavior (e.g., in a video or in vivo). Such demonstrations are particularly applicable when the target behavior is complex, and work best when the positive consequences of the desired behavior are highlighted. Yet modeling goes further than the mere demonstration of a behavior. It includes the idea that behavior that conforms to social norms is more likely to be adopted (Osbaldiston & Schott, 2012). Indeed, there is considerable evidence to substantiate the power of perceived social influence to direct behavior towards pro-environmental choices (e.g., Griskevicius, Cialdini, & Goldstein, 2008; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Modeling is a relatively effective intervention type (g = .63; Osbaldiston & Schott, 2012).

Our review (see Table 5) shows that there are few practical applications of modeling against consumer food waste. The "Love Food Hate Waste" campaign by WRAP (UK) provides a video archive with demonstrations of everyday food practices which reduce food waste. Behaviors demonstrated include, for example, how to store, portion, or freeze certain foods. These videos are intended to build household skills related to planning, shopping, and leftover reuse, and thus address important antecedents of consumer food waste (see Stancu et al., 2016). However, practitioners have not yet evaluated the effect of modeling on consumer food waste behavior.

From an academic perspective, there seems to be some evidence that there are social norms in terms of food waste (e.g., leftover taking) and that these norms excerpt social pressure that, in turn, determines food waste behavior (see Table 5; Hamerman, Rudell & Martins, 2018). Future research needs to confirm the influence of social norms on food waste behavior and gain a deeper insight into underlying mechanisms.

Table 5

Modeling (Social Norms) Against Consumer Food Waste

Practical Interventions			
Campaign (Origin, Start), Initiator	Description	Aim	Evaluation
Love Food Hate Waste (UK, 2007), NGO (WRAP)[a]	Video archive[20] with demonstrations of everyday food practices (e.g., how to store, portion, or freeze certain foods)	Build up household skills related to planning, shopping, and leftover reuse	No evaluation

Academic Interventions				
Reference	Description	Theoretical Basis	Effect Measurement	Limitations
Hamerman, Rudell & Martins (2018)	Study 1: Survey-based envisioned dining experiment with a 2x2 factorial design (*social norm* [*server establishes taking leftovers as norm vs. no comment of server about taking home leftovers*] *vs. social situation* [*known dining companion vs. unknown dining companion*]. It was hypothesized that when companions were known there was no need to impress, whereas there was a need to impress when the companion was unknown. Study 2 (follow-up study): Similar to study 1, with additionally testing of whether social desirability of taking leftovers could explain the effect	Literature on impression management, conformity/social norms (partly TPB) was used to develop, implement and evaluate intervention	Greater likelihood of taking leftovers when dining with unknown (vs. known) companion when server sets taking leftovers as norm. Leftover taking was considered as greater norm violation when the customer (vs. server) initiated the leftover taking for dining situation with unknown (vs. known) companion	Artificial dining situation

Note. Overview of practical and academic modeling (social norm) interventions against consumer food waste.
Categories for practical interventions: Campaign = name of the campaign; Origin = geographical location; Start = year of launch; Initiator = organization or type of organization running the campaign; Description = design and communication of the campaign; Aim = intended effect on the target population and details of the procedure; Evaluation = effect of the campaign (if available) and limitations of available evaluation results.
Categories for academic interventions: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.
Target (population addressed by the campaign): [a]Broad consumer population.

[20] https://www.youtube.com/user/LoveFoodHateWasteUK

3.5 Commitment

In general, *commitment* is asking people to formally agree (e.g., in writing or verbally) to perform a target behavior. Signing pledges or promise cards increases the likelihood of a person performing the behavior they have committed to (Geller, Kalsher, Rudd, & Lehman, 1989; Lokhorst, Werner, Staats, van Dijk, & Gale, 2013; Wang & Katzev, 1990). This is attributed to people's desire to behave, and appear to behave, coherently (Cialdini, 2001). Such behavioral commitment works best when the commitment is public (e.g., pledges posted online), lasting (vs. temporary), specific (vs. general), and when people are already motivated to perform the target behavior (Klöckner & Matthies, 2004; McKenzie-Mohr, 2013). Commitment is an intervention type with moderate effectiveness (g = .40; Osbaldiston & Schott, 2012).

Our review shows that there are only a few practical applications of classical commitment strategies, such as pledges or promises, within the field of consumer food waste (see Table 6). Most of these are online declarations whereby consumers can sign up to an anti-food-waste community. Most food waste campaigners (e.g., WRAP) use social media platforms (e.g., Facebook) where consumers can publicly commit to the community by liking it. Based on the commitment and self-signaling literature, it is likely that such (public) signaling of one's care about food waste can promote sustainable food practices (see Baca-Motes, Brown, Gneezy, Keenan, & Nelson, 2013).

In contrast to these practical examples of commitment, there is only one academic study that we are aware of that examines a commitment intervention in the field of consumer food waste (see Table 6). In fact, the intervention consists of the provision of knowledge (i.e., recommendations such as only buying as much food as is needed) in combination with a public commitment and a goal-setting strategy. Results suggest that this is effective in improving food waste prevention and the perceived ability to prevent household food waste (Schmidt, 2016a, 2016b). It is noteworthy that this effect was maintained for several weeks.

However, since the intervention combined commitment with an informational intervention, it is not possible to single out the particular role of commitment. Future research is needed to better understand the effect of commitment alone on consumers' sustainable food practices, and to learn how it can be used most effectively. It would be of interest to test whether commitment interventions against consumer food waste can activate psychological processes that, for instance, alter attitudes, as has been proposed within the general behavioral change literature (see Cialdini, 1971; Pauling & Land, 1969).

Table 6

Commitment Against Consumer Food Waste

Practical Interventions			
Campaign (Origin, Start), Initiator	Description	Aim	Evaluation
Global Feedback (UK), NGO[a]	Online pledge to reduce one's food waste[21]	Encouraging people to commit to avoiding food waste	No evaluation
FoodWise (AU), NGO[a]	Online sign up to the FoodWise community[22]	Encouraging people to commit to avoiding food waste	No evaluation

Academic Interventions				
Reference	Description	Theoretical Basis	Effect Measurement	Limitations
Schmidt (2016a)	Field experiment testing recommendations in combination with a strategy to commit to food waste prevention goals (e.g., after reading a recommendation to avoid impulse purchases, participants were asked to indicate their motivation to follow this)	Integrative influence model of pro-environmental behavior, commitment and goal-setting technique	Pre and post measurement of experimental and control group (survey), improvement in self-reported food waste prevention and perceived ability to do so	Post-test with only a subsample; self-reported food waste prevention (e.g., susceptible to social desirability), no evaluation of single interventions due to confounding of combined interventions (providing information and asking for commitment)

Note. Overview of practical and academic commitments against consumer food waste.
Categories for practical interventions: Campaign = name of the campaign; Origin = geographical location; Start = year of launch; Initiator = organization or type of organization running the campaign; Description = design and communication of the campaign; Aim = intended effect on the target population and details of the procedure; Evaluation = effect of the campaign (if available) and limitations of available evaluation results.
Categories for academic interventions: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.
Target (population addressed by the campaign): [a]Broad online consumer population consumer population.

[21] http://feedbackglobal.org/join-movement/
[22] http://www.foodwise.com.au/about-foodwise/sign-up-to-be-foodwise/

3.6 Consequence Interventions

Unlike antecedent intervention types, the different types of consequence interventions conceptually overlap. Feedback, rewards, and penalties are often not strictly distinguished but rather used in combination. For this reason, in this review we discuss the findings for consequence intervention types within consumer food waste jointly. Nevertheless, we will briefly define all of them individually.

Feedback is providing people with information about the frequency and/or consequences of a target behavior. This makes the consequences of the desired behavior (e.g., resources saved) more salient and increases the likelihood of behavior change. Feedback strategies work best when people are already motivated to show the target behavior (Schultz, 2010) and when combined with other motivators such as competition (Bittle, Valesano, & Thaler, 1979; Katzev, Cooper, & Fisher, 1981; Katzev & Mishima, 1992). Feedback belongs to the intervention types with the weakest effectiveness (g = .31) as meta-analyzed by Osbaldiston and Schott (2012).

Rewards are positive consequences for people who perform a target behavior, and are intended to increase the frequency of this behavior. Rewards can be delivered in various financial or non-financial forms (e.g., money or praise; Diamond & Loewy, 1991; Jacobs, Fairbanks, Poche, & Bailey, 1982; Slavin, Wodarski, & Blackburn, 1981). But effects are often short-lived and people stop showing the desired behavior as soon as the reward ends. The major reason for this is that rewards motivate behavior change extrinsically but not intrinsically (Steg et al., 2008).

Analogously, *penalties* are negative consequences for people who perform an undesired target behavior. Again, the effects are often short-lived. In fact, penalties are often associated with negative emotions and attitudes, and primarily motivate people to avoid the negative consequences rather than perform the desired behavior (Steg et al., 2008).

Often, rewards and penalties are preceded by an announcement. An announcement of a reward is usually referred to as an *incentive*, whereas an announcement of a penalty is termed a *disincentive*. Practitioners and academics seldom distinguish between rewards and penalties *with* versus *without* announcement, but instead combine positive and negative consequences for a target behavior. In their meta-analysis, Osbaldiston and Schott (2012) recognize this "inaccuracy," noting that their "reward" intervention also includes strategies that we term penalty, incentive, or disincentive. Based on the effect size that Osbaldiston and Schott (2012) found for rewards (g = .46), we conclude that reward and penalty are intervention types of average effectiveness.

Within this review, we could only identify a few applications of consequence interventions against consumer food waste. Given that we found these applications (see Table 7) in the course of our ‘academic literature search’, we refer to them as ‘academic interventions’. However, all the technology-based interventions we reviewed (Table 7; see also Table 8) were developed and evaluated for real-world application. The examples of the Grumpy Bin and BinCam apps show that apps allow the integration of various consequence strategies. The BinCam, for instance, takes pictures of items thrown away and makes them visible to the BinCam community on Facebook, and provides scores to visualize consumers’ food waste behavior. This provides feedback not only to consumers themselves but also to the BinCam Facebook community. Further, the gamification element of increasing (or decreasing) gold bars (depending on one’s behavior) constitutes rewards (or penalties) for performing desired (or undesired) food waste behavior (Farr-Wharton et al., 2014a). Evaluation results of the BinCam are mixed and show that technology can have individual, social, and motivational effects that foster more sustainable consumer behavior, but that these effects do not necessarily persist over time (Comber & Thieme, 2013; Thieme et al., 2012).

Note that, to date, several practitioners have created apps with the aim of reducing consumer food waste (e.g., WRAP’s Love Food Hate Waste app). However, these apps do not

433 implement consequence strategies, but mainly provide household food management tools
434 (e.g., recipes to use up leftovers, a shopping list, a food stock tracker, and a meal and portion
435 planner) and have not yet been sufficiently evaluated.

Table 7

Consequence Interventions Against Anti-Consumer-Food-Waste Interventions

Academic Interventions				
Reference	Description	Theoretical Basis	Effect Measurement	Limitations
Altarriba, Lanzani, Torralba, & Funk (2017)	Development of Grumpy Bin, a smart food waste bin designed for student housing which gives feedback on users' waste behavior and empowers users to collectively judge waste actions (food waste pictures are taken and sent to Instagram with sarcastic messages and the opportunity for commenting on others' waste). The Grumpy Bin also expresses moods depending on the waste.	Idea of 'social means' and feedback (behavioral change literature) was considered to develop and implement the intervention	No evaluation	-
Comber & Thieme (2013); Thieme et al. (2012)	Development of BinCam, an app that aims to raise awareness of food waste and support intentions for behavior change. BinCam is coupled with a waste bin that captures and shares food waste images (with a Facebook community). The effect of BinCam is examined with interviews and surveys (pre and post; two weeks)	Literature on behavioral change and TPB was used to develop and implement the intervention	Increase in self-reflection, feelings of shame, awareness of recycling behavior, perceived behavioral control, social influence/pressure (feedback about others' behavior), no effect on attitudes toward recycling; app was perceived as reminder; effects decrease over time (people lost interest)	Methodological bias (e.g., social desirability due to self-report), not representative sample (already good recyclers)

Note. Overview of feedback, rewards and penalties (or combinations thereof) against consumer food waste.
Categories: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.

3.7 Extended Analysis of Academic Evidence

Some of the academic articles that the literature search suggested could not be assigned to one of the intervention types in the framework (see Table 1) because they combined several intervention types and/or only discussed an intervention with food waste reduction as a side effect. Although these articles were excluded in the course of the literature search, they are still worth mentioning.

As Table 8 reveals, academics have occasionally addressed quite specific interventions that reduce food waste behaviors, such as documentary films (Tadajewski & Hamilton, 2014), cooking classes (Dyen & Sirieix, 2016), or plate size (Wansink & Van Ittersum, 2013). Most of the additional academic articles listed in Table 8 address some form of technology, mostly apps. Although these technologies seem promising and are able to combine numerous effective intervention types, future research is needed to systematically measure their effects.

3.8 Summary

Practitioners have implemented numerous anti-consumer-food-waste interventions across all intervention types in the last decade. According to our review, these are often large-scale campaigns that combine diverse intervention types, with informational interventions being most common. In contrast to practitioners, academics have rarely addressed anti-consumer-food-waste interventions. Overall, our review shows that practitioners and academics have not yet systematically evaluated interventions within the field of consumer food waste.

462 *Table 8*

463 *Extended Academic Effort to Examine Anti-Consumer-Food-Waste Interventions*

Academic Interventions				
Reference	Description	Theoretical Basis	Effect Measurement	Limitations
Tadajewski & Hamilton (2014)	Discussion of films/documentaries (*Trashed* by Brady, 2012; *Waste Land* by Walker, 2010) as pedagogic tools to demonstrate the complex topic of (food) waste and to raise awareness of the consequences and the need for social change	-	Discussion of effect	No evidence of discussed effect
Dyen & Sirieix (2016)	Examination (observation and interviews) of cooking classes for people living with social instability that aim to provide advice about sustainable consumption and establish food management skills	-	Cooking classes encourage sustainable food practices, increased interest in household skills	Non-representative consumer sample, no evaluation of long-term effects, no quantitative evidence
Wansink & Van Ittersum (2013)	Experimental research on the effect of visual consumption norms (plate size) on food self-serving (quantity) and the underlying mechanism (i.e., the *Delboeuf Illusion*; how much food we serve on different sized plates)	Literature on anchors for food consumption and the *Delboeuf Illusion*	Dinnerware as visual anchor of fill-level, one serves and wastes more food with large versus small plates	Further insight on underlying mechanisms is needed
Sharp, Giorgi, & Wilson (2010)	Discussion of systematic review of practical policy-relevant evidence on interventions against general household waste behavior (e.g., home composting, food waste, smart shopping); what has been learned, and recommendations	-	Range of interventions is more effective than isolated interventions, determining influences of isolated interventions is often not possible in the real world, waste prevention interventions are often not evaluated; recommendation that evaluation of anti-waste interventions are needed in order to optimize their effect	No evidence of discussed effect

Ganglbauer, Fitzpatrick, & Güldenpfennig (2015)	Case study on a mobile food waste diary app that helps to capture food waste and its reasons, aiming to understand and prevent food waste. Qualitative analysis of the free comment entries (reasons and experiences) was conducted	-	App helps to reflect on food waste	Non-representative consumer sample (already motivated people), no quantitative evidence
Yalvaç, Lim, Hu, Funk, & Rauterberg (2014), Lim et al. (2017)	Development and evaluation (interviews) of a social recipe recommender (app) aiming to reduce food waste by recommending recipes to a group of connected people based on their food and waste logins	-	Increase of awareness of in-home food availability, initiation of food related conversations among users, no perceived food waste reduction	Methodological bias (e.g., social desirability due to self-report)
Foth, Choi, Lyle, & Farr-Wharton (2011)	Exploration and discussion of developing technologies (apps) that motivate healthy and environmentally friendly food practices (e.g., in regard to use of leftovers)	-	Description of technology prototypes that foster desirable food practices (e.g., share food)	No evidence of discussed effect
Farr-Wharton, Foth, & Choi (2012); Farr-Wharton, Choi, & Foth (2014)	Discussion of two interventions: The *Colour Code Project* (paper-based color scheme for fridges assigning colors to particular foods with the aim to increase the awareness of available food) and the FridgeCam (app to improve supply and location knowledge by means of taking photos from the fridge interior and making them electronically available to household members)	-	Both interventions raised awareness of available food in the fridge, resulting in reduction in expiration of food	No quantitative evidence, methodological bias (e.g., social desirability due to self-report, small sample size)
Farr-Wharton, Foth, & Choi (2013)	Description and discussion of EatChaFood, a prototype app designed to increase food availability and location knowledge of household members with the aim to reduce expired food waste	-	Questionable usability, manual data entry as main barrier, recommendation of automatic scanning of food (barcodes or photos) to prevent manual data entry	No evidence of discussed effect
Farr-Wharton, Choi, & Foth (2014)	Discussion of mobile technology to support behavior change in the field of food waste. Three mobile apps (Fridge Pal, LeftoverSwap and EatChaFood) are discussed by evaluating how each app can influence consumers	-	Apps assist with behavior change due to an increase in food availability and location knowledge, apps can foster social food sharing	No evidence of discussed effect

Note. Overview of additional academic interventions against consumer food waste.
Categories: Reference = source; Description = details of the examined intervention; Theoretical Basis = theory/concept explicitly used to develop, implement and/or evaluate intervention; Effect Measurement = analysis conducted on the intervention effect; Limitations = methodological shortcomings of conducted research.

4 Conceptual and Methodological Challenges for Future Research on Anti-Consumer-Food-Waste Interventions

Based on the above review of practical and academic anti-consumer-food-waste interventions, we challenge future researchers to (1) address a wider repertoire of intervention types and (2) more systematically evaluate interventions. This section expands on the call for future research by discussing conceptual and methodological challenges, specifically by stressing (1) the potential of learning from general behavioral change literature, (2) the need to systematically implement and test interventions, and (3) the potential of more cooperation between practitioners and academics.

4.1 Learning From Research on Behavioral Change (Interventions)

Research on behavioral change (interventions) is interdisciplinary and vast. Evidence from many social science fields (e.g., consumer and environmental psychology) has contributed to a profound understanding of behavioral change, interventions, and their boundary conditions. (For an overview of behavioral change and intervention research see, e.g., McKenzie-Mohr, 2013; Michie et al., 2014; Steg et al., 2008.) To date, behavioral change (and intervention) researchers have not fully exploited synergies. Research projects are often separated from one another according to the issue that they address. For instance, researchers examining road safety or littering among adults would not necessarily consult researchers examining the perception of environmental pollution or promoting physical activity among children. Yet, these researchers all examine behavioral change and interventions, and are confronted with similar conceptual and methodological challenges (Mick et al., 2012). Although some researchers do not explicitly refer to the general behavioral change literature, several researchers do explicitly apply the broad and interdisciplinary evidence on behavioral change and interventions to the issue of consumer food waste (see e.g., Schmidt, 2016a, 2016b).

In the following sections, we react to this criticism and apply lessons from the general behavioral change literature on intervention types to the field of consumer food waste. When surveying general behavioral change research, three learnings stand out as relevant to the field of consumer food waste: first, the limited effectiveness of informational interventions; second, the potential of intervention types other than informational interventions; and third, the limitations of the TPB as a conceptual model for behavioral change.

4.1.1 Questioning the dominance of informational interventions

The wisdom of the predominant use of informational interventions in practical anti-consumer-food waste campaigning is questionable when comparing the relative effectiveness of different intervention types. As shown in Osbaldiston and Schott's (2012) meta-analysis, informational interventions are one of the least effective intervention types. Informational interventions to reduce food waste, which assume that providing knowledge is sufficient to induce behavioral change, are built on an assumption that often doesn't hold (Abrahamse & Matthies, 2012; Abrahamse et al., 2005; Homburg & Matthies, 1998; Osbaldiston & Schott, 2012; Schultz, 2002).

A further, often-overlooked weakness of providing information on specific food-waste-preventing behaviors is that some consumers do not perceive the information to be relevant because they already perform the behavior. One way to optimize the influence of recommendations is by tailoring information to the consumer so they receive information that addresses behaviors that they do not yet (sufficiently) perform (Schmidt, 2016a, 2016b). Though this is thought to increase the effect of information intervention, it has not yet been evaluated.

Having said all this, we challenge those who carry out future anti-consumer-food-waste interventions to consider two points: First, to make sure that informational interventions are specific to the target consumer and behavior, and second, to implement intervention types

that have proven to be relatively effective — that is, more effective than informational interventions.

4.1.2 Exploring promising non-informational intervention types

In order to implement relatively effective intervention types, it seems worthwhile to refer to Osbaldiston and Schott's (2012) meta-analysis that identified modeling (social norms) and prompts as the most effective intervention types, followed by rewards and punishment (see Table 1). Considering that, as we have shown here, the use of intervention types other than information is rare, we urge researchers and practitioners to be creative in designing new applications of these other, relatively more effective intervention types. To illustrate this, we provide a number of ideas for such anti-consumer-food-waste interventions (see Table 9).

One could argue that correlational research questions the importance of social norms as antecedent of food waste behavior (e.g., Visschers et al., 2016). However, various (experimental) demonstrations in behavioral change research show social norm interventions to be effective at inducing pro-environmental behavior (e.g., Griskevicius, Cialdini, & Goldstein, 2008; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). We argue that this motivates further testing of social norm interventions against consumer food waste. A potential application could be normative appeals in restaurants to take home leftovers: First evidence shows that restaurants can increase the likelihood of patrons taking home leftovers by establishing this behavior as norm (Hamermann, Rudell, & Martins, 2018). For further ideas for the application of social norms, see Table 9.

Practitioners (i.e., WRAP) as well as academics (i.e., Kallbekken & Sælen, 2013; Whitehair, Shanklin, & Brannon, 2013) have applied prompts in the consumer food waste domain, for example, by prompting consumers to refrain from piling up large portions at buffets (Kallbekken & Sælen, 2013) or eating up at the cafeteria (Whitehair, Shanklin, & Brannon, 2013). As previously mentioned (see section 3.3), prompts have not yet been tested

in private settings. Given that first evidence confirms the promising effect of prompts against consumer food waste, we call for the application and further testing of this intervention type. Potential applications could be personalized labels on cupboards and/or fridges reminding consumers to use up stocks, eat leftovers, or make a shopping list before shopping. Icons on packaging could remind consumers where to store this product best (e.g., in the fridge). For further ideas for the application of prompts, see Table 9.

Interventions which apply rewards and penalties to the problem of consumer food waste are rare. Despite the moderate effectiveness of consequence interventions due to their short-livedness and extrinsic motivation (Steg et al. 2008), these intervention types have been more effective across various pro-environmental behaviors than informational interventions (Osbaldiston & Schott, 2012). We call for further testing of consequence interventions. Potential rewards and penalties in restaurants could be giving monetary (e.g., discounts) or non-monetary (e.g., free coffees) incentives to customers who do not waste food, and penalizing those who do (e.g., extra charge). For further ideas for the application of consequence interventions, see Table 9.

Table 9

Ideas for Future Behavioral Change Interventions Against Consumer Food Waste

Intervention		Potential Food Waste Applications
Antecedent	Modeling (Social Norms)	• Establishing the norm of taking home leftover in restaurants; e.g., by waiters • Establishing the norm of ordering small portions in restaurants; e.g., by setting the small portion as default • Establishing the norm of bringing leftovers to lunch at work; e.g., by employers • Establishing the norm of not over-serving guests at dinner parties; e.g., by instructing waiters
	Prompts	• Labels on cupboards and/or fridges reminding subjects to use up stocks • Labels on fridges reminding subjects to eat up leftovers • Reminder on shopping list memo and/or on the kitchen cupboards to make a list before shopping • Icons on packaging to remind people where to store the item best (e.g., in or outside the fridge)
Consequence	Rewards	• Rewards for having no leftovers in restaurants, e.g., free coffee or discounts • Rewards (e.g., raffle entry) for donating overstocked products to soup kitchens, homeless shelters or other non-profit associations
	Penalties	• Penalties for having leftovers in restaurants (e.g., extra charge) • Penalties for generating food waste in public places, e.g., in buses, trains, airports

Note. Potential applications of the four most effective intervention types according to Osbaldiston and Schott's (2012) meta-analysis (see Table 1).

Clearly, we do not provide a definitive list of potential interventions and possible intervention types. There are further intervention types worth applying to consumer food waste, particularly those using unconscious influences (Dijksterhuis, Smith, Van Baaren, & Wigboldus, 2005; Sheeran, Gollwitzer, & Bargh, 2013) such as changing the context and thereby facilitating the desired behavior outside of consumers' awareness (Block et al., 2016; Marteau, Ogilvie, Roland, Suhrcke, & Kelly, 2011). Within the domain of consumer food waste the application of such unconscious *nudges* (see Thaler & Sunnstein, 2008) has just started. Nudges such as downsizing plates or altering plate quality (i.e., reusable vs. disposable plates), for example, have led to reduced food waste (Kallbekken & Sælen, 2013; Wansink & Van Ittersum, 2013; Williamson, Block, & Keller, 2016). Although the effect of such nudges for single consumers might appear moderate, they are attractive for their

simplicity and low cost. Furthermore, they highlight the potential of interventions that include perceptual and other unconscious motivational and behavioral components.

There is also an increasing attempt to combine multiple non-informational intervention types within the consumer food waste domain. Technology such as the BinCam app (see Table 7), for instance, integrates feedback, reward, and punishment components by means of a playful visualization. Numerous other online tools assist consumers with everyday food waste prevention; these include websites and apps that connect consumers who want to share food (e.g., foodsharing.com, LeftoverSwap) or that help to manage groceries, create shopping and inventory lists, and alert the consumer when food is expiring (e.g., Fridge Pal, EatChaFood). In fact, these applications combine various intervention strategies and perceptual, motivational, and behavioral components. Although there is first evidence on the effectiveness of this technology, there are also potential drawbacks (see Table 7; Farr-Wharton et al., 2014a, 2014b; Lueg, 2002). Tests of unconscious influences are promising, but still at the early stages within the field of anti-consumer-food-waste interventions. Further testing is needed in order to exploit the potential of the various promising (non-informational) intervention types.

4.1.3 Moving beyond the TPB perspective

To date, most academic effort to understand why consumers waste food has used the TPB and its extensions as a conceptual model (e.g., Graham-Rowe, Jessop, & Sparks, 2015; Russel, Young, Unsworth, & Robinson, 2017; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016). The TPB is well-established among researchers and familiar to many practitioners such as policy makers (Sniehotta, Presseau, & Araújo-Soares, 2014). However, there is significant question as to whether the TPB is a suitable conceptual model for behavioral change in general, and specifically change related to consumer food waste. First, it is questionable whether intention is a good predictor for behavior (Wong & Sheth, 1985). Evidence from meta-analyses showed that behavioral intention only explains about 30% of

variance of actual behavior (Armitage & Conner, 2001; Bamberg & Möser, 2007) and interventions targeting intention have negligible effects on behavior (Michie, Whittington, Abraham, & McAteer, 2009). Also within the field of consumer food waste, there is support for the so called "intention–behavior gap". Consumers' household routines are a better predictor of food waste behavior than their behavioral intentions (Stancu et al., 2016; Stefan et al., 2013).

Second, the idea that all external influences on behavior are mediated through TPB constructs has been criticized (Sniehotta et al., 2014). In many fields where the TPB is adopted, it is evident that age, socioeconomic status, and contextual factors predict behavior considerably, even when controlling for TPB determinants. This is also evident for food waste behavior where *age* and *sex* predict food waste behavior even when controlling for TPB constructs (Visschers et al., 2016).

Given that the TPB has been repeatedly criticized as an inappropriate conceptual model of behavioral change (Sniehotta et al., 2014), it is necessary to consider other theoretical bases that model how consumers change their behavior and guide those who implement interventions to help consumers to do so (see Chatzisarantis & Hagger, 2005; Hardeman et al., 2002; Sniehotta et al., 2014). Possible alternative theories could be action theories that are less focused on cognition, such as self-regulation theories (Hagger, Wood, Stiff, & Chatzisarantis, 2010), or theories that incorporate multiple goals (Presseau, Tait, Johnston, Francis, & Sniehotta, 2013), or unconscious influences, as well as the impact of emotions (Block et al., 2016; Sheeran et al., 2013).

Two further promising theoretical bases for anti-consumer-food-waste interventions are the *stage model of self-regulated behavioral change* (SMSBC) and the *integrative influence model of pro-environmental behavior* (IMPB).

The SMSBC (Bamberg, 2013) advances the constructs of the TPB (Ajzen, 1991) into a phase model of behavioral change (Heckhausen & Gollwitzer, 1987; Prochaska &

DiClemente, 1982). By integrating the idea that behavioral change includes a volitional and an action phase, it deals with the major criticism of the TPB (Bamberg, 2003). An application of the SMSBC to the domain of energy conservation offers a comprehensive overview of which intervention type is most suited for each behavioral change phase, in order to impact which TPB construct (Ohnmacht, Schaffner, Weibel, & Schad, 2017). For example, consumers at the pre-decision phase can be targeted by social role models, which should impact consumers' social norm. Although this framework has not yet been applied to consumer food waste (for an application to energy conservation in housing, see Schaffner, Ohnmacht, Weibel, & Mahrer, 2017), it lends itself to building on the existing TPB-oriented consumer food waste research (e.g., Graham-Rowe, Jessop, & Sparks, 2015; Russel, Young, Unsworth, & Robinson, 2017; Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016). This, in turn, would allow researchers to determine efficient anti-consumer-food-waste interventions.

The IMPB (Matthies, 2005) has already been applied to the domain of consumer food waste. (For a food waste specific description of the four phases of the IMPB, see Schmidt 2016a, 2016b.) The IMPB has the advantage of addressing almost all antecedents of consumer food waste behavior identified so far (Matthies & Blöbaum, 2007) and providing information on how to design effective anti-food-waste interventions (see Schmidt 2016a).

One aspect of the critique of the TPB as an appropriate theoretical basis for anti-consumer-food-waste interventions is raised in the behavioral change literature (see Osbaldiston, 2013): the coexistence of theoretical (and primarily correlational) research and intervention (and primarily experimental) research. Theoretical research typically uses self-reports to understand how various psychological constructs (e.g., attitudes, norms) are related to a certain behavior, with the aim of testing the validity of a theoretical model (e.g., TPB, *Value Belief Norm Theory*) for predicting behavior. Experimental intervention research directly tests interventions by measuring behavior. Theoretical models often predict only a

moderate amount of variance in the effect sizes of the experimental intervention studies. This is also true for TPB studies, where the situation and context is often a stronger predictor for behavior than the classic TPB predictors (i.e., attitude, perceived behavioral control, norms) (Osbaldiston, 2013). Situation and context include social factors (e.g., culture, economic status), physical factors (e.g., natural/build environment), and personal factors (i.e., age, sex, education). This discrepancy between theory and experiment is also evident for the consumer food waste field. On one side, there is correlational cause research that identifies TPB-based consumer food waste predictors (e.g., Stancu et al., 2016; Stefan et al., 2013; Visschers et al., 2016) and on the other side, there is intervention research which experimentally tests specific anti-consumer-food-waste interventions (e.g., Kallbekken & Sælen, 2013; Whitehair, Shanklin, & Brannon, 2013). Although speculative, this discrepancy could be reflected in the findings of the experimental study that found that message prompts reduce food waste, but do not influence (the theory-driven construct of) beliefs concerning food waste (see Table 4; Whitehair, Shanklin, & Brannon, 2013). This specific example, as well as the more general critique in the behavioral change literature, implies that academics and practitioners should not settle for correlational evidence but also strive for causal evidence when developing, implementing, and evaluating anti-consumer-food-waste interventions.

Overall, research on consumer food waste has done well to apply the TPB and its extensions to examine the antecedents of consumer food waste. When it comes to the question of how to change consumer food waste behavior, however, it becomes apparent that this theoretical basis has its limitations. Alternative theoretical bases seem more promising. Irrespective of the theoretical framework, however, it is a key challenge for future researchers to systematically evaluate interventions and apply their findings to the development and implementation of future anti-food-waste interventions.

4.2 Systematically Evaluating Anti-Consumer-Food-Waste Interventions

A successful anti-food-waste campaign requires interventions that are not only effective, but cost-efficient; interventions must be evaluated for both factors (Schultz, 2014). The evaluations enable meta-analyses to be conducted in the long run, to test the aggregated effectiveness of interventions (e.g., Maki, Burns, Ha, & Rothman, 2016) and to directly compare the effectiveness of various interventions against each other (e.g., Osbaldiston & Schott, 2012). The current effort to make raw empirical research data available (Open Science Collaboration, 2015) allows aggregated analyses to be continuously updated. By means of a Bayesian evidence synthesis, tests on the effectiveness of interventions can be updated as new evidence becomes available (e.g., Scheibehenne, Jamil, & Wagenmakers, 2016). We challenge practitioners and academics in the field of consumer food waste to increase their efforts to systematically evaluate anti-food-waste interventions.

Next we outline six methodological propositions to systematically evaluate anti-food-waste interventions: First, define food waste, primary food waste behaviors, and prevalent quantification methods. Second, identify key target groups. Third, gain insights into specific behavioral change processes. Fourth, differentiate between combined interventions (i.e., a campaign as a whole) and isolated interventions. Fifth, shift the perspective from short-term evaluation to long-term evaluation. Sixth, establish a systematic evaluation framework.

4.2.1 Defining food waste, measuring food waste, and identifying target behaviors

A key challenge in the evaluation of anti-food-waste interventions is that food waste research to date varies in definitions, targeted behavior, and measuring methods. The fact that there is no generally accepted definition of *food waste* is striking, particularly as most studies that focus on food waste at a particular stage of the food supply chain applied a holistic definition of food waste rather than a definition specific to that particular stage (Beretta et al., 2013; Ganglbauer et al., 2014; Lebersorger & Schneider, 2011; Porpino, Parente, & Wansink, 2015).

The variety of food waste behaviors that consumers can engage in is wide. Consequently, behavioral change researchers and practitioners can target multiple behaviors. The most commonly cited consumer food waste behaviors can be categorized into four sets of behaviors: purchase, storage, preparation, and serving (Porpino et al., 2015). For a detailed categorization of consumer food waste behaviors, see Table 10.

Table 10

Overview of Consumers' Main Food Waste Behaviors

Purchase	• Lack of planning of food purchases (e.g., daily vs. monthly shopping) • Purchase of food in excessive amounts (e.g., due to special offers) • Impulse purchases (i.e., buying items that are not currently needed) • Purchasing of new products that then are disliked
Storage	• Poor food storage management (e.g., failing to refrigerate perishable items) • Lack of knowledge of food storage (e.g., confusion about date labels) • Lack of planning of food storage • Being too sensitive to date labels (e.g., discarding food that has passed labeled date but is still edible) • Preference for freshness • Preference for variety
Preparation	• Poor meal planning • Cooking too much • Poor application of strategies to handle overproduction (e.g., failing to freeze leftovers promptly) • Not using leftovers
Serving at home/buffet	• Serving too much (at home: overestimating the needed portion; in restaurants: not ordering half portions and second helpings) • Using overlarge dishes

Note. Categorization and overview of relevant consumer food waste behaviors.

Specifying such behavior(s) is not only essential for measuring consumer food waste, but also for designing interventions against consumer food waste (see McKenzie-Mohr, 2013). Table 10 summarizes consumer behaviors that cause food waste and therefore implies interventions which aim to reduce them. However, when designing interventions, reducing undesired behaviors is only one side of the coin. It is important to simultaneously specify the desired anti-food-waste behavior. For instance, it is important to prevent impulse purchases while simultaneously promoting the use of shopping lists. Independent of whether one is concerned with food waste behavior or anti-food-waste behavior, the inclusion of various

behaviours into a theoretical behavioral change framework requires the identification of their specific costs and the situational factors that explain and determine them (see Schmidt, 2016a, 2016b; Schultz, 2014).

Researchers have used various methods to quantify consumer food waste such as self-reported questionnaires (Abeliotis, Lasaridi, & Chroni, 2014; Parizeau, von Massow, & Martin, 2015), diaries (Richter & Bokelmann, 2017; Silvennoinen, Katajajuuri, Hartikainen, Heikkilä, & Reinikainen, 2014; Williamson et al., 2016), leftover analysis (Kallbekken & Sælen, 2013), waste composition analysis (Bernstad, Jansen & Aspegren, 2013; Hanssen, Syversen & Sto, 2016; Lebersorger & Schneider, 2011), and food waste statistics from public authorities (Beretta et al., 2013; Bräutigam, Jörissen, & Priefer, 2014; Monier et al., 2010). A comprehensive description and comparison of known measurement methods can be found in van Herpen et al. (2016). However, the reliability and accuracy of these measurement methods suffer from four fundamental problems that lie in the nature of consumer food waste. First, directly asking consumers (e.g., with questionnaires) about their food waste makes them more conscious of it and thus more likely to reduce and/or underestimate it in order to conform to social ideals (Parizeau et al., 2015). Second, asking consumers about their food waste disregards the fact that people's memory is limited and error-prone (Hallström & Börjesson, 2013). Third, waste composition analyses are time- and labor-intensive and are difficult to carry out for certain types of waste (e.g., composted foods; Parizeau et al., 2015). Fourth, statistics from public authorities vary substantially in their definitions and measurement (Bräutigam et al., 2014). One can only speculate whether these methodological challenges might have contributed to the great variety in food waste quantification methods. Today, this variety of methods challenges the evaluation of intervention research. We urge practitioners and researchers to cooperate in agreeing upon common definitions, target behaviors, and methods (e.g., the exact classification of individual food items).

Recently, promising dialogues on food waste definitions and quantification methods have been initiated by international authorities, resulting in manuals that offer standards and guidance for measuring food waste. These are the *Food Loss and Waste Accounting and Reporting Standard (FLW Standard)* and the *EU-FUSIONS Quantification Manual*. Both manuals define food waste in a holistic manner and specify definitions for food waste at different stages of the supply chain (i.e., primary production, processing/manufacturing, wholesale/retail/markets, food services, households). Based on these definitions, comprehensive quantification methods are now documented (e.g., direct weighing, counting, assessing volume, waste composition analysis, records, diaries, surveys). Although the *FLW Standard* and the *EU-FUSIONS Quantification Manual* primarily address authorities, we urge researchers to consider using these methodological guidelines.

Consumer food waste is not a single behavior but a multiplicity of behaviors. Correspondingly, there are multiple definitions, target behaviors, and methods which aim to capture consumer food waste (prevention) behavior. In order to address the complexity of this problem, we call for researchers to formulate common definitions, identify key target behaviors, and find methods that allow unobtrusive measurement[23], to effectively tackle consumer food waste.

4.2.2 Identifying key target groups that correspond to the target behavior

Knowing who is most prone to waste food, to not engage in food waste prevention for what reasons, or to be susceptible to what kinds of incentives is fundamental to designing effective interventions. The identification of the target group(s) and barriers and benefits of the target behavior (e.g., Lee & Kotler, 2015; McKenzie & Mohr, 2013; Schultz, 2014) is

[23] For experimental/field studies and practical evaluations in monitored settings (e.g., school, restaurant), it might be useful to review the broad literature on food consumption research and analyze the various developed and applied unobtrusive approaches to measuring food intake, e.g., by weighing food before and after consumption, direct observation (live human rating), or indirect observation (photograph analysis) (see e.g., Kenney et al., 2015; Stämpfli, Stöckli & Brunner, 2017; Wansink & Van Ittersum, 2013).

closely related to defining target behaviors. The finding that sociodemographics (e.g., age, sex, number of children/adults in the household) predict food waste behavior irrespective of TPB constructs (Visschers et al., 2016) illustrates the importance of sociodemographic and situational and/or contextual factors in understanding consumer food waste behavior (Filipová, Mokrejšová, Šulc, & Zeman, 2017). Just recently, academic food waste research started to segment consumers into key target groups and discuss specific leverage points for these segments (e.g., Delley &Brunner, 2017; Gaiani, Caldeira, Adorno, Segrè, & Vittuari, 2017). For instance, Delley and Brunner (2017) highlight two segments, the 'conservative' and the 'eco-responsible', as the most willing to reduce consumer food waste and as key role models to introduce new food waste norms to members of other, less willing segments. This type of consumer-food-waste-specific target-group analysis is of great value for designing effective anti-consumer-food-waste interventions, in particular, when linked to general knowledge from the behavioral change literature; for example, that social norms are one of the most effective intervention types.

4.2.3 Gaining insights into specific behavioral change processes

In order to gain valid inferences about an intervention's effect and underlying mechanisms, it is vital to measure psychological constructs. Most interventions are designed to trigger a specific behavioral change process. The current efforts to identify antecedents of consumer food waste (see e.g., Hebrok and Boks, 2017; Priefer, Jörissen, & Bräutigam, 2016; Thyberg & Tonjes, 2016) offer valuable insight into the core predictors of food waste behavior. For instance, if an anti-food-waste intervention (e.g., a shopping app) is designed to change behavior (e.g., overstocking) by modifying consumers' perceived behavioral control, then it is crucial to measure whether perceived behavioral control increases in response to the intervention. Evidence of changes to the targeted psychological constructs are vital regardless of the behavioral effect of the intervention, because it allows researchers to determine whether an intervention's effect is due to successfully modifying the targeted psychological construct.

This, in turn, reveals whether an intervention was adequately theorized or, in other words, whether the selected intervention type suited the targeted psychological construct (see Abraham, Johnson, de Bruin, & Luszczynska, 2014; Steg & Vlek, 2009). In sum, we encourage the measurement of psychological processes in order to gain insight into how effective intervention types function.

4.2.4 Disentangling individual effects within combined interventions

This review stresses the difficulty of evaluating individual (vs. combined) anti-consumer-food-waste interventions. A large proportion of the here-reviewed campaigns apply multiple interventions, so an evaluation of the effectiveness of single real-world campaigns is problematic and confounded. Understanding the comparative effectiveness of multiple interventions is essential for the effective implementation of anti-food-waste campaigns. A major task for future research is teasing apart the relative individual effects of interventions within campaigns; for example, by testing single interventions in an experimental setting.

4.2.5 Shifting the focus to long-term evaluations

Another finding complicates efforts to evaluate anti-consumer-food-waste interventions: Almost all the interventions that we evaluated were tested for effectiveness at one time only, and within a short time interval. An exception is a study that used a time point of five months after the intervention in addition to two weeks after the intervention (Young, Russel, Robinson, & Barkemeyer, 2017; also see Schmidt, 2016a). Consequently, for most work we cannot conclude that these interventions lead to long-term behavioral change. To tackle consumer food waste it is necessary to identify interventions that produce lasting behavioral change. General intervention research suggests that many interventions lead to behavioral change in the short term, but are unable to establish change in the long term (see Abrahamse et al., 2005). Thus, we challenge practitioners and academics to collect follow-up data in order to shift the focus to long-term evaluation of interventions against consumer food waste.

4.2.6 Using a systematic framework for intervention evaluation

A more general problem in the field of consumer food waste is that intervention research contributes the most when it is comprehensive, including detailed and standardized descriptions of the intervention and measuring behavioral outcomes as well as psychological constructs and processes (Abraham et al., 2014; McKenzie-Mohr, 2013; Michie et al., 2011).

In order to establish standardized evaluations, practitioners and academics could adapt and apply reporting standards like the Consolidated Standards of Reporting Trials (CONSORT; Moher, Schulz, & Altman, 2001) or the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND; Des Jarlais, Lyles, & Crepaz, 2004). The core idea of these guidelines is that evaluation reports provide a systematic description of characteristics such as the content of the intervention (e.g., knowledge transfer), who is delivering the intervention (e.g., NGO), the target group (e.g., restaurant guests), the setting (e.g., at school), the mode of delivery (e.g., personal contact), the intensity (e.g., contact time), and the duration (e.g., frequency of contact over a given period). These details are all indispensable for accumulating evidence about effective interventions and for translating research into practice (Davidson et al., 2003).

Thus, we encourage practitioners and researchers to develop and apply standardized descriptions, evaluation criteria, and reporting. At best, this leads to the formation of a systematic framework that allows a valid comparison of the effectiveness of any interventions against consumer food waste (see Geller et al., 1990; Schultz, 2002).

4.3 Endorsing Cooperation Between Practical and Academic Contributors

This review finds that there are disproportionately more real-world interventions than academic studies on consumer food waste prevention. In addition to the different amount of attention paid to preventing consumer food waste by practitioners and academics, there are differences in what is considered a valuable approach to reducing consumer food waste. We acknowledge that these differences correspond to differences in the roles and scope of both

groups. While practitioners, like authorities and policy makers (as well as some policy-oriented researchers; e.g., Betz, Buchli, Göbel, & Müller, 2015) have proposed informational interventions against consumer food waste, academics have so far been reluctant to evaluate such interventions. Clearly, it seems legitimate to propose that informational interventions raise public awareness of food waste (see Kantor et al., 1997) and that intensifying public discourse on the issue of food waste is beneficial (see Garrone et al., 2014). However, there is also much evidence (from general behavioral change research) that such propositions are myopic and that purely informational interventions are often insufficient (e.g., McKenzie-Mohr, 2013). These differences in approach between practice and theory illustrate how much the field of consumer food waste could benefit from practical and academic cooperation. The literature on behavioral change offers frameworks for aligning different perspectives and approaches of academics and practitioners to generate the necessary synergies. Particularly, the stages of social marketing (e.g., McKenzie-Mohr, 2013; Lee & Kotler, 2015) illustrate well how the identification of target behaviors and target groups, the analysis of specific behavioral antecedents, the implementation of an intervention campaign, and the evaluation of the effectiveness of an intervention campaign should ideally merge into a linear process.

5 Conclusion

In conclusion, this review's analysis of antecedent and consequence interventions in the area of consumer food waste reveals that, while practitioners have implemented and combined diverse intervention types, academics have rarely examined anti-consumer-food-waste interventions. With reference to general behavioral change and intervention literature, two key challenges become apparent: First, informational interventions are the predominant intervention type even though conceptual and empirical evidence indicates that this intervention type is relatively ineffective. Second, anti-consumer-food-waste interventions have not been sufficiently evaluated and thus, there is a lack of clarity on their effectiveness. Driven by the consequential need to consider a broader scope of intervention types and the

need for more comprehensive intervention evaluation, this review discusses specific conceptual and methodological challenges. Here, two key implications become apparent: First, non-informational intervention types, namely modeling (social norms), prompts, and rewards, should be considered. Second, anti-consumer-food-waste interventions should be evaluated in a systematic manner; that is, by using a framework that implements standardized definitions and measurement methods, addresses specific behaviors and behavioral change processes, differentiates between combined interventions (i.e., a campaign as a whole) and isolated interventions, and ensures evaluations of long-term effectiveness. Overall, this review sets an agenda for implementing effective anti-consumer-food-waste interventions.

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