Evidence-based messaging to decrease food waste at the consumer level

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Abstract

Food waste at the consumer level poses a global challenge for natural resources management and contributes to climate change. However, there is limited evidence regarding the best messaging strategies to fight household food waste. Here we experimentally test several food waste messages, aiming to identify the most effective strategies to promote individuals' willingness to tackle food waste in the future (sampling 2500 U.S. residents). Study 1 tested three common prompts ("reduce waste", "don't waste" or "stop waste") and showed that prompts to "reduce waste" are the most effective. Study 2 tested several consequences of food waste (economic, social or environmental), showing that messages about social and environmental consequences are the more impactful. Lastly, Study 3 tested whether combining different stimuli (prompts, consequences, tips for action) would produce stronger effects, but revealed mixed results, suggesting that more information is not necessarily better to help fight food waste. Implications for policy-making and intervention are discussed.

Keywords: food waste, communication strategies, evidence-based intervention, experiment

Private households are the largest contributors of food waste along the food supply chain, estimated in about 25% of all total wasted food (1). The food wasted by individuals and households at the end of the supply chain renders useless the array of energy resources - and associated greenhouse gas emissions - put into its production, processing, transportation, cooling and preparation (2). This state of affairs is expected to worsen as the size and wealth of the global human population continue to grow (3). Given the high amounts of food waste occurring at the household level, addressing food waste in this target group is crucial to mitigate climate change and conserve natural resources.

In order to address household food waste, it is imperative to stimulate behavior changes in consumer patterns. However, behavioral research about food waste at the consumer level is incipient, scattered, and mostly focused on exploring the complex nature of the drivers of household food waste (4). This research tends to be descriptive, and proposing recommendations or solutions with limited empirical support (5). Yet, there are pressing calls for action (6) and parallel practical efforts are happening in the form of social marketing messages, disseminated by governmental agencies, NGOs and environmental advocates, urging for a decrease in food waste (e.g., U.S. Environmental Protection Agency [7]; Food and Agricultural Organization [8]; European Commission [9]).

A probe of the messages developed by these stakeholders exposes a myriad of contents, ranging from simple, quick prompts such as “Stop Food Waste” or “Reduce Food Waste”, to more elaborate messages often detailing the consequences of food waste and/ or suggesting behavior changes (10). The most common consequences presented are economic, social and environmental costs (11). Messages about economic costs highlight the amounts of money wasted along the supply chain to produce food eventually not consumed, and how much money households are losing due to their own food waste (12). Messages about social costs focus on how food waste may contribute to food insecurity, particularly in low-income families, and the large number of poor individuals that could be fed with the food wasted (11). Messages about environmental costs emphasize the overuse of natural resources such as land and water to produce food that is ultimately uneaten, as well as methane emissions produced from food waste in landfills (13). Moreover, these consequences may be presented in isolation or combined with tips or advice for action. Many argue (14) that a barrier to tackling food waste may be limited information about how to change, and that practical information on how to tackle food waste facilitates addressing this problem – thus tips for action are often included in food waste messaging.

However, the impact of exposing consumers to food waste messaging has not been empirically substantiated to date. Marketing-type approaches based on focus groups (15) or “best ad” campaigns (e.g., Love Food Hate Waste) are imperfect methods to inform evidence-based interventions, due to their limited focus on impact evaluation, and their use of small samples of self-selected people, reporting their views with no comparable control group. Moreover, the effect of incorporating multiple informational elements in food waste messages remains unclear, and there are no clear evidence-based guidelines about how to best compose these messages. Evidence-based guidelines imply that interventions should not only be based on empirical evidence, but in the best available causal evidence (16).

This paper evaluates the impact of exposing individuals to the most common food waste messages, which are disseminated, for instance, in student cafeterias, food courts, or online (Table 1). We focus on the impact of these messages to promote a general willingness to tackle food waste, and do not restrict the analysis to a specific type of household food waste (e.g., leftovers from home cooking; excessive restaurant feasting).

Table 1. Summary of studies and type of messages tested per study

Study	Examples of messages tested per study
Study 1. Quick Prompts
Study 2. Consequences of food waste
Study 3. Bundled messages

Note: Further details on messages used are presented in Supporting Information

We start in Study 1 by testing the most commonly used simple prompts, including “Reduce Food Waste,” “Don’t Waste Food” or “Stop Food Waste”. Study 2 aims to test the comparative impact of exposing consumers to the main consequences of food waste, namely economic, social and environmental costs. Lastly, Study 3 tests messages that combine a variety of stimuli (prompts, consequences, tips for action). This study tests the impact of these stimuli, either in isolation or in bundles of two, three or four elements.

Results

Study 1. The impact of quick prompts

Controlling for sociodemographic variables (Table 2), multiple regressions models show that both “Reduce Food Waste” ($\beta=.163$ $p=.034$) and “Don’t Waste Food” ($\beta=.183$ $p=.017$) increase the perceived importance of food waste as a societal problem (Model 1). However, no prompt was effective to increase individuals’ concern with food waste (Model 2). Regarding the willingness to tackle food waste in the future, only the prompt “Reduce Food Waste” ($\beta=.165$ $p=.030$) produced a significant increase. The prompt “Stop Food Waste” was not effective to increase any of the outcomes measured.

Table 2. Effect sizes per quick prompt

	(1)	(2)	(3)
<i>Reduce Waste</i>	.163**	-.017	.165**
<i>Don’t Waste</i>	.183**	.070	.122
<i>Stop Waste</i>	.029	-.073	.029
Age	-.024	-.044	.155**
Gender ¹	.092	.083	.153**
Education ²	-.073	-.042	-.021
Income ³	.091	-.016	-.022
Employment ⁴	.008	.108	.021
F-Test	1.644	.947	2.380
Adj-R ²	.020	.002	.041

Note: Reporting standardized regression coefficients ** $p<.05$; * $p<.10$; ¹ (1=Male; 2=Female); ² (1=Less than high school to 5=Master/ Doctorate); ³ (1=Annual income less than \$10,000 to 12=More than \$150,000); ⁴ (1=Full-time employment; 0=Otherwise).

(1) Model 1 Societal importance of food waste;

(2) Model 2 Concern about food waste;

(3) Model 3 Willingness to tackle food waste in the future

This corresponds to an average willingness to tackle food waste of 69.9% in the control group (no prompt), similar to “Stop Food Waste” (70.4%) (Figure 1). “Don’t Waste Food” (76.0%) and “Reduce Food Waste” (77.1%) resulted in a higher willingness to make future efforts to tackle food waste, but only the latter reached statistical significance.

Figure 1. Willingness to tackle food waste in the future, per prompt (%)

Regarding image evaluation, the three evaluation items were standardized due to their different measurement scales and then combined in a single overall assessment variable ($\alpha=.58$). The overall quality assessment of the images did not differ between experimental conditions ($F(2, 193)=.632$ $p=.532$).

Study 2. The impact of the consequences of food waste

Controlling for covariates (Table 3), multiple regression models show that only messages about social costs increase the perceived societal importance of food waste ($\beta=.089$ marginally $p=.062$ – Model 1) and perceptions of personal responsibility ($\beta=.131$ $p=.048$ – Model 2). All messages were effective to increase perceived knowledge about food waste, except messages about economic costs, which had a marginal negative impact ($\beta=-.120$ $p=.061$ – Model 3) compared to no message. Messages about economic costs also had a negative impact in the perceived awareness about the consequences of food waste ($\beta=-.133$ $p=.047$ – Model 4), whereas only environmental messages result in more reported awareness about these consequences ($\beta=.133$ $p=.049$ – Model 4). Lastly, compared to the control group, none of the

messages about the consequences of food waste produced an impact on the willingness to tackle food waste in the future (Model 5).

While none of the messages were statistically better than the control group, within the messages provided, the social costs increased the willingness to tackle food waste in the future by 5.6% (up to 80.5%), compared to just basic information ($p=.021$) and messages about economic costs ($p=.024$) (both 74.9%). Messages about social costs did not differ from messages about environmental costs (76.6% $p=.108$), suggesting these are potentially the two more effective costs to be highlighted.

Table 3. Effect sizes per food waste consequence

	(1)	(2)	(3)	(4)	(5)
<i>Basic Information</i>	-.003	.026	.207**	-.048	-.067
<i>Economic Costs</i>	-.056	-.017	-.120*	-.133**	-.056
<i>Social Costs</i>	.089*	.131**	.231**	.104	.045
<i>Environmental Costs</i>	.058	.106	.245**	.133**	-.025
Age	-.073*	-.141**	.021	-.096*	.116**
Gender ¹	.049	.041	-.056	-.001	.050
Education ²	-.040	-.137**	-.070	-.121**	-.029
Income ³	.008	.044	.091	.076	-.033
Employment ⁴	.058	.162**	.154**	.079	.096**
F	2.335	4.038	8.300	4.447	2.577
Adj-R ²	.016	.072	.158	.081	.019

Note: Reporting standardized regression coefficients ** $p<.05$; * $p<.10$; ¹ (1=Male; 2=Female); ² (1=Less than high school to 5=Master/ Doctorate); ³ 1=Annual income less than \$10,000 to 12=More than \$150,000); ⁴ (1=Full-time employment; 0=Otherwise).

(1) Model 1 Societal importance of food waste;

(2) Model 2 Perception of personal responsibility about food waste;

(3) Model 3 Perceived knowledge about food waste;

(4) Model 4 Awareness of consequences about food waste;

(5) Model 5 Willingness to tackle food waste in the future

The image quality measures were also standardized and combined into a single assessment factor ($\alpha=.715$). In this study, there were significant differences between groups ($F(3, 283)=15.582$ $p<.001$). Images related to social costs were evaluated as the highest quality images compared to all groups, followed by environmental costs images. The quality of the images in the basic information group and environmental costs group did not differ ($p=.166$). Nonetheless, controlling for image assessment in the regression models did not change the results e.g., willingness to tackle food waste in the future was still not predicted by any message.

Study 3. The impact of bundled messages

An analysis per number of stimuli included in the message – regardless of the content included – shows that messages conveying a single idea are more impactful (Figure 2). Post hoc mean differences (LSD tests) show that, compared to no message, single stimulus messages increase participants' reported willingness to tackle food waste in the future ($p=.024$; two stimuli marginally $p=.083$).

Figure 2. Willingness to tackle food waste in the future per number of stimuli in the food waste message (%). ** $p<.05$; * $p<.10$

Per specific content (Figure 3), there is a limited number of messages statistically better than no message. Results show that the control group (no message) reports an average willingness to tackle food waste in 68.2% and that only messages conveying social and environmental consequences in combination (75.5% $p=.008$) or messages simply focused on environmental consequences (74.3% $p=.021$) significantly increase participants willingness to tackle food waste. Marginally significant are messages exposing participants only to tips on how to cut back waste (73.5% $p=.074$) and messages combining the prompt “Reduce Food Waste” with social consequences (72.6% $p=.086$).

In this study, there were significant differences between groups about image quality according to the number of stimuli included in the message ($F(2)=5.074$ $p=.006$). Interestingly, average image quality per experimental group was positively associated with the number of stimuli included in the messages ($\beta=.113$ $p=.002$). However, this did not change the main result

that the higher the number of stimuli included in the message, the lower the willingness to tackle food waste ($\beta = -.070$ $p = .031$).

Figure 3. Willingness to tackle food waste in the future per combination of stimuli in the food waste message (%). ** $p < .05$; * $p < .10$; ----- Control Group Reference

General Discussion

We contribute to the incipient behavioral literature focused on evaluating communication strategies to tackle household food waste. Given that messages against food waste are becoming widely disseminated, their design should be informed by causal empirical evidence. However, our results largely show small effects of such messages to address the problem of food waste. We show negligible impacts in promoting more concern about food waste and its societal importance. The stronger effects were found in increased knowledge and awareness about the consequences of food waste, yet this did not translate into a substantial higher willingness to address this problem in the future. We show that the few messages that increase the willingness to tackle food waste do so on average 6% to 7%. Per structure of the message, results suggest the use of simple messages – up to two pieces of information per message – and to focus on the social and/ or environmental consequences of food waste.

Our results corroborate previous evidence about public service announcements: their effectiveness typically falls short of expectations (17-18), and there is consistent evidence

about the psychological processes that may counteract the expected effects. First, more imperative messages (e.g., “Stop Food Waste”) tend to be ineffective and potentially counterproductive because they tend to elicit psychological reactance i.e., resistance to feeling one’s freedom is threatened (19). Milder persuasive messages often produce better results – such as “Reduce Food Waste” - because they are perceived as less controlling and authoritative (20). The results about these simple prompts may have direct implications for important organizations, such as the European Commission, which has its food waste flagship platform anchored on “Stop Food Waste!” (9).

Second, messages should be developed taking into consideration evidence about information processing and cognitive overload (21). People have limited cognitive resources and thus more complex messages, that is, heavy on information cues, facts and figures, are not necessarily better. Simple, easy to grasp messages, with focal takeaways that are quickly understandable are more likely to be effective. Our results suggest this is likely better achieved by messages including one, or maximum two, pieces of information about food waste.

Thirdly, there is an ongoing debate about whether intrinsic motives (e.g., social or environmental appeal) versus extrinsic motives (e.g., financial benefit) are more effective to promote pro-environmental behavior (22). Our results suggest intrinsic motives are more effective to increase reported willingness to tackle food waste and that messages about the economic (extrinsic) costs seem to produce null or negative effects. However, our work relies on self-reported measures, which tend to overestimate how much people are really willing to change (23). This means that food messages, even the ones we identified as more effective, may have in reality negligible impacts in tangible, daily household behaviors. Thus, future research is needed to validate whether our suggested best strategies hold in the naturalistic settings to change objective household actions. Such a field testing is critical to establish more conclusively whether intrinsic or extrinsic motivations (or both) actually promote behavioral changes in food waste production.

Past research suggests extrinsic motives such social norms (24) tend to be effective interventions to change household pro-environmental behavior. For instance, we should not simply advise households to use leftovers, but should disseminate the message that most household in their community/region/country use leftovers. Moreover, alternative forceful interventions such as regulations or economic disincentives (e.g., taxes on overconsumption; limits imposed on garbage collection; fees per dining leftovers), which are by definition extrinsic motivators, have also proven to be effective (25). Other successful behavioral interventions include re-shaping the extrinsic environment in which food waste occurs e.g.,

reducing plate size in buffets (3). This strategy could be implemented more widely in supermarkets and food courts, by reducing the default portion/ package size. These (extrinsic) strategies are likely more effective than any food waste messaging, regardless of which motivations food messages are targeting.

In conclusion, our work suggests that social marketing messages to reduce food waste may not be a particularly effective strategy to tackle food waste, and that alternative (or complementary) strategies are needed. Nonetheless, the low effectiveness of these soft messages could be moderated according to social context (25) e.g., proximity to deprived areas where food insecurity is more salient; community cafeteria where people can visually notice the food waste produced by others. This analysis would be an important addition to our results because we restricted our focus to individual attitude change, whereas many food waste contexts involve social gatherings with family and friends. Future research should further explore how food waste messages help consumers negotiate between their reported willingness to avoid food waste and other competing priorities, such as food safety, convenience, and time demands, and particularly examine which social contexts best magnify the effect of food waste messaging.

Materials and Methods

Study 1

Participants were recruited on Amazon's Mechanical Turk (MTurk) — a crowdsourcing platform where individuals can accept tasks (e.g., surveys) in exchange for payment. We restricted sampling to U.S. locations. Power calculations for this study, with four experimental groups, assuming a medium effect size ($f=.025$) and 80% power (22), suggest a sample of 180 participants. Two hundred and sixty-one participants were recruited ($Mean_{age}=34.13$ $SD_{age}=9.35$; Female 43.8%; Education 41.9% up to some College, 58.1% University degree and above; Income 50% up to \$45,000 annually, two thirds up to \$55,000; Employed full-time 76.5%; Caucasian 75.8%).

Participants ($N=261$) were randomly assigned to see visual prompts either about (i) “Reduce Food Waste”; (ii) “Don’t Waste Food”, (iii) “Stop Food Waste” or (iv) a control group (no images). All participants exposed to five images, different according to the experimental group they were assigned to. Due to the wide variety of colors, fonts and shapes of the images in food messages, participants in all studies were asked to evaluate each of the images in terms of their visual appeal, intelligibility and overall perceived quality as a message to address food waste.

This evaluation works to control for potential attitudes changes simply driven by visual differences in the pictures, and not by their content. Visual appeal and intelligibility of images were both measured as 1=No, 2=To some extent, 3=Yes, and perceived quality of the image as a message to address food waste was measured between 0% to 100%. All images were evaluated and then image quality was averaged out across experimental groups.

Participants were then asked about the outcomes of interest: i) To what extent do you think food waste is an important issue in our society? (1=not at all important to 5=extremely important); ii) How concerned are you about the food waste that exists in our society? (1=not at all concerned to 7=extremely concerned); iii) Thinking about your future behavior, how much effort are you willing to make to tackle food waste? (0% to 100%).

Study 2

Study 2 followed the same steps for participant recruitment and data collection as Study 1. Power calculations for this study, with five experimental groups, assuming a small-to-medium effect size (to reflect effect sizes from study 1; $f=.15$) and 80% power (23), suggest a sample of 540 participants. A total of 733 participants were recruited ($Mean_{age}=39.01$ $SD_{age}=12.15$; Female 48.1%; Education 55.2% College or above; Income 50% up to \$40,000; Employed full-time 65.8%; Caucasian 74.1%).

Participants (N=733) were randomly assigned to see images about either (i) economic costs; (ii) social costs, (iii) environmental costs, (iv) plain information about food waste without mentioning any consequence i.e., about a third of all food produced is lost along the food supply chain. This group acts as a form of control group, where information about the problem is provided but not awareness of consequences; or (v) a “pure” control group (no information, no image). All participants were exposed to five images, according to the experimental group they were assigned to. Visual appeal, intelligibility and overall perceived quality of messages were evaluated as in Study 1.

Participants were then asked about several outcomes: i) To what extent do you think food waste is an important issue in our society? (1=not at all important to 5=extremely important – as Study 1); ii) To what extent these messages increase your perceived personal responsibility about food waste? (1=not at all to 7=extremely); iii) To what extent these messages increase your knowledge about food waste? (1=not at all to 7=extremely); (iv) To what extent these messages increase your awareness about the consequences of food waste? (1=not at all to 7=extremely); and (v) Thinking about your future behavior, how much effort are you willing to make to tackle food waste? (0% to 100% - as Study 1).

Study 3

Study 3 followed the same steps for participant recruitment and data collection as previous studies. In this study, we test the impact of messages combining bundles of stimuli – the most common form of food waste messages (7-9). These bundled messages share an underlying assumption that, the more pieces of information included, the more effective the message will be (17). We replicate the test of the stimuli shown more effective in Studies 1 and 2, in addition to introducing tips for action to cut food waste. These stimuli were tested in isolation or in combination.

A rigorous analysis of stimuli combination requires a factorial experimental design, by which both main effects and interaction effects can be estimated. We conducted a factorial design with 16 experimental groups: 4 (Message Content: “Reduce Food Waste”, Social Costs, Environmental Costs, Tips for action) X 4 (Number of different stimuli included in message: one, two, three or all elements). Power calculations for this factorial design with 16 experimental groups, assuming a small effect size ($f=.10$) and 80% power (23), suggest a sample of 1289 participants. A total of 1459 participants were recruited ($Mean_{age}=39.34$ $SD_{age}=11.79$; Female 50.4%; Education 45.1% College or above; Income 50% up to \$50,000; Employed full-time 71%; Caucasian 78.1%).

The images for the prompt “Reduce Food Waste” and the social and economic consequences were the same as used in previous studies. Images with tips for action were randomly selected from the popular initiative Love Food Hate Waste (www.lovefoodhatewaste.com) e.g., plan your meals; keep food fresh with proper storage; use leftovers [examples shown in SI]. Visual appeal, intelligibility and overall perceived quality of messages were evaluated as in Studies 1-2. All participants were exposed to six images, which could be about the same stimuli or images about different stimuli, depending on the experimental group they were randomly assigned to.

Participants (N=1459) were randomly assigned to one of these experimental groups and then asked about several outcomes: i) Thinking about your future behavior, how willing are you to tackle food waste? (0% to 100%); ii) Thinking about your future behavior, how much effort are you willing to make to tackle food waste? (0% to 100%); iii) How much do you think you personally need to decrease food waste? (0% to 100%). In this study, outcomes were restricted to measure future intentions and thus could be combined in a single factor ($\alpha=.691$).

Ethics Statement

This work was reviewed by the Institutional Review Board of the New York University Abu Dhabi. Informed consent was requested to all participants.

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Competing Interests Statement

The authors declare no competing interests.

Data Availability

All datasets will be made available in Figshare upon potential publication.

Author Contribution Statement

Claudia F. Nisa was involved in all steps of this work from funding to final manuscript submission. Jocelyn J. Bélanger was involved in funding, data collection and manuscript editing. Birga M. Schumpe was involved in data analysis and manuscript editing.

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Supporting Information

Example of Images Tested

Figures 1a-1c. Examples of prompts related to food waste: A. Reduce; B. Don't waste; C. Stop

A

B

WASTING FOOD IS WASTING MONEY

An American family of
FOUR
ends up throwing away
AN AVERAGE OF
\$1,600
annually in food

C

Figures 2a-2c. Examples of consequences related to food waste: A. Social; B Economic; C Environmental

Figures 3a-3b. Examples of basic information about food waste

Figures 4a-4b. Examples of tips to reduce food waste