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When Many Waste Little: Using Descriptive Norms to Reduce Household Food Waste

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Abstract

Household food waste has damaging environmental consequences. To tackle this, food waste reducing behaviours must be promoted. The present research aimed to contribute to the scarce literature on household food waste interventions by exploring how targeting descriptive norms as part of an informational, message-based strategy can influence these behaviours. A pro-environmental descriptive norm (i.e., creating the perception that many carry out food waste reducing behaviours) was expected to be more effective than receiving information only. Conversely, an anti-environmental descriptive norm (i.e., creating the perception that few carry out food waste reducing behaviours) was expected to be less effective. Study 1 was longitudinal and, as well as using self-reported measures, used data on participants' accounts with their waste collection provider in Dublin, Ireland as an objective food waste measure. Study 2 was cross-sectional and aimed at addressing the sample size limitations of Study 1 in Groningen, the Netherlands. Results revealed an overall increase in food waste reducing behaviours and decrease in self-reported food waste (Study 1). However, there were no differences between the interventions (Study 1 and 2). Therefore, our hypotheses were not supported. Future research is needed to explore the potential use of normative household food waste interventions.

When Many Waste Little:

Using Descriptive Norms to Reduce Household Food Waste

From production to consumption, our current global food system sees food wasted at every stage (Crippa et al., 2021). The U.S. Food and Agricultural Organisation estimates that one third of the world's food is wasted (Gustavsson et al., 2011). When considering each sector's contribution, it appears that households in developed countries generate the largest proportion of food waste (Tonini et al., 2018). In fact, around 53% of Europe's food waste stems from households (Stenmarck et al., 2016) and a considerable amount is avoidable (i.e., food edible at some point prior to being discarded; Koivupuro et al., 2012). This is alarming since food waste poses major environmental consequences such as the release of carbon and methane during disposal, and the wasting of valuable resources involved in food production, treatment, packaging and transportation (Reutter et al., 2017; Scherhaufer et al., 2018; Yeganeh, 2020). Since the carbon footprint of food increases as it passes through the supply chain, food waste in the household (i.e., at the final stage), is of particular concern (Priefer et al., 2016). To curb these environmental impacts and achieve important targets such as the United Nations' Sustainable Development Goal 12.3 to half consumer food waste by 2030 (United Nations, 2021), there is a pressing need to reduce household food waste.

Such a reduction in household food waste can be achieved through a change in individual behaviours concerning grocery shopping, food preparation, food storage and food safety assessment (Thyberg & Tonjes, 2016). Specifically, food waste reducing behaviours (FWRBs) must be adopted, such as planning meals ahead of time, consuming leftovers and having an overview of one's food stock (Principato et al., 2021). However, an important question is how these behaviours can be promoted. Thus far, there have been few attempts to reduce household food waste in the form of campaigns and interventions, and of these few have assessed their impact (Stöckli et al., 2018b). While the standard approach has been to

target food waste awareness through information provision (Van Geffen et al., 2020), this tends to be one of the least effective strategies for the promotion of pro-environmental behaviours (Grilli & Curtis, 2021) and has produced mixed results when used to reduce household food waste (Schanes et al., 2018). Accordingly, food waste campaigns must target other psychological constructs in addition to awareness. However, further research is needed to identify psychological constructs that can be targeted to create more effective food waste interventions. Reflecting on past pro-environmental behaviour interventions, targeting descriptive norms could increase the efficacy of such attempts (Bergquist et al., 2019). Thus, the present research aims to contribute to this topic by being the first to explore how interventions targeting descriptive norms can influence household FWRBs.

Descriptive Norms for Pro-Environmental Behaviour Change

Descriptive norms refer to individuals' perceptions regarding the extent to which a behaviour is carried out by others (Cialdini et al., 1991). In the literature these are often contrasted with injunctive norms, which refer to the extent to which behaviours are perceived to be approved, or disapproved of by others (Kallgren et al., 2000). Although the actual descriptive norm is generally not known with certainty, we make inferences regarding the prevalence of a given behaviour from cues in our physical and/or social environment (e.g., litter on the street, or seeing others bring items to the recycling centre; Tankard & Paluck, 2016). In turn, we use these normative beliefs when making decisions regarding our own behaviour (Stok & Ridder, 2019). Research suggests that when a behaviour is perceived as prevalent in one's social circle, one is more likely to act in a norm-consistent manner (Bicchieri & Xiao, 2009; Irwin & Simpson, 2013; Pryor et al., 2019). Proposed reasons for the tendency to act in line with descriptive norms include using others' behaviour as a gauge for what is effective and worthwhile (Farrow et al., 2017), and the desire for social approval as well as the desire to prevent social disapproval (Cialdini, 2007).

Normative beliefs can also be strategically influenced to elicit behaviour change. Various approaches to do so have been taken in past research. These include providing feedback comparing one's own performance to others, using social models, and changing one's observed environment, however the use of a written message communicating normative information is predominant due to its cost-effectiveness and ease of implementation (Cotterill et al., 2019; Ge et al., 2020). Such messages can be formulated in many ways to influence descriptive norms. They can present statistics on the prevalence of a behaviour, or simply state many (few), or the majority (minority) of people engage in a given behaviour. Furthermore, messages may be falsified, or based on true information (Nolan, 2021).

Many interventions targeting descriptive norms using a message-based approach have been successful in promoting pro-environmental behaviours. Specifically, creating the perception that many engage in the desired behaviour (i.e., pro-environmental descriptive norm) can promote norm-consistent behaviour (Abrahamse & Steg, 2013; Bergquist et al., 2019). For example, Goldstein et al. (2008) found significantly higher towel reuse by guests in hotel rooms with a prompt featuring a pro-environmental descriptive norm (i.e., 75% of guests reuse towels) compared to a standard prompt focused on environmental protection. Also, Nolan et al. (2008) found a message with a pro-environmental descriptive norm was more effective at reducing energy consumption than information only. These findings are supported by recent studies for guest towel reuse (Gössling et al., 2019; Terrier & Marfaing, 2015) and electricity reduction (Ornaghi et al., 2018; Tetlow et al., 2015), as well as for other behaviours such as sustainable transport use (Kormos et al., 2015), water conservation (Ferraro et al., 2011; Jaeger & Schultz, 2017; Richetin et al., 2014) and waste separation (Geislar, 2017; Schultz, 1999). Thus, it appears perceiving the target, pro-environmental behaviour as commonly performed by others can increase pro-environmental action, and its inclusion in a message-based informational intervention can increase its efficacy.

Targeting Descriptive Norms in Household Food Waste Interventions

Despite the success of previous interventions targeting pro-environmental descriptive norms, after a thorough search of the literature, a study exploring the role of descriptive norms as part of a household food waste intervention was not identified. Instead, the standard approach in both academic and real-world interventions is to solely target food waste awareness by providing declarative (i.e., why an action should be carried out) and procedural information (i.e., how an action can be carried out; Osbaldiston & Schott, 2011; Schanes et al., 2018; Van Geffen et al., 2020). Yet, there is evidence that descriptive norms are correlated with household food waste (Piras et al., 2021; Thompson et al., 2020; Van Geffen et al., 2017) and calls have been made for descriptive norm-based interventions in promoting household FWRBs (e.g., Attiq et al., 2021; Barker et al., 2021; Stöckli et al., 2018b).

A very similar domain in which this was explored, however, is consumer food waste outside of the home. This has had mixed success. The use of a pro-environmental descriptive norm was successful in encouraging suboptimal food purchase in a grocery store (Do Carmo-Stangherlin et al., 2020) and in increasing the bringing home of leftovers by guests in dining facilities (Giaccherini et al., 2021). Meanwhile, using similar descriptive norm manipulations, Whitehair et al. (2013) and Stöckli et al. (2018a) were not successful in increasing the bringing home of leftovers compared to an informational prompt. Notably, extrapolations of these results to household FWRBs may be limited by differences between the wasting of food in the household and in the public sphere. For example, while normative beliefs may be more easily influenced for household behaviours, social pressure to conform may be higher for behaviours outside of the home (Do Carmo-Stangherlin et al., 2018; Templeton et al., 2016). Nevertheless, these mixed results inform interventions targeting household food waste and underpin the need to explore whether this could be applicable for the promotion of FWRBs in the household.

While there is an absence of a pro-environmental descriptive norm in past household food waste interventions, interestingly it appears that the opposite is frequently included in past interventions. Looking at materials used in previous informational interventions, the high levels of food wasted are often emphasised (e.g., Every year, millions of tons of edible food are thrown away"; Buttlar et al., 2021). This occurs in both academic studies (Buttlar et al., 2021; Collart & Interis, 2018) as well as real-world interventions (e.g., Foodwise, 2021; Stop Food Waste, 2021; WRAP, 2013) and indicates that many do not carry out FWRBs (i.e., anti-environmental descriptive norm). While some have had success using such an approach (Collart and Interis, 2018; WRAP, 2013), others have not (Buttlar et al., 2021). As these studies did not have an information only condition, it is hard to ascertain the effects of the inclusion of an anti-environmental descriptive norm in informational messages.

Although stating that many waste high levels of food may be factual and intended to aid the intervention by highlighting the severity of the issue (Cialdini, 2003), it may increase the saliency of the undesired behaviour (i.e., wasting food) and thus decrease chances of pro-environmental behaviour change (Goldstein & Mortensen, 2012; Nolan & Wallen, 2021; Wally & Cameron, 2017). In experimental studies, Cialdini et al. (2006), Mollen et al. (2013), Schultz et al. (2007), and Yeomans and Herberich (2014) provide evidence that when one perceives many others as engaging in the undesired behaviour, it may not be effective in eliciting the desired behaviour change and may even backfire, leading to higher levels of the anti-environmental behaviour. Therefore, messages with an anti-environmental descriptive norm are prevalent in household food waste campaigns and there is evidence to suggest that their inclusion may hamper the success of a message-based intervention. Thus, in addition to the need to explore the addition of a pro-environmental descriptive norm in an informational message, research is required to explore the inclusion of an anti-environmental descriptive norm in household food waste campaigns.

The Present Research

The present research aims to explore a pro- and anti-environmental descriptive norm manipulation as part of an informational, message-based intervention providing procedural and declarative information. Three conditions will be employed, namely a pro-environmental descriptive norm (pro-DN), anti-environmental descriptive norm (anti-DN) and information only condition as a control. Reflecting on previous research, normative information in the intervention will use a local reference group to increase personal relevance (i.e., others in participants' city; Agerström et al., 2016) and to increase credibility, will consist of true information with different frames (Nolan, 2021). Study 1 will aim to address two limitations of previous studies, namely the dependence on cross-sectional designs and lack of objective food waste measures (Elimelech et al., 2018). Instead this study will be longitudinal and, as well as using two commonly employed measures, self-reported food waste and frequency of FWRBs, the study will employ an objective food waste measure. In Dublin, Ireland the majority of households segregate organic waste via an organic waste bin which is collected every two weeks. Data on waste collections are easily accessible to consumers via an online portal from their private waste collection provider. Therefore, this study will aim to make use of this data. Study 2 aims to replicate Study 1.

H1. The pro-DN condition will be more effective in reducing household food waste (or a proxy measure) than the anti-DN, or control condition.

H2. The control condition will be more effective than the anti-DN condition in reducing household food waste (or a proxy measure).

Study 1

This online study aimed to explore the efficacy of an informational household food waste intervention targeting descriptive norms with an objective food waste measure and a longitudinal design. There were three surveys; pre-intervention (T1), two weeks post-intervention (T2) and four weeks post-intervention (T3). Our two hypotheses were tested on frequency of FWRBs (*H1a* and *H2a*), self-reported food waste (*H1b* and *H2b*) and weight of food waste (*H1c* and *H2c*).

Method

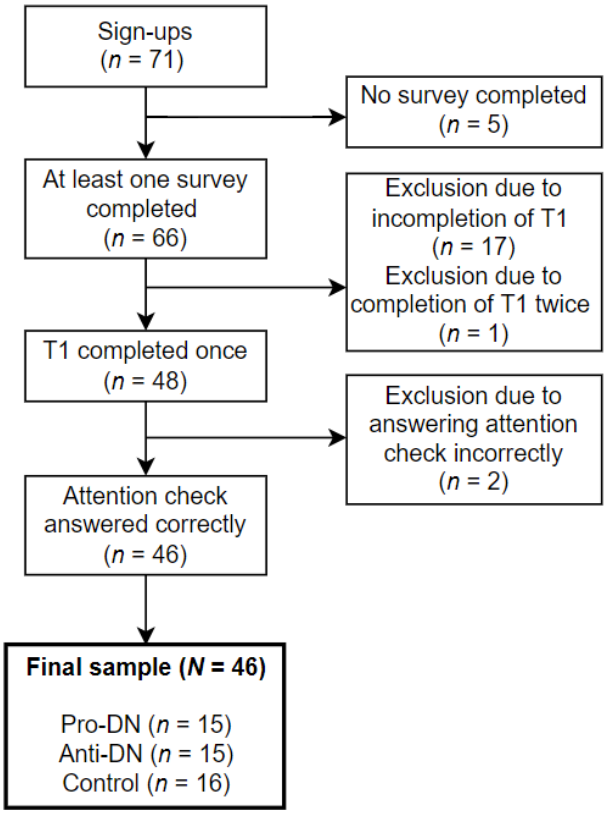
Participants and Design

Recruitment involved advertisement through mailing lists and social media platforms (Facebook, Twitter and Instagram) of Dublin City Council, councillors, community centres and residence associations across Dublin. Participants were required to be over 18 years old, live in Dublin and play some role in food shopping and preparation. Furthermore, only one person per household could take part. The study was a 3 (intervention: pro-DN, anti-DN, or control) × 3 (timepoint: T1, T2, and T3) mixed experimental design. The dependent variables were frequency of FWRBs, self-reported food waste and weight of food waste. A desired sample size of 98 participants was established with an a priori power analysis for a RM-MANOVA with 80% power, an alpha level of .05 and a medium effect size of .25.

Initially, 71 individuals signed up to the study. Inclusion criteria were completing T1 (i.e., must have been subject to an intervention) and correctly answering the attention check for the intervention (i.e., must have paid attention to the intervention). In total 20 participants were excluded (see Figure 1). Forty-six participants (38 female, 7 male, 1 *prefer not to say*) with an age range of 23-75 (M = 50.8; SD = 14.82) were included in the analyses. While 34 completed all surveys, seven completed T1 and T2 only, and four completed T1 only.

Figure 1

Flowchart of Participants



Procedure

The online study ran from August 3rd to September 3rd, 2021. During sign-up, participants were informed, consented to participation and provided their email addresses. Surveys were sent to participants via email. There were two weeks between each survey, reflecting the time gap for organic waste collections. Participants had three days to complete each survey and a reminder email was sent on the third day. At T1, to match responses over time, participants were asked to create a self-generated identification code which they would fill in for subsequent surveys. Then, questions regarding demographics (age, gender and household size) as well as measures for frequency of FWRBs, self-reported food waste and weight of food waste weight were presented. Finally, participants were randomly assigned to one of the three conditions featuring a written intervention and were asked to answer an attention check. Surveys at T2 and T3 only consisted of the three dependent measures.

Materials

FWRBs Measure. Taken from Schmidt (2016), this measure consisted of 14 items pertaining to different behaviours related to reducing food waste (e.g. “Do you immediately discard food that has passed its expiration date?”; see Appendix A). Answers were collected on five-point Likert scales (1 = *always*; 5 = *never*). Reverse-scored items were reverse coded and mean scores were computed (see Table 1 for descriptive statistics). Cronbach’s alpha values were .73 (T1), .69 (T2) and .73 (T3).

Table 1

Means and Standard Deviations for the Dependent Variables

Measure	T1	T2	T3
Food waste reducing behaviours	3.74 (.41)	3.8 (.36)	3.91 (.39)
Self-reported food waste (portions)	8.96 (8.25)	8.38 (9.28)	7 (8.01)
Weight of food waste (in kg)	9 (4.69)	25.46 (10.31)	8.42 (4.42)

Self-Reported Food Waste Measure. This measure was adapted from Visschers et al. (2016) and asked participants to indicate the number of food portions wasted in their household during the last two weeks for 11 food categories (e.g. bread, fruit and meat) on a scale of 0-20 (see Appendix B). A portion roughly corresponds to a handful and is widely used in the literature due to its relative ease in estimating (e.g., Ammann et al., 2021; Djekic et al., 2019; Flanagan et al., 2021). Total sum scores were computed.

Weight of Food Waste. This measure consisted of the weight of participants' household organic waste (in kg). To obtain this, participants were asked to log on to their account of their waste collection provider. Links and tailored instructions were provided.

Since some households also discard garden waste via the organic waste bin, participants were asked to estimate the percentage of garden waste in their last organic bin. This was subtracted from the weight of organic waste provided. For example, if a participant reported 10kg organic waste and 10% garden waste, a corrected weight of 9kg was used in the analysis.

Also, participants were asked for the date of their last and second last waste collection. Based on this, provided weights were excluded if they did not pertain to the time period of interest, or corresponded to over two weeks worth of waste. Furthermore, participants were asked for the proportion of food waste they dispose of via the organic bin as opposed to other waste streams (e.g., general waste). Scores on this item were compared to rule out the possibility of the intervention having resulted in higher levels of waste segregation. Finally, participants who did not answer this section were asked to provide a reason for this. See Appendix C for all questions related to this section of the survey.

Interventions. The control condition presented negative consequences of food waste, a definition of avoidable food waste and food waste reducing tips. Additionally, the pro- and anti-environmental descriptive norms conditions featured findings on FWRBs from a study by the Irish Environmental Protection Agency (EPA, 2020). These findings were framed differently in order to influence participants' perceptions of others' FWRBs. The pro-DN condition stated that many people engage in FWRBs in Dublin, while the anti-DN condition stated that many in Dublin do not engage in these behaviours (e.g., 70% write a shopping list VS. 30% do not). In addition to the text, images were added to increase attention span and to reinforce conditions as these may also act as normative cues (Feinberg et al., 2014). Participants were asked to share and discuss the information with members of their household. To ensure participants had read the text sufficiently, an attention check was added (see Appendix D for the full interventions).

Results

Missing Data

Analysis of the patterns of missingness showed nearly half of all variables had missing data. Most participants (83%) had at least one missing datapoint, while 20% of all possible datapoints were missing. There were two main sources of missingness. Firstly, some participants did not complete the survey at each timepoint (i.e., unit non-response; 29% of participants). Secondly, many did not provide their household's food waste weight (i.e., item non-response; 69% of participants at T1, 78% at T2, and 80% at T3). This was due to a variety of reasons (e.g., not having an organic waste bin, being on holiday). Missingness was not assumed to be missing completely at random (MCAR).

Initially, a RM-MANOVA was planned to analyse the dataset. However, due to the missing data this would have resulted in a considerably smaller sample size due to listwise deletion, and may therefore have introduced bias. Instead, multilevel modeling was chosen since despite missing data all observations could be included, thus increasing sample size and decreasing chance of bias. Although multilevel models may include multiple dependent variables, this was considered out of scope for the current study due to its complexity. Therefore, multilevel models for FWRB frequency and self-reported food waste were carried out, while a non-parametric analysis was carried out for weight of food waste due to a non-normal distribution and a small sample size. For the three univariate analyses, Bonferroni-corrected alpha levels of .016 were used to adjust for Type I error inflation.

Effect of Interventions on Food Waste Reducing Behaviours

Normality was assumed through visual inspection of the distribution of residuals, box plots and significance tests. A multilevel model was used to test our hypotheses that the pro-DN condition will be more effective than the control and anti-DN condition (*H1a*), and that the control will be more effective than the anti-DN condition (*H2a*) in increasing

FWRBs. For the model, observations on the frequency of FWRBs measure (level 1) were nested within individuals (level 2). The maximum likelihood (ML) method was used to estimate parameter values. A random intercepts model was created. Main effects of time (modelled as a linear function) and condition (modelled using effects coding, with the control as the reference group), as well as their interactions were added. An Akaike information criterion (AIC) of 57.68 was observed. Next, a random slope for time was added to allow subject-specific slopes to vary and variance components was chosen as the covariance matrix. This yielded a lower AIC of 51.08, indicating better model fit.

Regarding random effects, significant variance in intercepts across participants, $\text{var}(u0_j) = .12$, $\chi^2\ (1) = 4.22$, $p < .001$, and slopes, $\text{var}(u1_j) = .01$, $\chi^2\ (1) = 2.54$, $p = .01$, was observed. The full model revealed no time $\times$ pro-DN interaction effect, $F(1, 43.31) = .01$, $p = .93$, or time $\times$ anti-DN interaction effect, $F(1, 43.31) = 3.09$, $p = .09$. There was also no main effect of intervention on FWRBs for the pro-DN condition, $F(1, 47.67) = 4.07$, $p = .05$, or the anti-DN condition, $F(1, 47.67) = .6$, $p = .44$. However, a main effect of time was observed, $F(1, 43.3) = 11.34$, $p = .002$. Therefore, interventions did not differ in their effectiveness of increasing FWRBs as expected, thus *H1a* and *H1b* were not supported. Despite this, overall FWRBs increased over time. Due to the complexity and debate surrounding effect size calculations in multilevel models (Rights & Cole, 2018), parameter estimates are instead provided in Table 2 as recommended by Field (2009).

Effect of Interventions on Self-Reported Food Waste

Violations to normality were observed for self-reported food waste; histograms were generally right-skewed, Kolmogorov-Smirnov tests were nearly all significant, and kurtosis and skewness often fell out of the acceptable ranges of -1 to 1, and -3 to 3 respectively. Data were transformed using a root squared transformation in order to tend to true zero scores on the measure. To test our hypotheses on self-reported food waste (*H1b*) and (*H2b*), a similar

multilevel model was set up (i.e., random intercept model with time, intervention and their interaction; AIC = 357.14). Adding a slope did not increase model fit (AIC = 357.64). However, based on similar studies (e.g., Stancu et al., 2015; Visschers et al., 2016) household size was entered as a covariate and this improved model fit, with an AIC of 353.06.

Table 2

Parameter Estimates of the Multilevel Models Food Waste Reducing Behaviours (FWRBs) and Self-Reported Food Waste (SRFW)

Effect	FWRBs			SRFW		
	Estimate	Std Error	*t*	Estimate	Std Error	*t*
Intercept	3.73	.05	68.02***	.85	.74	1.14
Pro-DN VS Control (reference)	.06	.08	.77	.28	.25	1.12
Anti-DN VS Control (reference)	-.16	.08	-2.02	-.23	.25	-.9
Time	.08	.02	3.37*	-.21	.08	-2.83*
Time X Pro-DN	-.003	.04	-.09	.19	.11	1.72
Time X Anti-DN	.06	.04	1.76	.07	.11	.62

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

There was substantial between-subject variance at baseline, var($u0_j$) = 1.04, χ^2 (1) = 4.01, $p < .001$. The results for fixed effects showed no time ✕ pro-DN interaction effect, $F(1, 77.28) = 2.94$, $p = .09$, or time ✕ anti-DN interaction effect, $F(1, 77.26) = .39$, $p = .54$. Main effects for both the pro-DN condition, $F(1, 60.4) = 1.25$, $p = .09$, and the anti-DN condition, $F(1, 60.3) = .81$, $p = .37$, were not significant. There was a significant time effect, $F(1, 76.96) = 8.01$, $p = .01$. Therefore, both *H1b* and *H2b* were not supported since conditions did not

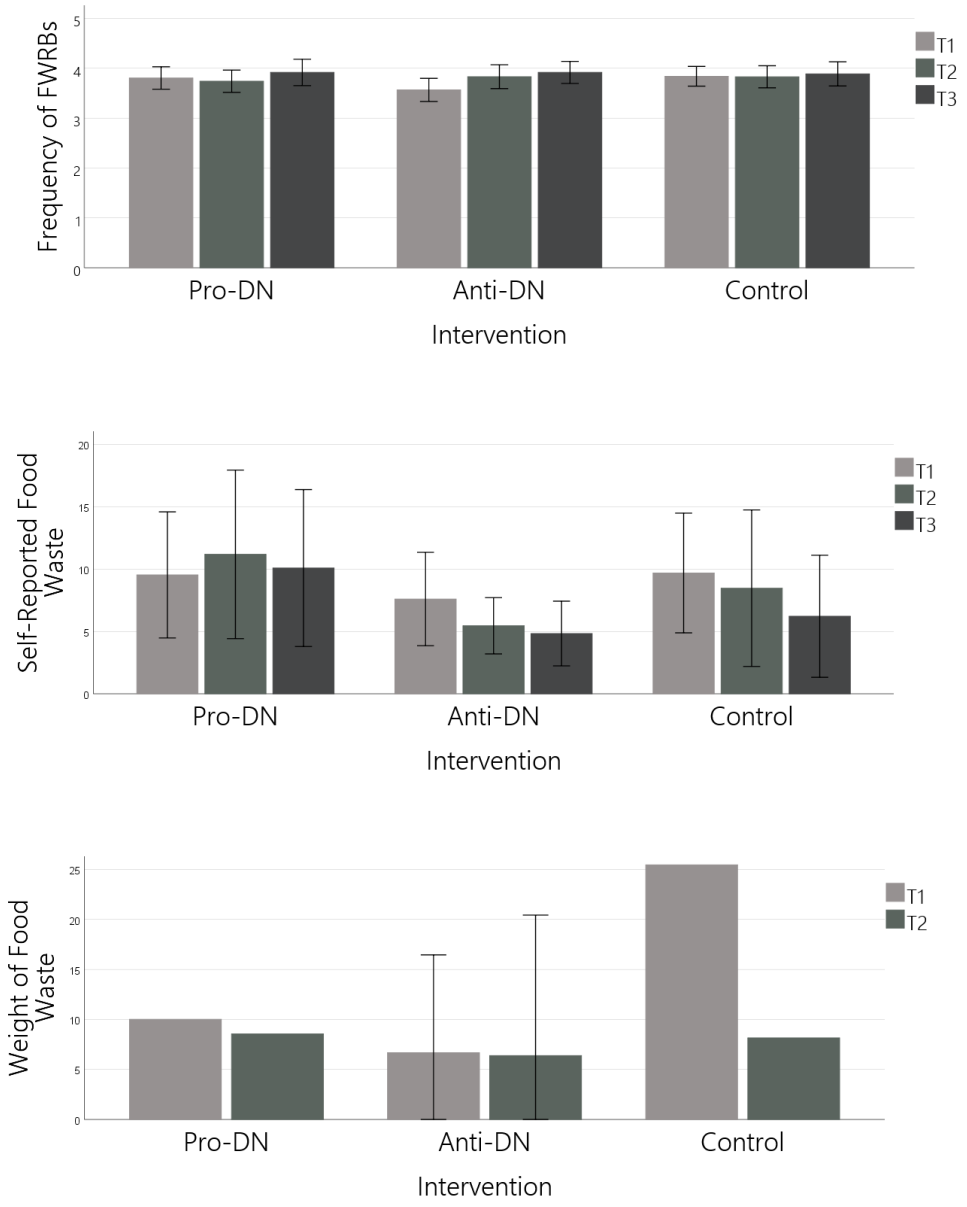
differ in their effectiveness to reduce self-reported food waste. However, irrespective of the conditions participants were assigned to, a significant decrease in self-reported food waste was observed over time.

Effect of Interventions on Weight of Food Waste

Of the 35 provided organic waste weights, 20 were not included in the analysis due to exclusion criteria for the measure. Due to incomplete data across time, the best solution was to compare T1 and T2 for five participants (n = 1, 3 and 1 for the pro-DN, anti-DN and control condition, respectively; see Appendix E for flowchart of missing and excluded data on this measure). On average across conditions, household food waste decreased by 3.93 kg from T1 to T2. To test our hypotheses on objective food waste (*H1c*) and (*H2c*), a Kruskal Wallis one-way analysis of variance was carried out on difference scores (i.e., organic food waste scores at T2 minus scores at T1). This revealed no significant difference in food waste between the control (mean rank = 1), pro-DN (mean rank = 3) and anti-DN conditions (mean rank = 3.67), $H(2) = 2.13$, $p = 0.7$, $\eta^2_H = .07$ (using the effect size formula in Tomczak & Tomczak, 2014). In other words, changes in food waste weight did not depend on the intervention participants were assigned to and thus, *H1c* and *H2c* were rejected. Also, changes in levels of food waste segregation could be ruled out using the same analysis, which showed no significant difference, $H(2) = .00$, $p = 1$, $\eta^2_H = .00$. See Figure 2 for means and confidence intervals across conditions and time points for each dependent variable.

Figure 2

Means of the Dependent Variables with 95% Confidence Intervals



Note. Means, or confidence intervals are not provided for the pro-environmental descriptive norms and the control condition on the weight of food waste measure, since there was only one participant in these conditions. Therefore, participants' raw scores are provided.

Study 2

The aim of Study 2 was to replicate Study 1 in order to address its limitations that stemmed from the small sample size. To do this, an online study was carried out in Groningen, the Netherlands.

Method

Participants and Design

Participants were recruited through SONA, an online platform for Psychology students at Rijksuniversiteit Groningen, through which course credits are given in return for study participation. To be eligible for the study, participants were required to be over 18 years old, and play some role in food shopping and preparation. The study was a between-subjects design where participants were randomly assigned to the pro-DN, anti-DN, or control condition. The dependent variable was intentions to engage in FWRBs. An a priori power analysis revealed a minimum sample size of 159 participants was required for a one-way ANOVA with 80% power, an alpha level of .05 and a medium effect size of .25. In total, 224 individuals participated in the study. Two cases were deleted due to providing no scores on the dependent measure and seven were excluded for failing the attention check. Therefore, 215 participants were included in the analysis whos ages ranged from 18-33 (M = 19.94; SD = 2.25) with 158 identifying as female, 54 as male and three as non-binary. Seventy-one were assigned to the pro-DN, 72 to the anti-DN norms, and 72 to the control condition.

Procedure

After being informed and consenting to study participation, participants were asked to provide demographic information (age and gender) and read the text of the condition they had been randomly assigned to. An attention check followed. Subsequently, intentions to engage in FWRBs were measured.

Materials

Intentions to Engage in FWRBs. The measure used in Study 1 by Schmidt (2016) was adapted to capture behavioural intentions (see Appendix F). Changes to item wording were kept to a minimum (e.g., "Do you immediately discard food…?" was changed to "Will you immediately discard food…?"). Although response options were also altered, it remained a five-point scale (1 = *very likely*; 5 = *very unlikely*). Reverse-scored items were recoded and mean scores were computed (M = 2.46; SD = .46). Since considerable changes were made, a pilot study with 37 participants (age range = 20-71; M = 29.78; SD = 13.29; 65% female) was carried out to assess reliability of the measure prior to carrying out Study 2. This revealed a Cronbach's alpha of .82. However, the Cronbach's alpha for Study 2 was lower at .68. The majority of the items were positively correlated, while some showed a negative association, the lowest being -.21. Since only negligible differences in alpha levels were observed if items were deleted, all were deemed worthy of retention.

Intervention. Interventions featured in this study were identical to Study 1, except that the statistics from the EPA (2020) communicating descriptive norms were stated to have been based on inhabitants in Groningen, as opposed to Dublin. Although the EPA's study had been carried out in Ireland, and not in the Netherlands, limiting changes to the intervention by keeping the statistics constant was argued to increase comparability between the studies.

Results

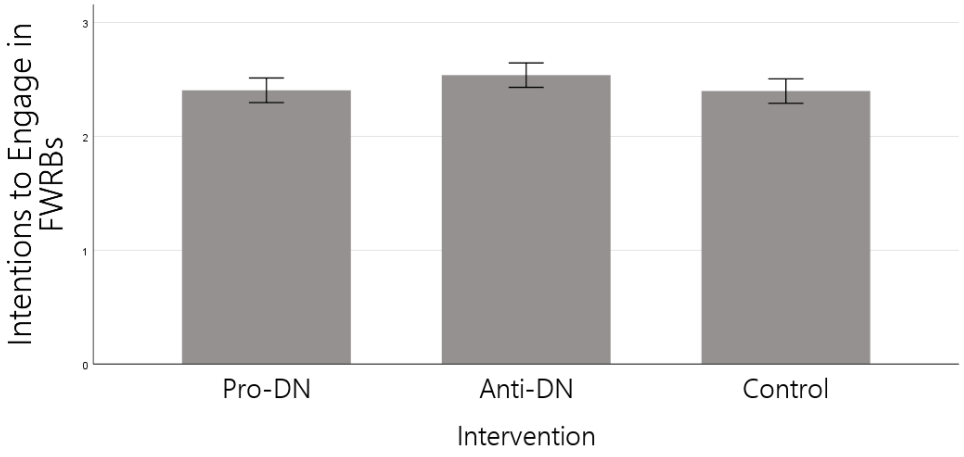
A one-way between-subjects ANOVA was used to explore whether intentions to engage in FWRBs differed between the pro-DN (M = 2.4; SD = .48), anti-DN (M = 2.54; SD = .43) and control conditions (M = 2.4; SD = .47; see Figure 3). Normality was assumed since scores on the dependent measure were approximately normally distributed within the groups with no influential outliers, values for skewness and kurtosis all fell within an acceptable range, and a Kolmogorov-Smirnov test revealed a non-significant result. Additionally, the

assumption of homogeneity of variances was not rejected by inspecting the standard deviations for each group, and a Levene's test for equality of variances.

A one-way ANOVA revealed no significant difference in scores on the FWRB scale between the three conditions, $F(2, 212) = 2.1$, $p = .13$, $\eta_p^2 = .019$. In other words, our hypotheses that participants in the pro-DN condition would score higher on intentions to engage in FWRBs than participants in the control group and anti-DN condition (*H1*), and that participants in the control condition would score higher than those in the anti-DNs condition (*H2*) were rejected.

Figure 3

Mean Scores on Intentions to Engage in Food Waste Reducing Behaviour per Intervention, including 95% Confidence Interval



Discussion

Household food waste must be cut down to reduce emissions related to food disposal and conserve the earth's valuable resources. To encourage the necessary behaviour change, calls have been made to build on existing informational interventions that solely target awareness (Van Geffen et al., 2020) and to explore the role of descriptive norms in household food waste interventions (Attiq et al., 2021; Barker et al., 2021; Stöckli et al., 2018b). Highlighting that many engage in FWRBs (i.e., pro-environmental descriptive norm) may add to an informational message (Bergquist et al., 2019). However, it seems that no previous study has explored this in the domain of household food waste. Instead, campaigns have often indicated that many waste high levels of food (i.e., anti-environmental descriptive norm; Buttlar et al.,, 2021; Collart & Interis, 2018; WRAP, 2013). Such an approach may hinder desired behaviour change (Wally & Cameron, 2017). Using an experimental design, the present research aimed to investigate how either a pro-, or anti-environmental descriptive norm in addition to a standard, informational approach involving procedural and declarative information provision influences FWRBs.

Study 1 aimed to explore this research question while also addressing two limitations in the literature by employing a longitudinal design and an objective food waste measure. This study found no significant differences across the three timepoints between the pro-environmental descriptive norms, anti-environmental descriptive norms and control condition on scores on the dependent variables frequency of FWRBs, self-reported food waste and weight of food waste. There was, however, a main effect of time for frequency of FWRBs and self-reported food waste. In other words, irrespective of the condition participants were assigned to, higher levels of FWRBs and a decrease in self-reported food waste were observed across timepoints. Study 2, which aimed to replicate Study 1 with a larger sample size from a different population, revealed no significant differences between

the conditions on intentions to engage in FWRBs. Thus, our first hypothesis that the pro-environmental descriptive norm condition would be more effective than both the anti-environmental descriptive norms and the control condition was not supported. Similarly, there was no support for our second hypothesis that the control condition would be more effective than the anti-environmental descriptive norms condition. Taking these findings together, while the interventions as a whole may have been effective at reducing food waste (Study 1), they did not differ in their effectiveness (Study 1 and 2).

These unexpected results are reflected in the inconsistent literature for other pro-environmental behaviours. Some have found that the addition of a pro-environmental descriptive norm did not increase the efficacy of a standard informational approach (e.g., Bohner & Schlüter, 2014; Carrico & Riemer, 2011; Trujillo et al., 2021). This was also the case for both Whitehair et al. (2013) and Stöckli et al. (2018a) in the attempt to reduce consumer food waste at dining facilities. Furthermore, our findings are in line with studies that found an informational message with the inclusion of an anti-environmental descriptive norm no more effective than information provision in and of itself (e.g., Gerber et al., 2018; Panagopoulos et al., 2014). However, the present findings are not consistent with many experimental studies supporting the superiority of pro-environmental descriptive norm-based interventions for a range of pro-environmental behaviours (e.g., Goldstein et al., 2008; Kormos et al., 2015; Nolan et al., 2008; Reese et al., 2014; Terrier & Marfaing, 2015) and supporting the inferiority of anti-environmental descriptive norms (e.g., Cialdini et al., 2006; Schultz et al., 2007; Yeomans & Herberich, 2014). This is also the case for studies targeting similar behaviours related to household food waste like consumer food waste in dining facilities (Giaccherini et al., 2021) and grocery stores (Do Carmo-Stangherlin et al., 2020).

Despite seemingly conflicting findings between the results of the current research and the many other studies influencing behaviour with normative manipulations, these inconsistencies may be reconciled. Firstly, although highlighting a pro-environmental descriptive norm to encourage behaviour change has been commonly and successfully employed (De Groot et al., 2021), such an approach may not be equally effective in all behavioural domains (Dempsey et al., 2018). A particular behavioural characteristic that may undermine the extent to which normative perceptions concerning FWRBs can be manipulated is their low visibility. While many have been successful using normative information for other low visibility behaviours such as waste separation and electricity reduction (Niemiec et al., 2020), there is evidence to suggest that such information may be more effective for high visibility behaviours due to increased social pressure to conform to the norm (Carattini et al., 2019; Do Carmo-Stangherlin et al., 2018). This argument is congruent with studies that have been successful with a pro-environmental descriptive norm for consumer food waste outside the home (Do Carmo-Stangherlin et al., 2020; Giaccherini et al., 2021). Therefore, in the present research the normative information presented to participants may have failed to influence participants' behaviours due to the lack of pressure to conform.

Alternatively, since many studies support the use of a descriptive norm-based intervention (Shulman et al., 2017), it could be the case that particular characteristics of the message in the present research hindered its effectiveness. The reference group chosen, fellow citizens in one's city, may have been too distal. Although the use of similar reference groups appear to be commonly used in the literature (Rhodes et al., 2020), interventions using more proximal referents (e.g., colleagues, neighbours) may be more successful in eliciting pro-environmental behaviour change (Agerström et al., 2016; Farrow et al., 2017; Goldstein et al., 2008). Specifically, social influence may be higher for a proximal reference group due to increased chance that the group is relevant to one's identity (Lapinski & Rimal, 2005). It

therefore seems that there may be a trade-off between choosing a reference group and the number of individuals the descriptive norm intervention can be administered to. Nevertheless, the normative information in the present research may have failed to influence FWRBs due to the use of a distal reference group and the use of a more proximal reference group may have yielded results in line with our hypotheses.

Limitations

Further insight into the present research may be gained by considering its limitations. One limitation was the absence of a no-intervention condition. The increase in FWRBs and decrease in self-reported food waste observed in Study 1 is congruent with studies supporting the use of procedural and declarative information provision in reducing household food waste (e.g., Romani et al., 2018; Young et al., 2017). However, these trends cannot be confidently attributed to information provision in this study, since information was present in all conditions. These trends may instead be due to factors unrelated to the intervention such as study participation (e.g., high environmental concern among participants), or time-related factors (e.g., increased FWRBs during the time of the study, when many go back to school, or work). Despite this, since information is often included in standard food waste campaigns (Van Geffen et al., 2020) and some level of information appears to be needed in adopting FWRBs (Maciejewski, 2020), such a condition was beyond the scope of this research.

Another limitation of this research was that data was not collected on the underlying psychological processes perhaps involved in such a food waste intervention, like changes to personal norms and perceived social pressure to conform (Schanes et al., 2018). Although no differences between conditions were observed, inclusion of such variables may have led to interesting insights which could inform future food waste interventions. Therefore, this research does not contribute to knowledge in this area. Nevertheless, since a major concern for the current research was participant retention, additional variables were not included.

Additionally, the reliability of the data in the present study was impacted by the measures used. The difficulty of measuring food waste has been frequently discussed in the literature and debates regarding best practice continue (e.g., Bellemare et al., 2017; Elimelech et al., 2018; Xue et al., 2017). Specifically, in Study 1 collecting objective food waste data was hindered by factors such as participants lacking knowledge on how to access organic waste data and not putting their waste out for collection regularly. This regrettably led to a small dataset for this measure and a lack of statistical power. Since limited information was available on organic waste collections, these issues could not be entirely anticipated. Also, the FWRB measures in Study 1 and 2 had a relatively low Cronbach's alpha and some negative inter-item correlations, suggesting that items were not tapping into an underlying construct. Despite this, since there is no validated measure for FWRBs and instead the use of two- or three-item measures is predominant (e.g., Graham-Rowe et al., 2015; Russell et al., 2017), the current research contributed to the knowledge on development of such a measure.

Strengths and Implications

The present research is one of few studies testing a household food waste intervention with an experimental design. This is a strength for two main reasons. Firstly, research aimed at addressing the issue of household food waste thus far has mainly focused on the composting of food waste (Attiq et al., 2021; Neff et al., 2015). Although food waste segregation is integral in reducing emissions from food that has been discarded, food waste prevention must be prioritised due to its greater potential to address the environmental impacts as a whole (Slorach et al., 2019; Tonini et al., 2018). Future interventions should focus on the promotion of food waste reduction as this yields more environmental benefits.

Secondly, the exploration of a household food waste intervention represents a further strength given that most other studies on household food waste prevention have been correlational, or qualitative (e.g., Principato et al., 2015; Schanes et al., 2018; Visschers et al.,

2016). Although such research is valuable and necessary in identifying and understanding psychological variables associated with FWRBs, attempts must be made to create campaigns and interventions for the promotion of FWRBs. In taking this approach, the present research contributes to the development of future interventions both in the real world and in academia. Specifically, the findings of this study indicate that future message-based interventions aiming to reduce household food waste may not need to pay attention to highlighting the prevalence of behaviours related to food waste. The addition of a pro-environmental descriptive norm may not increase the efficacy of an informational approach, while an anti-environmental descriptive norm may not have an adverse effect on food waste levels. However, further research on normative food waste interventions is required to replicate this study and to explore the use of other normative interventions such as individualised feedback.

A further strength of the present study was addressing two limitations of previous research. Thus far, research on household food waste has mostly been cross-sectional. Instead, this research used a longitudinal design to explore a food waste intervention over time which adds to its implications in the field. Furthermore, this research employed an objective food waste measure. Previous research on household food waste has predominantly used self-reported measures (Elimelech et al., 2018). However, they may be affected by memory deficits, particularly when asked to estimate waste for other household members, and can be susceptible to cognitive biases such as social desirability (Ammann et al., 2020). These measures may correlate with actual food waste levels, though this relationship may be weak (Giordano et al., 2018). While the benefits of using an objective measure were not fully apparent in this research and our study shows that many issues can arise in collecting such data, future studies would benefit from the use of similar food waste measures.

Conclusion

Efforts must be made to create effective, evidence-based interventions to prevent household food waste. The present research aimed to do so by building on past informational approaches that have solely targeted food waste awareness. Across two studies, the addition of two descriptive norm manipulations to an informational approach were compared with an information only message. While a pro-environmental descriptive norm was expected to increase the efficacy of an informational message, an anti-environmental descriptive norm was expected to be less effective than information only. Although there was an increase in FWRBs and a decrease in self-reported food waste in Study 1, findings across both studies revealed unexpected results regarding our hypotheses. Namely, our research provides evidence that a pro-environmental descriptive norm may not increase the efficacy of a message-based household food waste intervention. Additionally, on a more positive note, the findings suggest that an anti-environmental descriptive norm may not hinder such campaigns. Future studies ought to explore the use of other forms of descriptive norm manipulations to support these results and the targeting of other psychological constructs that can be influenced as part of a message-based approach. More broadly, it is clear that there is a need for the development of household food waste interventions of all types. Only in doing so can steps be made towards achieving the global goal of a household food waste reduction.

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Appendix A

Frequency of Food Waste Reducing Behaviours Measure

Please answer the following questions, reflecting on the behaviour of your household during the past two weeks.

- Before grocery shopping, do you think carefully about the food you currently need?
- Do you have a good overview of the food stocks in your household (that is, you know what is already there and how long this food is edible)?
- When you go grocery shopping, do you spontaneously buy more than you actually need?
- When you go grocery shopping: Do you spontaneously buy more than you actually need due to...
    - Not enough planning before grocery shopping?
    - Special offers/discounts (e.g., buy 1, get 1 free)?
    - Promotion directly on site (e.g., food tasting)?
    - No available smaller quantities?
- Do you prepare too much food for your meals (so that there are leftovers)?
- If you prepare too much food, do you process and/or consume leftovers from your meals at a later stage?
- If you prepare too much food, do you finally discard leftovers of your meals?
- How often does food spoil, or pass its expiration date in your household?
- Do you immediately discard food that has passed its expiration date?
- Do you discard (still) edible food, which you can't, or don't want to consume?
- Do you use specific measures to extend the durability of your food (e.g., covering or air-tight packaging of leftovers)?

Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never ☐

Appendix B

Self-Reported Food Waste Measure

Now, we would like to know roughly how many portions of avoidable food waste your household has produced in the last two weeks.

Avoidable food waste: This refers to all food which was edible at some point before its disposal (i.e., not fruit pits, or bones etc.) Therefore, it includes food that passed its expiration date, spoiled or mouldy food, leftovers, and excess food, regardless of how they were discarded (e.g., black bin, home composted).

Portion: One portion is roughly equal to one handful of food. For example, a portion of food is around one handful of berries, one slice of bread, one apple, and one small chicken breast.

In the last two weeks, roughly how many portions (i.e., handfuls) of avoidable food waste has your household produced from each of the following food categories (answer options 0-20)?

- Fruits and berries (fresh, frozen, from a jar/can)
- Vegetables (fresh, frozen, from a jar/can)
- Potatoes or potato products (e.g., chips, mashed potatoes)
- Pasta, rice or beans
- Meat
- Fish
- Milk and milk products (e.g., yogurt, cheese, dairy alternatives)
- Bread
- Sweet and savoury bakery products (e.g., cake, quiche, pizza)
- Fresh ready meals (e.g., sandwich, lasagne, soup)
- Processed vegetable or fruit products (e.g., pasta sauce, pesto, jam)

Appendix C

Weight of Food Waste Section

- Does your household have a brown bin[1] from a waste collection provider (e.g., Greyhound etc.)? Yes ☐ No ☐
- Who is your waste collection provider? Greyhound ☐ Thorntons ☐ Panda ☐ Greenstar ☐ Oxigen ☐ Other ☐
- On your Greyhound[2] account you can view your waste collection history including the type of bin which was collected, date of collection and weight of each bin lift. We would like to know the weight and date of your last two brown bin collections.

  1. Please log on to this account using either the Greyhound online portal, or the Greyhound app with your apple or android device.[3]

  2. Click collections and then collection history. Look at the last two brown bin collections. Please report these below.

  Date and weight of last brown bin collection: ___ ___

  Date of second last brown bin collection: ___

  If you cannot do this right now, or if your household was away for the majority of the last two weeks, please scroll down to the last question.
- Estimate what proportion of the last brown bin content was garden waste. ___
- Estimate what proportion of your household's food waste gets discarded in the brown bin (as opposed to the black, or green bin etc.). ___
- If you have not filled in the information above, please indicate the reason for this. Don't have time ☐ Can't find the relevant information on my account ☐ Can't get into my account ☐ My household was away for the majority of the last two weeks ☐

[1] *Brown bin* is the name given to the organic waste bin in Ireland.
[2] Instructions specific to the participant's waste collection provider were given e.g., Greyhound.
[3] Hyperlinks were included.

Appendix D

Food Waste Interventions

Control Condition

Food waste has negative **environmental, social and economic consequences**. These consequences include the wasting of valuable resources used during food production, transportation and packaging, the threat to global food security and unnecessary household spending.

Reducing your food waste means thinking about **avoidable food waste**. This refers to food which was edible at some point before it was thrown away (think discarded leftovers and bread that's gone mouldy).

Top food waste tips:

1. Plan your way out of waste

Check what you have at home before going to the shop, plan your meals and make a shopping list.

2. Make food last

Store items in the way they are intended to be stored, make sure older foods are used before newly purchased goods (i.e. the First-In, First-Out principle), and use the freezer for foods which won't be eaten in time.

3. Prepare with care

Use up what you have, incorporate root-to-shoot, nose-to-tail cooking by using all of the edible parts of your food (e.g. vegetable stems, fruit peels, offal) and get creative with your leftovers!

4. Think before you bin

Use your senses in order to make a judgement on whether food is still edible, despite its use-by, or best-before date.
If it's still edible: Can you freeze it to eat another time? Could you incorporate it in a recipe? Could another household member, family, or friend make use of it?
If it's too late: Is there a way this can be prevented next time?

These tips can be shared with your household members. Not all have to be adopted at once. Instead, choose tips that you feel are most likely to stick and build on them.

Over the next month, try to reduce your avoidable household food waste by however much you can!

Pro-Environmental Descriptive Norms Condition

- In addition, the normative information which was presented was the following;

  However, many households in Dublin are reducing their food waste and engage in habits and practices that ensure food waste is prevented. For example, a recent study by the Irish Environmental Protection Agency shows that 70% of people write a shopping list and 81% check their fridge before shopping. These practices lower the chances of impulsive and unnecessary food purchases, which in turn lower the amount of food thrown away. Therefore, it appears that many people implement food waste reducing behaviours and have changed their shopping, planning, storage and cooking habits.

- An additional picture depicting a FWRB, namely saving leftovers, was provided;

- Finally, this condition featured an alternative ending to the control condition;

  Over the next month, join households across Dublin and try to reduce your avoidable household food waste by however much you can!

Anti-Environmental Descriptive Norms Condition

- In addition, the normative information which was presented was the following;

  However, many households in Dublin are wasting food and do not engage in habits and practices that ensure food waste is prevented. For example, a recent study by the Irish Environmental Protection Agency shows that 30% of people do not write a shopping list and 19% do not check their fridge before shopping. These practices higher the chances of impulsive and unnecessary food purchases, which in turn higher the amount of food thrown away. Therefore, it appears that many people do not implement food waste reducing behaviours and have not changed their shopping, planning, storage and cooking habits.

- An additional picture depicting a food wasting behaviour, namely discarding leftovers, was provided;

- Finally, this condition featured an alternative ending to the control condition;

  Over the next month, be a pioneer and try to reduce your avoidable household food waste by however much you can!

Attention Checks

Control

What is an example of a food waste reducing behaviour?

Checking your food stock before grocery shopping ☐

Grocery shopping without a shopping list ☐

Throwing away vegetable stems ☐

Pro-Environmental Descriptive Norms

What percentage of people write shopping lists before doing grocery shopping?

30% ☐ 50% ☐ 70% ☐

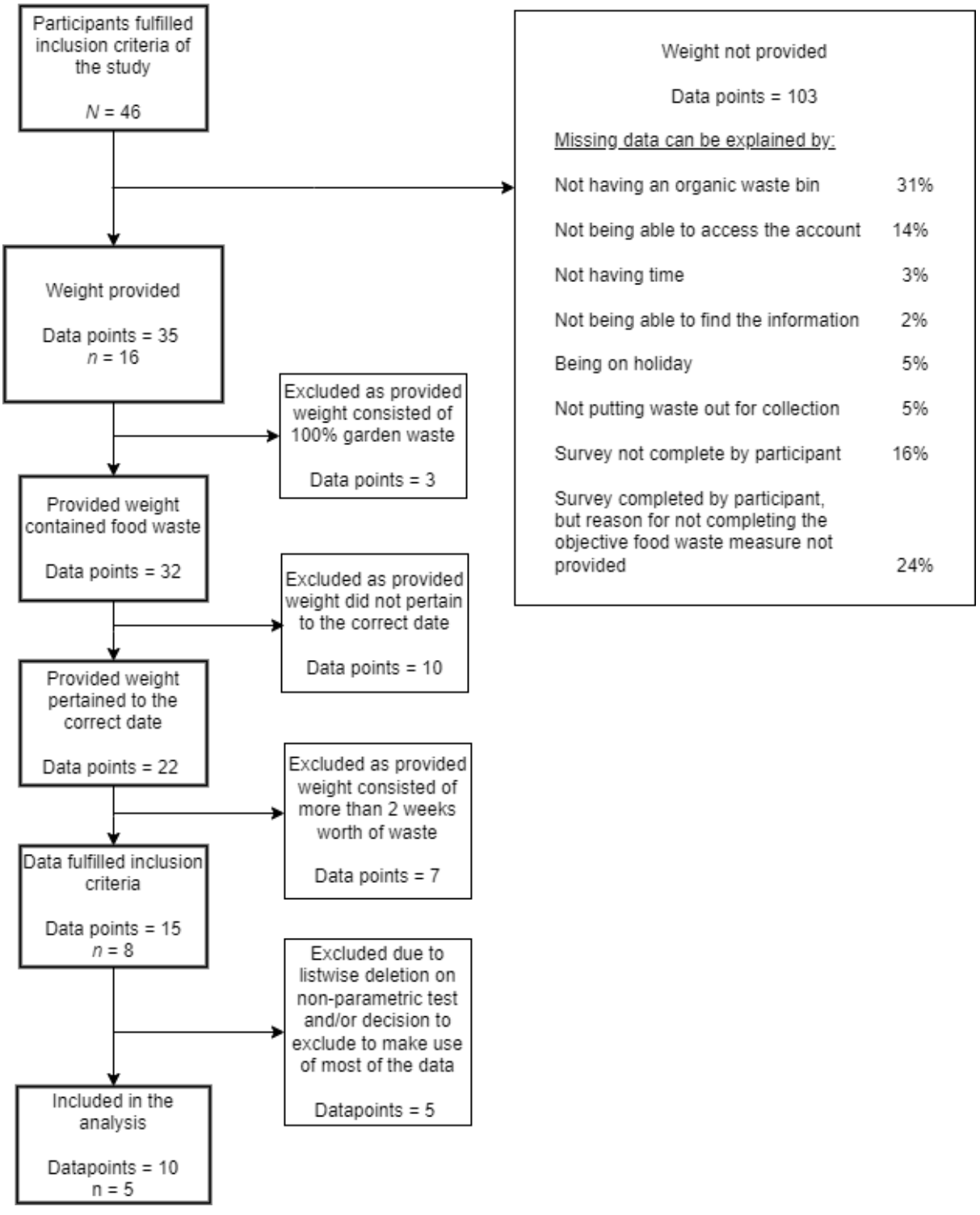
Anti-Environmental Descriptive Norms

What percentage of people do not write shopping lists before grocery shopping?

10% ☐ 20% ☐ 30%

Appendix E

Flowchart for Missing Data and Excluded Data Points on Objective Food Waste Measure



Appendix F

Intentions to Engage in Food Waste Reducing Behaviours Measure

Please indicate how likely you are to carry out the following behaviours over the next two weeks.

- Will you think carefully about the food you really need before grocery shopping?
- Will you have a good overview of the food stocks in your household (that is, knowing what is already there and how long this food is edible)?
- Will you spontaneously buy more than is actually needed when going grocery shopping?
- Will you spontaneously buy more than you actually need when going grocery shopping due to..
    - Not enough planning before grocery shopping?
    - Special offers/discounts (e.g., buy 1, get 1 free)?
    - Promotion directly on site (e.g., food tasting)?
    - No available smaller quantities?
- Will you prepare too much food for your meals (so that there are leftovers)?
- Will you process and/or consume leftovers from your meals at a later stage, if you prepare too much food?
- Will you discard leftovers from your meals, if you prepare too much food?
- Will you allow food to spoil, or pass its expiration date in your household?
- Will you immediately discard food that has passed its expiration date?
- Will you discard (still) edible food, which you can't, or don't want to consume?
- Will you use specific measures to extend the durability of your food (e.g., covering or air-tight packaging of leftovers)?

Very Likely ☐ Likely ☐ Neither Likely, or Unlikely ☐ Unlikely ☐ Very Unlikely ☐