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Food waste: Disapproving, but still doing. An evidence-based intervention to reduce waste at  
household

1

## Abstract

2 This action-research project conducted in partnership with French local public authorities aims at  
3 designing an intervention procedure to reduce food waste in households. To broach the complex  
4 problem of food waste reduction as a behavioral gap, we compared three interventions: a  
5 classical information-based intervention, an awareness-based intervention using a kitchen diary  
6 to make people aware of their own waste, and a dissonance-based intervention using principles  
7 of cognitive dissonance. Behavioral changes were estimated by weighing food waste and  
8 analyzing them (compositional analyses) one week before and after the interventions, and also  
9 five weeks later in order to comprehend middle-term effects. Results showed that dissonance-  
10 based intervention was the most efficient in actually reducing food waste, but only within a  
11 middle-term perspective. This delay could be necessary given the behavioral complexity of the  
12 global act of “reducing food waste”, known as the result of multiple and interacting activities  
13 taking place at different times and in different contexts.

14           *Key words:* food waste prevention, characterization, cognitive dissonance, induced  
15 hypocrisy, awareness, behavioral change, action-research.

16

17

## 1. Introduction

18       The reduction of food waste became a political issue when the European Parliament  
19   adopted a motion aiming at a 50 % reduction of food waste by 2025 in January 2012. More  
20   recently, the Sustainable Development Goals of the United Nations (SDG) extend this objective  
21   in goal 12.3: to halve food waste by 2030 at retail and consumer level. To achieve this ambitious  
22   target and respond to issues associated with food waste, which were not solely political, but also  
23   food-related, economic and environmental (Thyberg & Tonjes, 2016), there have been many  
24   calls for action launched by public policies on the management of waste. In Europe, 280 kg of  
25   food per year per inhabitant is wasted throughout the food production chain, including 40 % at  
26   the distribution and consumption stages (Lundqvist, de Fraiture, & Molden, 2008). **Private**  
27   **households** are significant contributors to the total amount of food waste along the food supply  
28   chain. At household level, consumer behavior played an important role in food waste production:  
29   for example, lack of planning or bad habits concerning food purchase and storage, impulse  
30   purchase, poor storage management, lack of skills for food preparation and so on (Priefer,  
31   Jörissen, & Bräutigam, 2016). To encourage the adoption of behaviors favoring a reduction in  
32   waste, raising awareness amongst households has become a priority area for public action as  
33   pointed out by the Preparatory Study On Food Waste Across EU 27 (European Commission,  
34   2010, p.21): “*Targeted awareness campaigns, aimed at the household sector and the general*  
35   *public, to raise awareness on food waste generation, environmental and other impacts of*  
36   *biodegradable waste, prevention methods and practical tips to encourage behavior change and a*  
37   *long-term reduction in food waste generation*”. This political involvement typically generates  
38   large-scale campaigns such as "Love Food Hate Waste" in UK or “Stop au gaspillage

39 “alimentaire” in France, whose aims are to create awareness of the consequences of food waste  
40 and inform individuals about the measures and actions to be implemented in order to reduce it.

41         Alongside this political involvement, a growing body of research is being conducted on  
42 understanding the practices of waste (Evans, 2011a, 2011b; Graham-Rowe, Jessop, & Sparks,  
43 2014; Quested, Marsh, Stunell, & Parry, 2013; Schanes, Dobernig, & Gözet, 2018, Schmidt,  
44 2016) and identifying the determinants which lead to food waste and its avoidance. Using a  
45 systematic review, Schanes et al. (2018) emphasize two ontological approaches to explain the  
46 phenomenon of food waste: the psychological related approach and the social practice theory.  
47 The psychological approach identifies the cognitive and individual factors underlying food waste  
48 behaviors. The most used theoretical model is the planned behavior theory (Ajzen, 1991) in  
49 which attitude, social norm, controllability and additional predictors such as environmental  
50 concern, habits, and situational predictors (household size, age) are considered as the  
51 determinants of the behavior. The social practice theory (Evans, 2011a, 2011b, Ganglbauer,  
52 Fitzpatrick, & Comber, 2013, Lazell, 2016, Leray et al., 2016) adopts a holistic view of food  
53 waste practices in which food waste is integrated in many other practices such as planning,  
54 shopping, storing, cooking, eating and managing leftovers.

55         In the same way, several studies were conducted with the aim of encouraging changes in  
56 behavior leading to an observable reduction in food waste. In their review, Stöckly, Niklaus and  
57 Dorn (2018) recently argued for a need to test behavioral intervention in order to reduce  
58 consumer food waste. From their point of view, researchers should consider intervention types  
59 other than information-based intervention to encourage changes in behavior leading to an  
60 observable reduction in food waste. In a systematic review, Kim, Knox, and Rundle-Thiele

61 (2019) analyze 23 food waste reduction programs for which behavior change is expected. 16 out  
62 of 23 programs illustrate an information-based approach (pamphlets and posters).

63 Even if it is essential to inform the public about food waste, other social psychological  
64 approaches can also be used to promote effective behavioral changes. For our part, we proposed  
65 an original approach combining theory-based and evidence-based approaches to design and  
66 conduct a research action on the reduction of domestic food waste in households. Starting with  
67 the premise that people do not like food waste and create it at all the same, as evidenced by the  
68 280 kg per year per inhabitant wasted, we will focus on the reduction of this behavioral gap.

69 **1.1. Food waste: a behavioral gap**

70 Wasting food is socially undesirable (Evans, 2011a, 2011b): individuals report negative  
71 moral attitudes with regard to food waste (Graham-Rowe et al., 2015; Stancu, Haugaard, &  
72 Lähteenmäki, 2016; Stefan et al., 2013; Visscher et al., 2016) and its reduction is viewed as the  
73 “right” thing to do (Graham-Rowe et al., 2014; Richter & Bokelmann, 2018). Thus, it would  
74 appear that there is a social norm regarding the reduction of food waste, even if this is only  
75 tenuously linked to the intention of doing so (Graham-Rowe et al., 2015; Stefan et al., 2013;  
76 Visschers, Wickli, & Siegrist, 2016). There is a behavioral gap between favorable attitudes  
77 concerning the avoidance of waste and actual behaviors which do not reflect these attitudes  
78 (Quested et al., 2013). Moreover, individuals report a gap between their desire not to waste, and  
79 what they actually do in terms of avoidance and reduction of waste (Evans, 2011a, 2011b). In  
80 other words, it seems that we find ourselves faced with a paradox: the avoidance of food waste is  
81 socially desirable and approved of by individuals, but actual avoidance behaviors are not  
82 adopted.

83           At the same time, individuals do not seem to be aware of the quantity of food that is  
84           thrown away. When people are asked to estimate how much food they are wasting, they say that  
85           they throw nothing or very little away (Abeliotis, Lasaridi, & Chroni, 2014; Stefan et al., 2013),  
86           and according to Neff, Spiker and Truant (2015), they even think that they throw less food away  
87           than other people. According to the authors, it is probable that individuals overestimate their  
88           efforts with regard to avoiding food waste. Several explanations can be mentioned: a lack of  
89           information or an absence of awareness of their own behavior. Remedyng this lack of  
90           information or lack of awareness could then prove useful and effective in promoting behavioral  
91           changes.

92           **1.2. Designing intervention to change food waste behaviors**

93           The objective of our action-research is twofold. Firstly, we aim to design and test three  
94           face-to-face intervention strategies for French households in order to encourage them to reduce  
95           their food waste. These face-to-face interventions are recognized as being effective in changing  
96           behaviors (Abrahamse & Steg, 2013). Secondly, it involves assessing the respective effectiveness  
97           of each of these strategies by introducing an effective measurement of food waste based on a  
98           compositional food waste analysis, more accurate than the measurements generally used (e.g.,  
99           self-reported behaviors or behavioral intentions to waste less in the future, Lebersorger, &  
100          Schneider, 2011; Schmidt, 2016, Young, Russell, Robinson, & Barkemeyer, 2017). The three  
101          intervention strategies selected were the following. The first was based on the distribution of  
102          information (for example by distributing leaflets) to households, and on the approach classically  
103          employed by field personnel (information-based intervention). The second intervention  
104          (awareness-based intervention) was based on the awareness of one's own bad practices and the  
105          idea that it is sufficient to become aware of one's own counter-productive behaviors to adjust

106 them and alter them to what is expected (Steg & Vlek, 2009). Finally, the third intervention was  
107 based on the implementation of principles arising from the cognitive dissonance theory  
108 (Festinger, 1957) which is known (Osbaldiston & Schott, 2012) to be effective in inducing  
109 change in the field of eco-responsible behaviors (dissonance-based intervention).

110           **1.2.1. Information: Knowledge for change**

111           Based on the persuasive communication field and the seminal work of the Yale approach  
112 (Hovland, Jani & Kelley, 1953), providing information increases individuals' knowledge and  
113 intensifies their awareness of their unsuitable behavior (Steg & Vlek, 2009). Information could  
114 emphasize the reasons for the necessity to change, and alternative behaviors to be adopted and  
115 their advantages and disadvantages, in order to increase concern and in turn, hope for change. A  
116 larger number of informative-type interventions are found among those implemented by public  
117 authorities. However, even though it is essential to provide information, it is not in itself  
118 sufficient to trigger behavioral changes (Bamberg & Möser, 2007) including in food waste  
119 prevention (Stöckli, Niklaus, & Dorn, 2018).

120           **1.2.2. Raising awareness: The kitchen diary as a tool**

121           Another way of increasing awareness consists in keeping a diary in which people record  
122 what they do, how often, and the reasons and the context for these actions. Reflecting on your  
123 own behaviors and their consequences leads individuals to identify counter-environmental  
124 behaviors and consequently change them to make them more eco-friendly (Lanzini & Thøgersen,  
125 2014; Reid, Hunter, & Sutton, 2009; Leverenz, Moussawel, Maurer, Hafner, Schneider, Schmidt,  
126 & Kranert, 2019). With the aim of encouraging households to become aware of their ecological  
127 footprint, Hunter, Carmichael and Pangbourne (2006, as cited in Reid et al., 2009) suggested to  
128 28 Scottish households that they keep a diary for 3 consecutive weeks, indicating their modes of

129 transport, their consumption and purchase of food products and their production of waste. The  
130 results obtained with the aid of pre-and post-questionnaires and focus groups with households  
131 demonstrated that their self-reported attitudes and behaviors were more eco-friendly after the  
132 completion of the diaries than they were before. According to Reid et al. (2009), everything  
133 seemed to indicate that the diary had created an awareness of environmental issues. Similarly,  
134 Visschers et al. (2016) suggested that keeping a kitchen diary would be a suitable way of  
135 enabling individuals to become aware of their own waste-related behaviors, and consequently  
136 adjust them.

### 137           **1.2.3. Arousing dissonance: A tool to trigger behavioral change**

138           The gap between what is socially valued and counter-normative behaviors illustrates the  
139 principle of one of the most recent paradigms of cognitive dissonance (Festinger, 1957), induced  
140 hypocrisy (Aronson, 1999; Aronson, Fried, & Stone, 1991). Induced hypocrisy was developed to  
141 promote socially desirable behaviors (Priolo, Pelt, Saint-Bauzel, Rubens, Voisin, & Fointiat,  
142 2019): protect health, protect the environment, observe road safety regulations, etc. These  
143 desirable behaviors are in line with social norms (Liégeois, Codou, Rubens, & Priolo, 2016). The  
144 aim of the induced hypocrisy paradigm is to make individuals aware of the gap which exists  
145 between their normative beliefs and their past transgressive behaviors. To do this, individuals  
146 carry out two tasks consecutively. Firstly, they construct an argument with the aim of publicly  
147 defending or supporting a behavior (i.e., “*preaching*”, Aronson et al., 1991). Secondly,  
148 individuals recall their own transgressive behaviors (i.e., “*mindfulness*”, Stone & Fernandez,  
149 2008). The combination of these two factors arouses a state of motivational psychological  
150 discomfort or a state of dissonance, which, as such, calls to be reduced. As individuals can  
151 change neither the social norm, nor their past behavior, they reduce this state of discomfort by

152 changing their future behavior in order to make it consistent with what they have just preached  
153 (Aronson et al., 1991).

154 In the past, the paradigm of induced hypocrisy was used to encourage behavioral change  
155 in the fields of health (for a review, see Stone & Focella, 2011), civic behaviors (Martinie &  
156 Fointiat, 2010; Son Hing, Li, & Zanna, 2002; Stone, Wiegand, Cooper & Aronson, 1997), road  
157 safety behaviors (Fointiat, 2004, 2008; Fointiat, Somat & Grobras, 2011; Fointiat, Morisot, &  
158 Pakuszewski, 2008 ) and the environment (Dickerson, Thibodeau, Aronson, & Miller, 1992;  
159 Focella & Stone, 2013; Fointiat, Priolo, Saint-Bauzel, & Milhabet, 2013; Fried, 1998; Fried &  
160 Aronson, 1995; Priolo et al., 2016). Priolo et al. (2016) have shown that transgressing the pro-  
161 environmental norm is a cause of psychological discomfort – so-called cognitive dissonance –  
162 which leads individuals to modify their future behaviors in a normative direction. The paradigm  
163 of induced hypocrisy therefore seems to us particularly suitable for the theme of food waste and  
164 able to induce behaviors aiming at its reduction.

165 **1.3. Aims and hypotheses**

166 The main objective of our research-action is to reduce **avoidable** household food waste.  
167 In order to overcome the limitations inherent in self-reported behavioral measurements or in  
168 simple behavioral intentions to waste less in the future, we set up effective measurements of food  
169 waste reduction in households by carrying out garbage collections at three different times: one  
170 week before the interventions, one week after the interventions and five weeks after the  
171 interventions.

172 In order to offer an alternative method to informative strategy, we developed and tested  
173 two behavioral change interventions, namely awareness-based intervention and dissonance-based  
174 intervention. Information is necessary but not sufficient to trigger behavioral changes (Bamberg

175 & Möser, 2007, Stöckli et al., 2018). Nevertheless, information based-intervention is the most  
176 implemented by public authorities, including on the territory concerned by the research-action.  
177 For all these reasons, we compared the information-based intervention with each of the other two  
178 interventions (awareness and dissonance based-intervention). The latter two strategies envisage  
179 behavioral change, but the dynamics of change on which they are based are different.  
180 Concerning the awareness-based intervention, the change stems from the awareness of one's  
181 own bad habits, and from incorporating a moral dimension into our behavior. Concerning the  
182 dissonance-based intervention, illustrating the induced hypocrisy paradigm, the change of  
183 behavior is related to a tension/reduction of tension dynamic, that is, arousal-then-reduction  
184 processes.

185 In line with the work by Visschers et al. (2016), although keeping a kitchen diary creates  
186 awareness of inappropriate behaviors, the awareness-based intervention should allow households  
187 to reduce the quantity of food waste more than the information-based intervention (hypothesis 1).  
188 Moreover, on account of the both counter-normative and frequent nature of food waste, the  
189 dissonance-based intervention should lead to a greater reduction in food waste than the  
190 information-based intervention (hypothesis 2).

## 191 2. Method

### 192 2.1. Research context and household selection

193 This research was carried out in collaboration with local public authorities, namely the  
194 authority for garbage collection and management. It took place in a medium sized French town.  
195 Seven communes were initially selected by local public authorities, based on the criterion of one  
196 household waste collection per week. This precaution enabled us to prevent the introduction of  
197 bias in quantitative measurements by taking account of a single waste production cycle (set at

198 one week, as these communes have a waste collection once every 7 days) and of the state of  
199 deterioration of comparable waste (Lebersorger & Schneider, 2011). The interventions were  
200 arranged to take place the same number of days before collections. The days of intervention and  
201 of waste composition analysis were therefore defined in accordance with the household waste  
202 collection days organized by the local public authorities. In each of these communes, households  
203 were drawn randomly from a list. For reasons mainly due to the area (collection and  
204 identification of bags containing household waste for weighing and analysis of food waste), only  
205 households residing in individual housing units were selected. Collected households were not  
206 informed that their garbage would be characterized and analyzed. Indeed, being informed that  
207 one is going to be observed leads to a change in behavior. Finally, waste was initially collected  
208 from 168 households. This sample size was negotiated with local public authorities. Based on  
209 their professional experience, this sample size seemed to be sufficient to guarantee a final sample  
210 of twenty households per intervention.

211 **2.2. Final sample**

212 The sample included households encountered during door-to-door operations and whose  
213 waste composition analyses could be carried out at three different measurement times. We also  
214 excluded partial interventions: 14 households were excluded for not having complied with the  
215 entire procedure. Overall, these exclusion rates were similar in each intervention: 31/56 for  
216 intervention-based intervention, 37/56 for awareness-based intervention, 36/56 for dissonance-  
217 based intervention. The final sample was composed of 64 households. **Among the 64 households**  
218 **encountered, the experimenter carried out face-to-face intervention with couples (N = 4) or one**  
219 **of the household members (women, N = 41 and men, N=19).** The mean age was 55.6 ( $SD =$   
220 13.68). On average, 2.75 people lived permanently in the household.

221    **2.3. Procedure**

222              The intervention and food waste analyses took place from the end of October until the  
223 beginning of December 2014 and 2015. Experiments included three steps: pre-experimental  
224 measurements (baseline, one week before the interventions), experimental step (door-to-door  
225 interventions), and two post-experimental measurements (Time 1, one week after the  
226 intervention and Time 2, five weeks after the intervention).

227              **2.3.1. Step 1: Baseline characterization (pre-experimental measurement)**

228              A first measurement (baseline) of food waste was carried out with 168 preselected  
229 households. The garbage bags containing household waste were collected individually, then  
230 taken to the waste management and sorting center. It should be noted that the garbage bags were  
231 not compacted (screening). Each bag was weighed individually (total **mass** of household waste),  
232 then opened, and the waste was sorted, taking care to separate food waste from other household  
233 waste. Food waste from each garbage bag was then analyzed and weighed (waste composition  
234 analyses). Food waste was sorted according to six types (table 1). The households were assigned  
235 randomly to each of the three experimental conditions, each one corresponding to an intervention  
236 strategy.

237              *Table 1. Food waste categories for sorting analysis*

Food waste categories	Description
Unopened packed food products	Includes industrial food products sold in packaging (such as unopened yogurt, ham packs, and so on) which have not been unpacked by households.
Open packaging food products	Includes industrial food products sold in packaging which have been opened but not finished by households.
Vegetables and fruits	Includes all vegetables and fruits, from food stores or garden.
Leftover meal	Includes leftover meal, food cooked or prepared by the individual (pasta leftovers for example).
Bread and bakery	Includes bread and bakery product (stale bread,

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products	sandwich bread, brioche, milk bread, and croissant).
Potentially avoidable food waste	Includes food waste which could be consumed by household, but which is not (vegetable or fruit peelings for example).

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238           **2.3.2. Step 2: Door-to-door intervention (experimental phase)**

239           Door-to-door interventions were carried out in the field one week after this first  
 240 measurement (baseline). Out of the 168 households initially selected, 96 households were met by  
 241 an experimenter (72 households were absent, refused to participate, or had not produced food  
 242 waste). The meetings lasted from 10 to 15 minutes.

243           The information-based intervention ( $n = 34$ , control condition), consisted of testing the impact of  
 244 the approach usually employed by prevention personnel, and by policies. In other words, the  
 245 experimenter, like the prevention personnel, supplied information and distributed pamphlets on  
 246 the consequences of food waste and the means to be implemented in order to reduce it. Leaflets  
 247 supplied to households gave them advice on how to reduce food waste during shopping (“Don’t  
 248 over buy”, “Check the use-by dates of fresh food”, “Plan your menu”), food storage, cooking and  
 249 meal re-use (recipes for leftover meals).

250           In the awareness-based intervention ( $n = 33$ ), the experimenter suggested that participants  
 251 keep a kitchen diary and report their food waste for one week. The experimenter provided a  
 252 paper kitchen diary containing a table to be completed by the participants. The following  
 253 instructions were to weigh each item of solid food waste, to indicate the category of food waste  
 254 (such as meal leftovers, food products in their packaging, rotten vegetables and fruits, bread,  
 255 bakery products). Participants also reported in the table the reason why the food was thrown  
 256 away. Liquid food waste (milk, water, oil) were excluded from the kitchen diary considering that  
 257 the characterization related only to solid waste. Then, each participant indicated what means they  
 258 planned to put into practice to reduce their food waste and the conditions for implementing the

259 behavior (“How? Where? Beginning when? For how long?”). These items were taken from the  
260 implementation of intention strategy (Gollwitzer, 1999), which we know increases the  
261 probability of carrying out targeted behaviors. To conclude the intervention, the participants were  
262 given pamphlets. One week after the door-to-door intervention, the experimenter returned to the  
263 home of participants to collect the kitchen diary.

264 In the dissonance-based intervention ( $n = 29$ ), under the pretext of supporting a future  
265 campaign against food waste launched by a local public authority, the participants preached in  
266 favor of the reduction of food waste (“What should we do in order not to waste food?”).

267 Participants filled in a form by writing about the means of reducing food waste, indicated their  
268 name, age and the city of residence. Then, in order to recall their transgressive behaviors (i.e.,  
269 recall of transgressions), they privately replied to three items in a survey (“During the last two  
270 weeks, I have thrown out food leftovers. On which day? Which dish? In what quantity  
271 approximately?) with the aim of having them describe transgressions (adapted from Fointiat  
272 2004; Fointiat et al., 2013; Sénémeaud, Mange, Fointiat, & Somat, 2013) and estimate the  
273 quantity of food thrown out during the last two weeks in their household. They completed an  
274 intention implementation plan and then were given pamphlets.

275 **2.3.3. Step 3: Post-intervention characterization**

276 Following the door-to-door interventions, we conducted additional food waste analyses:  
277 bins were collected one week after the intervention (Time 1) and five weeks after the  
278 intervention (Time 2) in order to study short and medium-term effects (Burn & Oskamp, 1986;  
279 De Leon & Fuqua, 1995).

280 **2.4. Main measurement: waste composition analysis**

281 The garbage bags collected were carefully examined. Only food waste in solid form was  
282 quantified: meal leftovers, food products in their packaging (unopened or opened), bread and  
283 bakery products and potentially avoidable waste (edible food like radish tops or potato peel, but  
284 not consumed by households). A team of six people carried out a blind examination of the  
285 content of each garbage bag, separating out the food waste. The quantity of food waste was then  
286 weighed by the experimenter.

287 Due to the influence of the size of the household on the production of food waste (Baker,  
288 Fear, & Denniss., 2009; Koivupuro et al., 2012), we calculated a food waste index by dividing  
289 the quantity of food waste by the number of people living permanently in the household (food  
290 waste per person per week, in grams).

## 2. Results

292 The data that support the findings of this study are openly available in osf.io at  
293 [https://osf.io/a9zrd/?view\\_only=e431d415d9e9486883e453f59ffd3dc6](https://osf.io/a9zrd/?view_only=e431d415d9e9486883e453f59ffd3dc6).

### 294 3.1. Sorting analysis for food waste at the baseline

Before intervention (T0), we conducted a sorting analysis of the 168 households. Out of the 1171.1 kilograms of solid waste collected, 237.7 kilograms of food waste were analyzed. This amount of food waste represents 20.3 % of solid waste. The details of characterization are presented in table 2.

299 Table 2: *Mean and standard deviation of food waste quantity (in grams) in each category at the*  
300 *baseline (T0)*

Categories of food waste	Mean (in grams)	Standard Deviation <sup>I</sup>
Unopened packed food products	133.1	285.8
Open packaging food products	151.1	287.6
Vegetables and fruits	441.4	671.3
Leftover meal	199.0	355.1
Bread and bakery products	145.9	277.3
Potentially avoidable food waste	344.7	610.1
Total	1415.3	1426.0

301  
302 Vegetables and fruits represent 31.2 % of food waste. This could be due to many consumer  
303 habits: people have bought too many fruits and vegetables or have a lack of motivation for  
304 cooking it, fruits and vegetables have been forgotten at the bottom of the fridge, or they have  
305 been stored incorrectly. A quarter of food waste (24.4 %) consists of potentially avoidable food  
306 waste (e.g. peels). This observation highlights the importance of informing people on how to  
307 cook edible peels (recipes for peel chips for example). Open and unopened packaged products  
308 represent 20 % of food waste. This percentage could be explained by a lack of knowledge  
309 concerning the expiration date or a difficulty in food storage for example. Leftover meals  
310 represent 14 % of food waste. Many reasons could explain this percentage: cooking too large  
311 quantities, an ignorance of cooking leftovers.

312 **3.2. Intervention effectiveness to reduce food waste**

313       **3.2.1. Preliminary results**

314       Firstly, the examination of distributions showed that data on food waste per person per  
315 week did not follow a normal distribution at the baseline ( $D_{\text{Kolmogorov-Smirnov}} = .198$ ,  $p < .001$ ) and

316 were positively skewed (skewness = 1.352, kurtosis = 1.164). Consequently, standard  
317 assumptions of ANOVA were violated. To deal with non-normality, we did a log-transformation  
318 ( $\log_{10}(x+1)$ ). Log-transformations allow us to re-center distributions presenting a positive  
319 asymmetry (Field, 2009). After transformation, distributions were consistent with normality  
320 ( $D_{\text{Kolmogorov-Smirnov}} = .078, p = .20$ ).

321 Secondly, to ensure that the quantity of food waste per person per week before the  
322 intervention was similar among the three experimental groups, we ran a one-way ANOVA  
323 design on food waste per person per week (log). The results indicated that before the intervention  
324 (baseline), the quantities of food waste per person per week (log) were equivalent amongst the  
325 information-based intervention group, the awareness-based intervention group and the  
326 dissonance-based intervention group  $F(1, 66) = .521, ns$ . Thus, before any intervention, the  
327 three pre-selected samples are comparable among the overall food waste quantity.

328 Food waste per person per week in each of the experimental conditions for the baseline,  
329 Time 1 and Time 2, are presented in Table 3.

330 Table 3. *Food waste in grams per person per week for each experimental condition for each of*  
331 *the three measuring times*

Intervention procedure	Number of households	Pre-measurement* (baseline)	Post-measurement T1* (1 week after)	Post-measurement T2* (5 weeks after)
Information-based	25	573.2 (586.6)	353.7 (403.3)	476.8 (423.5)

<sup>1</sup> We observed high standard deviations. This could reflect food waste social practices and explain the dispersion of the data.

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intervention

Awareness-based intervention	19	805.2 (657.5)	950.6 (981.5)	750.3 (810.2)
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Dissonance-based intervention	20	728.4 (718.3)	662.2 (564.8)	484.7 (679.1)
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332 *Note: \*Raw data before log10 transformation. Standard deviations are given in brackets.*

333       **3.2.2. Main results**

334       With the aim of identifying the most effective intervention for the reduction of food  
335       waste, a series of mixed-design ANOVAs on food waste per person per week (after the log  
336       transformation) were run. To put our hypotheses to the test, we firstly compared the awareness-  
337       based intervention with the information-based intervention one week and five weeks after the  
338       intervention and secondly, we compared the dissonance-based intervention with the information-  
339       based intervention one week and five weeks after the intervention.

340       **3.2.2.1. Awareness-based intervention versus information-based intervention.**

341       A first mixed-design ANOVA 2 (Time: 1 week later vs. 5 weeks later) x 2 (Intervention  
342       Procedure: awareness-based intervention vs. information-based intervention) was run, with Time  
343       as a within variable and Intervention Procedure as a between variable. The results did not  
344       demonstrate either the main effect of the Time factor ( $F(1, 42) = .147, ns, \text{partial } \eta^2 = .003$ ) nor  
345       the main effect of the Intervention procedure ( $F(1, 42) = .406, ns, \text{partial } \eta^2 = .01$ ) nor the  
346       interaction effect ( $F(1, 42) = 1.179, ns, \text{partial } \eta^2 = .027$ ). Contrary to our hypothesis, our results  
347       suggest that recording the quantities wasted daily is no more effective than receiving information  
348       on reducing the actual quantity of waste.

349       **3.3.3.2. Dissonance-based intervention versus information-based intervention.**

350 A second mixed-design ANOVA 2 was run (Time: 1 week later vs. 5 weeks later) x 2  
351 (Intervention Procedure: dissonance-based intervention vs. information-based intervention), with  
352 Time as a within variable and Intervention Procedure as a between variable. We did not observe  
353 any significant main effects of Time ( $F(1, 43) = 1.360, ns, partial \eta^2 = .031$ ) nor of the  
354 Intervention procedure ( $F(1, 43) = .476, ns, partial \eta^2 = .011$ ). According to our hypothesis, we  
355 observed a significant Time x Intervention procedure interaction ( $F(1, 43) = 6.097, p < .02,$   
356  $partial \eta^2 = .124$ ). To explore this interaction effect, follow-up ANOVAs for repeated measures  
357 were carried out for each of the two groups. In the information-based intervention condition, we  
358 did not observe any effect of Time ( $F(1, 24) = 1.211, ns, partial \eta^2 = .048$ ). The households  
359 which received information did not reduce their quantities of food waste between Time 1 and  
360 Time 2. On the other hand, in the dissonance-based intervention condition, we observed a  
361 significant main effect of Time ( $F(1, 19) = 4.675, p < .05, partial \eta^2 = .197$ ) in the sense of a  
362 reduction in the quantities of food waste produced between Time 1 and Time 2 in accordance  
363 with hypothesis 2.

364 **4. Discussion**

365 In accordance with our hypothesis, the dissonance-based intervention proved to be more  
366 effective than the information-based intervention in leading to an observable reduction in food  
367 waste. Asking the participants to state publicly that they knew what to do to avoid waste (i.e.,  
368 preaching), then to list their transgressive behaviors (i.e., mindfulness) made the behavioral gap  
369 salient. Due to the motivational dynamic of dissonance, individuals will then seek to reduce this  
370 behavioral gap, by committing themselves to socially desirable behaviors in the future. This  
371 change of behavior then becomes a tool for reducing dissonance, even if this change revolves  
372 more often around modifications of behavioral intentions than actual changes (Dickerson et al.,

373 1992; Stone & Focella, 2011). For example, Dickerson et al. (1992) showed that swimmers who  
374 signed a petition in favor of water-saving (i.e., preaching) after having listed the times when they  
375 personally had wasted water (i.e., mindfulness) took significantly shorter showers than  
376 swimmers in the control condition. It should be noted that the swimmers adjusted their  
377 subsequent water consumption “spontaneously”, and no specific request was made to them.

378 Although in the study by Dickerson et al. (1992), the hypocrisy results were immediate,  
379 our results did not show any short-term effect of induced hypocrisy on food waste, namely one  
380 week after the intervention, but rather a medium-term effect. Behavioral changes were only  
381 observed five weeks after the intervention. This period can be explained by the nature of the  
382 target behavior. Reducing food waste is related to a class of behaviors, and not to a single  
383 behavior. Reducing waste involves planning purchases, managing and preparing food products  
384 and organizing storage areas (Farr-Wharton, Foth, & Choi, 2014, Schanes et al., 2018). Changing  
385 involves a change on each of these levels, and therefore requires time to adjust. Time must  
386 therefore be allowed for these practices to develop and the effects to become observable  
387 (Quested et al., 2013). Future research would no doubt benefit from replicating and refining the  
388 temporal measurements we carried out, in order, for example, to determine more precisely the  
389 necessary period of time for the appearance of change with regard to complex behaviors.

390 Contrary to the proposals of Visschers et al. (2016), recording the quantities of food  
391 wasted daily is not likely to prove effective in triggering actual behavioral changes. This  
392 undermines the intuition of many involved at grassroots level, for whom making individuals  
393 aware of their inappropriate behaviors is thought to be sufficient to trigger actions likely to  
394 rectify the situation. The examination of kitchen diaries collected one week after the door-to-  
395 door interventions proved enlightening. Firstly, the inhabitants took their kitchen diaries

396 seriously: they recorded the types and quantities of food thrown away in it, day after day. The  
397 comments of the inhabitants show that awareness was really aroused, but not in the expected  
398 direction. Completing the kitchen diary is thought to have led households to observe that  
399 although they did create waste, it was only in small quantities. **This bias of behavioral reactivity**  
400 **could be reinforced by a misreporting bias (Quested, Palmer, Moreno, McDermott, &**  
401 **Schumacher, 2020).** These biases could lead people to admit only a slight responsibility for  
402 global food waste. This effect of dilution of responsibility, combined with the difficulty of  
403 understanding that a reduction in food waste requires an accumulation of little individual efforts  
404 (Messaoui & Desrichard, 2016; Rees & Bamberg, 2014), is related to perceived cumulative  
405 effort. High cumulative effort is one of the barriers identified for high-level ecological goal  
406 attainment, such as reducing food waste. This could explain that although households may have  
407 completed the kitchen diary correctly, this was not enough to trigger an alteration in observable  
408 behaviors in terms of the reduction of food waste. Surprisingly, our results did not confirm the  
409 efficiency of the kitchen diary as a behavioral change technique (Hunter et al., 2006; **Lanzini &**  
410 **Thøgersen, 2014; Leverenz et al., 2019).** For instance, Hunter et al. (2006) led participants to  
411 complete a diary in which they reported their ecological footprint (food and drink, housing,  
412 goods, transport, services and waste) over a period of three weeks. In our study, we adapted the  
413 diary to make it less time-consuming (solely one-week duration and food waste behavior). In  
414 doing this, we may have rendered the self-report duration too short to trigger any change.

#### 415 **4.1. Limitations and contributions**

416 The initial sample consisted of 168 households selected on the basis of different criteria:  
417 rural communes, individual residences, and the periodicity of the collection of household  
418 garbage bags. A first garbage collection and a first waste composition analysis were conducted

419 on these 168 households. We chose to collect solely from households residing in individual  
420 housing units to guarantee the identification of household food wasting. It would be obviously  
421 interesting in further research to investigate collective housing units to adapt the procedure.

422 At the end, only 64 households were followed throughout the procedure. This  
423 experimental mortality is frequent in action-research. This is explained by different factors, some  
424 related to the availability of inhabitants, and others related to our choice to include two extra  
425 collections, one week then five weeks after the door-to-door intervention. Although several  
426 possible quantitative measures of waste exist (e.g., self-reported behaviors), the choice of food  
427 waste analyses at different times takes the risk of seeing the initial sample reduce over time,  
428 since in France households have no obligation to take out their garbage. Nevertheless, it is the  
429 first time to our knowledge that the induced hypocrisy paradigm has been used to reduce food  
430 waste in an ecological setting. Finally, this participative research-action requiring the  
431 collaboration of many actors (mobilization of waste management department, officials for  
432 collecting and weighing, and researchers) has proven to be fruitful and must be encouraged in  
433 future research.

434           Encouragingly, it seems possible to promote food waste reduction at least up to five  
435 weeks. The question remains of a longer-term effect. We also assume that implementing new  
436 behaviors over five weeks facilitates new habits. Studies on habits show that these are important  
437 determinants of self-reported waste behavior (Russell et al., 2017) and that they are resistant to  
438 change. We can therefore assume that these habits will develop and continue even after the  
439 research-action. This point is to be confirmed, however, by extending the characterizations  
440 beyond the five weeks.

441           To conclude, requests are growing from public authorities for the introduction of  
442 interventions which have proven to be effective. Although our action-research may present the  
443 disadvantage of a door-to-door approach, the human cost that it represents is largely  
444 counterbalanced by its speed (around 10 minutes) and by its effectiveness. This type of one-shot  
445 intervention, because it is short and simple to implement, may be delivered by field personnel,  
446 during large-scale campaigns or home visits.

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## **Sample CRediT author statement**

449           Audrey Pelt: Conceptualization, Methodology, Investigation, Formal analysis, Data  
450           curation, Writing

451 Roxane Saint-Bauzel: Investigation

452 Laura Barbier: Investigation

453 Valérie Fointiat: Conceptualization, Methodology, Data curation, Writing, Supervision

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