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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.

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1. Introduction

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

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).

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).

291 **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.

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

295 Before intervention (T0), we conducted a sorting analysis of the 168 households. Out of
296 the 1171.1 kilograms of solid waste collected, 237.7 kilograms of food waste were analyzed.

297 This amount of food waste represents 20.3 % of solid waste. The details of characterization are
298 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 ¹
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)

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

intervention				
Awareness-based intervention	19	805.2 (657.5)	950.6 (981.5)	750.3 (810.2)
Dissonance-based intervention	20	728.4 (718.3)	662.2 (564.8)	484.7 (679.1)

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 ($F(1, 42) = .147, ns, partial \eta^2 = .003$) nor
345 the main effect of the Intervention procedure ($F(1, 42) = .406, ns, partial \eta^2 = .01$) nor the
346 interaction effect ($F(1, 42) = 1.179, ns, partial \eta^2 = .027$). 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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448 **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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