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To keep or not to keep? Sorting out leftovers from a refrigerator

Séverine Gojard, Marine Masson, David Blumenthal, Bérangère Véron

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Abstract

Most literature on food waste shows that food that ends up in the garbage can is often no longer considered as enjoyable, or even as edible. In this paper, we decided to focus on assessments of whether leftover food is still considered as worth eating, to provide a better understanding of the production of domestic food waste. We constructed a pluridisciplinary approach, combining sensory analysis and sociology. The first part was conducted in a test kitchen under controlled conditions: 50 participants had to sort out and decide to keep or to throw away different types of refrigerated leftovers. The second part used in-depth interviews with half of these participants (N = 25) to explore their food habits and perceptions and handling of leftovers at home. The first section of the paper presents the theoretical framework of the study, which is grounded in practice theory. Then we detail the methodology and the results. We show that sorting out leftovers is a process mobilizing embodied knowledge and resulting from domestic practices implemented to avoid waste, such as storing or reusing leftovers. In the discussion, we analyze the sorting of refrigerated food products as a compound practice, situated at the intersection of provisioning, cooking, meal organization, and judgment of taste (Warde 2013). Using this theoretical framework enables us to understand the heterogeneity observed in the outcome of the sorting process as the result of its weak degree of regulation. The sorting out practice is thus consistent with different modes of engagement such as food waste prevention, health maintenance, or providing enjoyable family meals. We conclude by providing suggestions of policy recommendations regarding domestic refrigeration, food storage, and assessment practices.

Keywords

Refrigerator, observational study, food waste, sensory perception, practice theory

1. Introduction

A growing number of studies investigate food waste and ways to reduce it (Bos-Brouwers *et al*. 2014; Hebrok and Boks 2017; Schanes *et al*. 2018). According to the FAO (2011), food waste is all products intended for human consumption that are instead discarded, lost, degraded or consumed by pets at the end of the food chain (distribution, sale and final consumption). The WRAP (2009) clusters households food waste into three groups according to its avoidability. The first two categories are composed of "avoidable and possibly avoidable food waste" and include food that is thrown away that was, at some point prior to disposal, edible (e.g. slices of bread, apples, meat), or food that some people eat and others do not (e.g. bread crusts, potato skins). The third category is composed of "unavoidable food waste" that includes waste arising from food preparation that is non-edible under normal circumstances (e.g. bones, egg shells, pineapple skins).

In Western countries, households account for a high proportion of food waste (more than half in European countries, according to Bos-Brouwers *et al*. [2014]). In France, food waste in households is estimated to be between 20 to 29 kg per person per year (Masson and Gojard 2019). According to a relatively recent study (Ademe 2016), 6% of all purchased foods are wasted at home. Based on 50 French households, this study showed that the majority of food waste (55 %) derives from unfinished dishes or plates: leftovers. Leftovers, can be defined as food and food ingredients that are unused after the preparation and completion of meals (Roe *et al.* 2019). Since they were intended for household consumption, when they end up discarded, leftovers can be said to be avoidable waste.

To provide a better understanding of the production of domestic avoidable food waste, the present paper focuses on domestic consumption and on assessments of whether food is worth eating and still edible. Most research on food waste seems to consider the distinction between edible food and non-edible waste to be obvious, and some studies emphasize the process leading from one to the other (Evans 2014). However, how the edibility of a given food item (such as leftovers) is assessed is far less often investigated. We focus here on this assessment, and show how it relies on a mix between sensory evaluation and practical considerations.

A number of studies relying on senses to address food matters use visceral approaches. "Visceral" is defined as "the bodily realm where feelings, moods and sensations are manifest" (Hayes-Conroy 2010: 734). Psychology (see Wiggins [2002] concerning the expression of gustatory pleasure) or anthropology (see, e.g., Højlund [2015, 2018] on taste as a shared

cultural activity) use similar approaches, but human geography in particular has recently taken a "visceral turn" (Sexton *et al*. 2017), with some studies related to food matters. For example, Waitt and Phillips (2016) develop a material and visceral understanding of domestic refrigeration and disposal practices by examining not only physical practices but also sensations "vital to determining how refrigerated things are valued and experienced" (372). Jackson *et al*. (2020), focusing on tasting, underline the difficulties "to convey the intangible qualities of food" (9) when judging tastes and textures. Through an original methodology, we aim to improve understanding of the integration of senses in the generation of food waste.

The first section of the paper presents the theoretical framework of the study, which is grounded in the literature on food waste. We then detail the methodology and the results. In the discussion, we highlight the contributions of the theoretical framework chosen here. Analyzing the sorting of refrigerated food products as a compound practice enables us to identify the various possible modes of engagement and to understand better why the observed practices are strongly heterogeneous.

2. Theoretical framework

Among the vast corpus of literature focusing on consumer food waste, a large number of synthesis studies of the issue have been published. Some focus on measurement (Elimelech *et al*. 2018; Lebersorger and Schneider 2011), economic evaluation (Bellemare *et al*. 2017), and policy implications (Schanes *et al*. 2018).

The identification of causes and drivers of food waste at the household level are often mentioned as a potential means to reduce food waste. Waste can occur at any stage of the food-handling process. As for shopping, studies insist that a lack of food planning often entails the purchase of excess food that will not be eaten (Schanes *et al*. 2018; Romani *et al*. 2018). Storage can also lead to food waste for reasons such as inadequate fridge temperatures (James *et al*. 2017) or because consumers do not know or misunderstand the proper rules of food handling (Wrap 2013). Cooking skills to prepare food from scratch or reuse leftovers are also often cited as a way to prevent food waste (Hebrok and Boks 2017). Most of those approaches tend to "blame the consumer" (Evans 2011) and consider food waste to be the consequence of inappropriate food handling or carelessness.

In contrast, a growing corpus of research suggests that consumers do not bear primary responsibility for food waste (among others Evans 2011). Factors that are outside their

control, such as loss of coordination in family life or packaging poorly adapted to their needs, should also be taken into account. The food-provisioning infrastructure also appears to play a major role in the generation of food waste (Dobernig and Schanes 2019). Other scholars state that food waste can be due to contradictory injunctions for households, especially for mothers, who are still most often in charge of the meals (Beagan *et al*. 2008; Burningham *et al.* 2014). For instance, leftovers in the fridge can prompt health concerns (Wills *et al*. 2015), and preserving family health is often considered more important than preventing food waste (Watson and Meah 2012). Other concerns, such as the provision of fresh fruit and vegetables, can also lead to waste when those perishable items are uneaten and left to decay (Evans 2012).

This change in perspective—i.e., reinserting food waste in the social and material context of food practices—is rooted in practice theory. This framework takes on practices as the locus of social activity as opposed to a vision centered on individual behavior. Without addressing the numerous debates about the definition of a practice, we follow the theoretical framing of practices for consumption provided by Warde (2005): "practices are sets of 'doings and sayings'; they involve both 'practical activity and its representation'" (cited in Welch and Warde [2015]). This framework is particularly adequate for the analysis of food handling activities where routines predominate (Gronow and Warde 2001), such as eating in general (Warde 2013, 2016) and more specifically cooking (Halkier 2009), using domestic appliances, such as a freezer (Hand and Shove 2007) or Thermomix (Truninger 2011), or shopping (Venn *et al*. 2017; Gojard and Véron 2019). Such a framework has also been used to analyze food waste (Evans 2011, 2014; Southerton and Yates 2015). Evans (2014) shows how food becomes waste: surplus food, purchased or cooked in excessive amounts and kept for a future use, may become waste. Southerton and Yates (2015) highlight how surpluses are created, which depends especially on types of meals (with or without guests) and the dishes served for the occasion. They use the theoretical framework provided by Warde (2013) of eating as a compound practice at the intersection of four component practices—supplying food, cooking, organizing meals, and judgement of taste— and show how food disposal can also be analyzed as a compound practice. It is indeed closely linked to eating, but their work specifically explores the two dimensions of food preparation and meal organization. They emphasize that the longest meals and those with guests produce more leftovers, yet these leftovers are less likely to be wasted. Thus, Southerton and Yates's (2015) conclusions enable the production of

surplus food to be dissociated from waste and open the way for studies on the use of leftovers. Because leftovers gain value both from the previous meal they come from, and from their further use, we argue that judgment of taste should be reintroduced in the analysis of disposal. In this paper, based on a relevant research material, we offer to cover all four dimensions of eating when analyzing food disposal.

Furthermore, keeping leftovers for a later use usually entails the use of a refrigerator, i.e., an ambivalent device potentially used either to extend the lifespan of food or as an antechamber to the bin (Evans 2012). Examining the refrigerated products requires not only domestic skills to avoid waste by reheating or recooking leftovers (Hebrok and Heidenstrøm 2019), but also bodily sensations such as disgust or pleasure (Hayes-Conroy 2010). Deciding on whether leftovers are still edible is often a matter of "just common sense" (Waitt and Phillips 2016: 372) and the decision-making process seems difficult to elaborate. The specific method we used for this study was particularly appropriate for investigating the sorting of refrigerated leftovers.

3. Methods

We focus on refrigerated food sorting, using an original methodology from a combination of two disciplinary backgrounds: sociology and sensory analysis. Following Waitt and Phillips (2016), we shift our focus from waste to the sorting process. To gain a better understanding of how food products are assessed, we chose to distance ourselves from domestic contexts and rely on a set of experiments.

3.1. A pluridisciplinary approach

Fridge studies have been mainly conducted through ethnographic approaches, observation, and sometimes pictures or videos in home kitchens (Hebrok and Heidenstrøm 2019; Devaney and Davies 2017; Wait and Phillips 2016). The materiality of food is often pointed out as having a decisive impact on the decision to keep it or not: smell, texture, and physical aspect of food are used as indicators of quality and safety. In order to better understand how these sensory properties of food are intertwined with other considerations, we decided to locate this study in an experimental kitchen where people were filmed and recorded. In line with a practice-theory approach, we sought to place participants in the same material settings to observe their different performances of food sorting. They were faced with the same products, which would not have been possible otherwise. Consequently, the range of performances we

observed is definitely linked to different configurations of embodied knowledge and skills, and different modes of engagement in food handling practices. As most food handling practices, sorting out food in order to keep or dispose of some food items is a routinized activity. Putting participants in an experimental kitchen with food items that they had neither bought nor cooked was a way to make them explicit about their sorting practices. Our approach was intended to reveal activities as well as discourses, so our methodology was based on both an experiment under controlled conditions and face-to-face interviews. Short and directive interviews were conducted immediately after the experiment in the test kitchen, in order to clarify the participants' decision-making process on what to do with each food item in the fridge. In-depth interviews with half of the participants took place two weeks later and entailed comparing the participants' actions during the experiment and their usual practices at home.

Thus, this pluridisciplinary collaboration between sociology and sensory analysis enables to implement mixed methods with a strong heuristic utility. The experimental part, relying largely on sensory analysis, aims at analyzing the participants' perceptions that lead them to keep or discard the products in the fridge and more specifically, to identify the sensory perceptions, i.e., visual, olfactory, and tactile, in the assessment process. This analytical scheme, centered on an individual analysis of consumers, may seem incompatible with a practice-theory approach. However, the analysis of the interviews leads us to consider that the participants' choice processes regarding leftovers can also be analyzed as performances of sorting practices rooted in embodied knowledge (e.g., linking a specific odor to inedibility), related to intertwined food handling practices and pertaining to different modes of engagements. With this approach, we add to the studies on eating that give credit to sensory experience. For example, Waitt and Phillips (2016) show that "visceral assessments entwine with past bodily experience, household management of health risks, responsibilities, social respectability and culinary competence" (375).

3.2. Data collection

The 18 food items (Fig. 1) used in our study were chosen to approximate a typical shopping list as closely as possible. The items included vegetables, meat, dairy, and ready-to-eat products (see Annex 1 for an exhaustive list of the products in the fridge). As use-by date was not the main issue of this study, the products had not expired (such as the tabbouleh), the

185 date was not visible (ground beef), or there was no date (precooked leftovers). In addition,
186 we chose to present the leftovers in different conditions. We deliberately presented the
187 participants with slightly degraded products (e.g., the packaging of the ham was opened two
188 days before the experiment to obtain dried edges) to encourage the participants to inspect
189 them. We also avoided situations where the sorting would be straightforward, such as
190 unopened packages of ham with distant use-by dates or spoiled raw meat.

191 **-Insert Figure 1 about here-**

192 In this study, we focused on families with two children aged between 6 and 17 years of
193 age with different household incomes. The participants were the people in the household in
194 charge of food shopping and cooking. Families with children were chosen, as previous
195 literature shows that nutritional and health preoccupations are especially salient among these
196 families and make menu planning more complicated for mothers (Régnier and Masullo 2009;
197 Watson and Meah 2012; MacKendrick 2014). Studies have shown that families with children
198 tend to produce more food waste (Parizeau *et al*. 2015) or that households in urban areas
199 tend to waste more (Secondi *et al*. 2015). Our experimental configuration is thus one in which
200 the participants may be prone to waste.

201 For this observational study, we selected a total of 50 volunteers (13 men and 37 women
202 aged between 30 and 49 years old [mean = 43, standard deviation = 4]). All the participants
203 were recruited by an institute specializing in consumer studies. The study was conducted at
204 AgroParisTech in Massy (France). Each participant received a gift voucher worth 25 Euros.
205 The experiment was designed in two successive stages. All sessions were individual. The first
206 stage was conducted in a test kitchen under controlled conditions and filmed by four cameras
207 fixed to the ceiling. The context of the experiment was presented to the participant as follows:
208 "*It's Saturday afternoon, close friends or your family lend you their flat for one week for*
209 *holidays. You have to do your grocery shopping."* Participants were informed that all the food
210 items had been in the refrigerator for less than three days and were asked to determine which
211 items they would keep and which they would discard. They had the opportunity to examine,
212 smell, and touch the items, but tasting was not allowed. We then asked them to plan a menu
213 for the coming week. This list allowed us to determine how they intended to use the food
214 items they kept. After this first stage, a short interview was conducted with all participants,
215 who were to explain their decision to discard or keep each food item. The aim of the interviews

was to identify their criteria. To help them recall the products, pictures had been taken of the food items they decided to throw away.

About two weeks later, half of the participants returned for an in-depth interview concerning their own practices at home and on comparing the experiment with their own daily life. The participants were selected based on their availability and the range of answers provided during the short interviews on their choices in the experiment. Those interviews lasted about one hour for each participant. Each participant received another 25-Euro gift voucher. Signed consent was obtained for each step of the study and as no tasting of the products was done, there was no need for ethics committee approval, according to French legislation. All data were given an anonymous code for each participant (so that we could link the videos, interviews and pictures for each person without using his or her name). Throughout the paper, pseudonyms are used that had roughly the same frequency in the year of birth as the real ones, so the social distribution of names in France has been taken into account (Coulmont *et al*. 2016). Table in Annex 2 details the list of the 25 participants.

3.3. Data analysis

For each participant and each food item, we looked at the decision made (to keep or to discard the food item) and the senses used to analyze the product (visual, olfactory, or tactile).

The short interviews were face-to-face individual sessions. The participants' responses were mostly sentences or expressions such as: "*I had a look at the ground beef; it looked dark. In addition, it may have been open for three days Usually, I eat it the day I open the packaging. It's not safe; I throw it away"* (Tiphaine). After a first reading of the interview transcript, we created a categorization grid according to the food item (e.g., pizza, pasta, ground beef), the decision (discarded or kept) and the explanation (five categories were defined: use-by date/time spent in the fridge, odor, appearance, texture, and "other"). The categories were based on the data. The analysis was replicated by two people.

The guide for the in-depth interviews was constructed after a first overview of the short interviews. Some of the participants mentioned that they would have handled the food differently at home, which led us to focus on their domestic practices in greater depth to compare them with the experiment. The interview guide was comprised of three sections: the first concerned the kitchen experiment, the second food handling activities at home, i.e., shopping and cooking, and the third leftover management. The interviews were recorded and

transcribed, and their content was analyzed separately by two members of the research team to assess the consistency of their interpretations.

4. Results

Overall, the participants considered that the experiment was not greatly different from their daily lives. For several people, a number of food items in the fridge did not differ greatly from their own fridge, and they seemed quite familiar with them. The reported discrepancies mostly concerned the way food had been stored in the fridge.

4.1. The importance of sensory perceptions in food sorting

4.1.1. Frequency of discarding or retaining items

Figure 2 shows the retention of food items in relation to wastage. First, we can observe no consensus among the participants on the products they would keep or throw away. No food was kept by all participants and none was discarded by all.

-Insert Figure 2 about here-

The three food items most often thrown away were the pizza, ground beef, and banana. Conversely, the three food items most often kept were the tomatoes, butter, and grated cheese.

Two participants decided to keep all food items. In contrast, the minimum number of products kept was six (the median number of products kept was 13 and the median number of discarded products was five). In addition, no participants discarded all products. Even for those who decided to throw away a single product, the choices varied greatly (e.g., pizza, surimi, ham, or banana).

4.1.2. Evaluations of the products by participants

Although the participants were encouraged to touch and inspect the food items, for 30% of the products, they kept or discarded the food item at first sight and without any detailed assessment, seemingly without much hesitation (e.g., *"it's some butter; I didn't ask myself any questions"* is a sentence that can be found in numerous interviews, including those with Stéphanie, Florence, Christophe, or Sylvie). In most of these cases (90%), the products were kept. This mainly concerns the butter and orange juice.

For the other 70% of cases, visual inspection was always used (to evaluate the product or to check the use-by date if present). Removing the yogurt from the analysis (it was

impossible to touch or smell it), products were smelled in 14% of cases and touched in 8% of cases. In addition, we observed that the decision process on whether to keep a product is more detailed than that on whether to throw it away. Evaluations (i.e., assessment of the visual appearance, use-by date/time spent in the fridge, texture, and odor) were more frequent when the products were kept (66%) than when they were discarded (34%). Seven participants only evaluated the 18 products by sight. In contrast, 24 participants used sight, smell, and touch at least once to evaluate a product.

Moreover, the mode of evaluation is linked to the nature of the product. For example, touch is mainly used to evaluate fruit, e.g., banana (28 times: kept nine times, discarded 19 times), and the tomatoes (26 times: kept by 20 participants, discarded by 6). However, it is also used to evaluate the slices of chicken (twice), grated cheese (once), ham (three times), surimi (five times), and pizza (twice). Smell seems to be more used for cooked or processed food and liquids, mostly for: the meat in sauce (21 times), milk (14 times), slices of chicken (14 times), pasta (12 times), tomato sauce (10 times). All food items have been assessed by smelling at least once, except for the tomatoes, banana and yogurt.

4.1.3. Comparison with household contexts

The participants reported that at home they used their senses in a specific order to decide whether to keep food: i.e., sight, smell, touch, and taste.

Sight is the most common way to evaluate the edibility of the food product, either on its own or to provide complementary information in addition to the time the item has spent in the fridge or the use-by date. Magalie explained that she does not have to taste anything as she relies on this double means of evaluation:

> I know roughly how long what I'm putting in the fridge can be stored, so I'll tell myself: "well, there you go, I'm beyond the date; too bad, I'm throwing it away." But I'll mostly decide on the way it looks... Yeah, no, actually, I think that... I won't taste it, I'll rely on the way the thing looks, and then I'll remember when it was prepared, and I'll think: well, it's a bit too late...

During the experiment, she threw away many food items: e.g., leftovers with meat or dairy products because she considered that three days in the fridge was too long for the products to be safe. She threw away the grated cheese because of the rancid odor and the yoghurt because the use-by date had passed. She declared herself to be an "extremist" on sanitary issues, especially in relation to meat. As "the granddaughter of a butcher", she knows that

308 “minced meat should be eaten on the day”; as a Tupperware culinary advisor she may also be
309 particularly sensitive to storing issues.
310 Sometimes smell is used for a complementary evaluation of the product, even if not
311 deliberately when opening the packaging. Tasting the products then appears to be
312 unnecessary. Tasting occurs when there is uncertainty about the time spent in the fridge or
313 when the usual techniques of food preservation have not been implemented, but it seems to
314 be used only as a last resort. For example, Laurent smelt the milk in the experiment and
315 decided to keep it. He seems to be accustomed to smelling and sometimes tasting milk at
316 home, when the bottles have been opened by other members of the household:

317 I may taste milk when I’m not sure. When children open a bottle of milk and then I can taste it or smell it
318 too... Well, yes, I did smell it a couple of times, but I wouldn’t taste it. Well, I would say it’s only the
319 bottles, because the rest... No, I’m not used to tasting it. Well, I’m careful. I don’t leave it for ages in the
320 fridge.

321 In some cases, sensory evaluation prevails over other information, such as use-by dates.
322 Several participants reported having immediately thrown away unexpired and unopened
323 meat wrapped in plastic film at home: i.e., the smell or appearance made it obvious that it
324 was inedible. Therefore, for particularly fragile products such as meat, sealed industrial
325 packaging does not appear in itself to be a guarantee of sanitary quality: visceral experiences
326 are then decisive. For instance, Laurie reported having thrown away packaged meat as soon
327 as she opened it because of a strong smell. Here, she explicitly questions the packaging
328 practices of a supermarket chain that is not the one she usually goes to:

329 *Have you ever thrown any away?*
330 Meat? It’s extremely rare! But actually, sometimes we go shopping at [supermarket], and several times
331 the meat we bought was... We should have brought it back because when we opened the package, it
332 was tightly [sealed], and when we opened it, it was spoiled! So I wonder if it hadn’t been repackaged.
333

334 This distrust of meat products is also noticeable in the experiment. She threw away the ground
335 beef and the ham because the packages were open and the yoghurt because the date had
336 passed. However, she kept the leftover meat in sauce, and said she would reheat it.
337 Other participants mentioned similar situations in their domestic supplies, but they
338 referred to a probable break in the refrigeration chain at some point. Accounts of past
339 experiences are provided to illustrate an association between sensory perception (e.g., odor

or visual appearance) and edibility. This embodied knowledge is used to sort leftovers, and this is even more visible in the experiment because the leftovers were not generated by the household.

4.2. Discarding or keeping as the result of a sorting process linked to other domestic practices

Some discrepancies appear between the results of the experiment and the domestic practices that the participants described. For instance, meat is regularly associated with strong health risks and caution and during the kitchen experiment it turned out to be among the most frequently discarded products (i.e., ground beef and sliced ham). The in-depth interviews showed that meat is among the food products that participants express least willingness to discard because of its symbolic value and/or price. In the kitchen experiment, they had not filled the fridge themselves and they knew little of the way the ground beef or sliced ham had been handled. This may explain the discrepancy between the practices observed during the experiment and those reported by the participants during the interviews. At home, interviewees say they store products to align as far as possible with their criteria (e.g., sensory data, health), or they are sure to use the products as long as these criteria are met. Storage practices may prevent consumers from wondering whether they should throw away or use a dubious product. The outcome of the sorting process refers to a number of food handling practices, linked to storing or reusing leftovers.

4.2.1. Freezing

The main technique to extend the lifespan of foods seems to be freezing of fresh produce as well as leftovers from cooked dishes.

Freezing is primarily used for meat to “neutralize” its use-by date and relieve the urge to consume it quickly. Moreover, managing turnover reduces the risk of food waste resulting from a potentially forgotten item. Frédérique, who during the experiment discarded the ground beef, meat in sauce, and slice of ham, explains that at home she systematically freezes the meat leftovers, so as to avoid waste:

> If it (the meat) is fresh, I’m going to be careful with the date, but as long as I take it and put in my freezer, I am not at all careful anymore. Besides, I don’t even know how long meat can be kept in the freezer, because there are certainly some rules. But I know that it never stays... Let’s presume that if I put meat in my freezer, it will never stay in it for two months. Because... often, when I buy meat, I don’t

> put the dates of when I bought it, but I know what I bought. And we only use what I've bought for the longest time.

Freezing also fulfils this regulating function for home-cooked dishes that are prepared in excess. These leftovers are often frozen in portions; they are used for convenience and are very useful. Therefore, freezing is a twofold response to the desire to avoid waste and the risks of consuming "old" leftovers. The unused surplus then regains a symbolic value once frozen. During the experiment, Florian only threw away the banana, which to him did not look right. He planned to use up all the leftovers within two days to avoid losing anything. At home, freezing allows him to relax the constraint of planning quick use for leftovers:

> Since I don't want to stress out right away by psyching myself out about how I'm going to proceed, I put in the freezer and then I take it out the next day or the day after. And that's when I give it a second life. That's right. But when the amounts I have left are really too substantial … So it's a good thing I have the freezer. It does help me actually.

While immediate freezing is primarily related to storage concerns for products or dishes that cannot be consumed in the very short term, delayed freezing is more often described as a means of managing the health risks of a perishable product that cannot be stored longer in the refrigerator and may be discarded at short notice. As such, it is often a method that respondents report using to avoid waste. Delayed freezing does not occur immediately after purchase or food preparation, but rather after a variable period of time, from a few hours to a few days. It is used not only in cases of excessive production, but also when the use-by date is looming and the product will not be cooked by then, or even when the use-by date has passed by a day or two:

> Well, as I was saying to my husband… I said to him, "Listen, about the meat, we're not going to force ourselves to consume just for the sake of consuming." [...] You know, forcing ourselves to cook things in order to eat them, no way! We can put it in the freezer! The refrigeration chain is respected, the date has not passed; it's one day ahead the expiry date, and presto! This way we can consume it later. (Victorine)

> As soon as we feel that things are close to slipping, and when freezing is possible, I actually prefer to freeze, even if it's for two or three days. And then thaw it to cook it afterwards. (Richard)

Freezing also enables people to deal with unexpected events leading to surplus cooked food that loses its immediate utility in an unanticipated way: e.g., a last-minute invitation or a dish brought in from outside.

4.2.2. Home conditioning of leftovers

Some of the products placed in the fridge for the experiment were considered to be inedible due to unsuitable storage. Some participants mentioned that bananas blacken in the cold so it was a mistake to place them in the refrigerator. Others insisted on the containers used to store the product. For example, Frédérique threw away the ham during the experiment because it was only covered with cellophane, unlike the chicken breast, which was in a container. She said that at home she stored this type of product in airtight containers, which keep foods better and enable her to monitor them and ensure that the product is still edible by smelling it:

> If there's some ham that's open, I know I'm going to put it in a container so that it's... so that I feel like it's better than in simple cling film. I will eat it without any problem, as long as when I open the container the smell doesn't bother me.

On the one hand, packaging considered to be unsuitable may result in food being discarded, whether on the grounds of appearance, altered taste, or health risks. On the other hand, packaging considered to be suitable is often subject to multiple trial and error to facilitate quick and simple reuse of leftovers: e.g., storage in the fridge or in the freezer in a microwaveable container or an ovenproof dish are ways to avoid transferring from dish to dish and additional washing. Bruno's awareness of the health risks associated with industrial packaging comes from previous professional experience. He is a transport warehousing manager but has previously made deliveries in refrigerated trucks, which explains according to him that he cleans his fridge twice a month and uses airtight containers for all half-eaten products to limit the risks of contamination through the packaging:

> Sometimes we go to buy stuff, and we don't unpack it ... we put it in the fridge right away. We go shopping, well, take the yoghurts: we put everything in the compartments, but you know, it's been dragged around a bit. So meat, or a prepared dish, even without a cover are more likely to catch bacteria and everything that comes with it, than once it's been wrapped. […] I've made big deliveries like this, and I know exactly how it's done. The fridges aren't cleaned; I mean the trucks. The refrigerated trucks are not always cleaned, the food is sometimes dragged around in places a little... Anyway, I'm speaking from experience.

This attention to packaging was also apparent in the experiment. He kept nearly all the products, commenting on how long the packages had been open or unrefrigerated—less than three days, which did not seem to be a problem for him. He only threw away two products:

ground beef in an opened package, because ground meat is a sensitive product, and expired yoghurt.

Thus, the evaluation of products is directly linked to their organoleptic characteristics and storage conditions. It is also linked to the later use of the products.

4.2.3. Reusing leftovers

Leftovers in small quantities may be considered of poor value and not worth reheating, especially for large families. Whether they are discarded or kept then relies on culinary practices. Some participants report that if served a second time in the same way, the leftovers would not be eaten. Cooking a new dish then gives new value to the leftovers. For instance, Fabien changed the way vegetables were served whenever his children did not eat them the first time:

> Kids don't get hooked the first time. You get screwed; you tell them: okay fine, you'll eat some tomorrow. So, when we serve the dish again, we do it differently to make it easier for them.

In the experiment, he threw away only the banana, because it looked too bad, and the pizza, mainly because of the aluminum wrapping. He kept most of the other leftovers, including those in very small quantities, stating, "It helps out." For instance, he foresees a recipe combining the cream and the tomato sauce to make a sauce for the pasta that he will eventually reheat with the grated cheese or curried chicken. The surimi or the ham could "help" if one of the children did not like it.

Thus, the performances of sorting observed during the experiment are in line with some domestic habits. Some participants cook often "on purpose," for future second use at home or at work, and hesitate to describe this surplus as leftovers:

> I'll cook beef bourguignon, I'll cook veal stew, something simple, usually a single dish. Or I'll cook a tagine, you know, things that are easy to make, a far as I'm concerned anyway. [...] In general, I make sure there is enough for two meals, so we can eat some more, not the next day, but two days later. This way, I'm avoiding a bit of the headache of thinking about what to cook. And if I have to cook, if I have to spend some time cooking, I might as well cook for two meals, if it's good and if it can be reheated two days later. (Béatrice)

Béatrice decided not to keep the sliced ham and chicken, cream or tomato sauce for sanitary reasons, considering that those products could have been touched by others. She also threw away the pasta, arguing that it is dry when reheated; but she kept the curried chicken and the beef and gravy, finding that "it is even better reheated."

Sanitary concerns are not only linked to the hygiene of others, but also to the proximity with other food products in the fridge and potential contaminations. For instance, in Richard's case, rejection of food waste combined with serious concerns about microbiological risks (he described the refrigerator as a "breeding ground for bacteria") are dealt with through the cooking process, especially for animal protein. Meat is then cooked thoroughly:

> So, as soon as I have a small doubt about smell or appearance, meat a bit shiny, a bit glossy, or pork—it is not great to store it anyway—things like that… Or eggs: when it's been too long, you know, we'll hard-boil them.

These concerns are also identified throughout the experiment: e.g., he threw away the ground beef, arguing that "it's not worth getting sick for a steak," but he kept the ham and chicken breast to make a quiche (thus cooking them again) and plans to make a ratatouille with the slightly damaged tomatoes. He also paid attention to taste. He threw away the pizza slice and the pasta for two reasons: it would not taste good when reheated, and it would be "nicer" to eat fresh.

In summary, participants reported other practices to avoid food waste, before and after the specific moment of sorting the contents of the fridge. These practices, relating to storing and cooking food, were mentioned both during the experiment—to explain why participants decided to keep or throw away the various products in the experimental fridge—and during the in-depth interviews, when they detailed their food habits at home. They rely both on material processes (such as freezing or microwaving) and on past experience acquired. These anterior experiences enable participants to anticipate whether leftover food will be palatable once reheated. We insisted here on global patterns, and on domestic practices of food handling, but in some cases we also identified intertwined domestic and professional practices, for those of our participants who work or used to work in the food industry sector.

5. Discussion

The methodology of our study was to place people in an unusual situation to ascertain their views on a routine activity from an experiment in sorting leftovers coupled with in-depth interviews about domestic food-handling practices. Even if the general discourse of the interviewees indicates a commitment to food waste prevention, the ways in which this is

implemented vary greatly in the performances observed. Sorting may lead to food being kept or disposed of in many different ways from one food item and participant to another, although the material settings and the fridge content were strictly the same for all participants. Sorting appears to be weakly regulated: e.g., there is no single manner reported to be appropriate. This can be explained by its nature as a "compound practice" such as eating (Warde 2013). Here, we develop the main integrative practices involved and then we draw some conclusions concerning engagement in the practice of sorting and the degree to which it generates food waste.

5.1. Sorting as a compound practice

Warde (2013) shows that eating can be considered a "compound practice," which can be analyzed as the intersection of four relatively autonomous practices: the supplying of food, cooking, the organization of meals, and judgments of taste. This framework can also apply to the sorting of leftovers. Here, the question of supply appears to be linked to preparation and storage techniques. The discrepancy between the presentation of products in the experiment and the participants' domestic techniques reveals the attention paid to such elements, which are often an unspoken set of habits. We deliberately presented the leftovers in a range of conditions to have people react to this point. For instance, the use (or absence) of aluminum foil, plastic, or glass containers was often mentioned in the subsequent interviews and appeared to be a way to preserve the organoleptic as well as sanitary properties of the food in the fridge.

Another component of the practice is cooking, which introduces the question of reusing leftovers. Sorting food items involves planning dishes that could be prepared with them, be it simply reheating or recombining the leftovers with other items to create a new dish. The items considered to be inappropriate for reuse, e.g., unappetizing food or insufficient amounts, end up in the garbage can. Moreover, cooking is also relevant here, as in the experiment participants had to handle foods that they had not cooked themselves. This makes the differences between the performances observed in the experiment and the domestic practices described by participants partly understandable. Considering a dish to be edible varies depending on whether it was prepared by oneself or another person (leftovers of cooked dishes) or prepared through an industrial process (grated carrots). These differences can tip the balance either way.

Meal organization appears to play an important role in the sorting of leftovers. First, some leftovers appear unfit for consumption by some members of the family, mainly children. The strong connection between food waste practices and meal organization has been outlined by Southerton and Yates (2015), who mainly discuss the types of meals from which leftovers remain. In contrast, we consider the future use intended for surplus food. Some interviewees report their use of leftovers to be a quick and easy lunch to reheat at work, e.g., when there is no canteen. Such leftovers may then take on a specific value in relation to the organization of meals at work. Some families seem to have meal practices that are adapted to the consumption of small amounts of leftovers, for instance appetizers with small portions of whatever is left (such as pizza slices or pieces of ham on bread and butter), whereas for others, leftovers are not considered to be a proper family dish. Some families insist on eating the same dish, so whenever the leftovers are not sufficient for all, they are considered unusable. Depending on the predicted use, interviewees then may have a different assessment of the same product.

The last component mentioned by Warde (2013) as an element of eating is the judgment of taste of food. He mentions gastronomy as an example of codification. For family meals, we can see that some food items are considered to be unfit for some meals, such as leftovers for family dinners. Moreover, in sorting fridge items, judgments of taste are associated with the use of smell to assess edibility. People also rely on embodied knowledge to forecast whether consuming leftovers will be pleasant for themselves or their family members. For instance, looking at some items gives clues about their taste, e.g., slices of ham or pizza may look desiccated, so people say they are probably not good to eat. Touching is also a way to assess the probable taste of an item, especially for fruit and vegetables. Past experience then allows to assess the taste of food without actually tasting it.

5.2. Sorting: A weakly regulated practice

The lack of consensus among the participants about the proper way to keep leftovers was noteworthy. This practice varied greatly, even though they were all confronted with the same set of products in the experiment. This indicates weak regulation of the practice of sorting leftovers. In relation to the different components of the practices listed above, a variety of rules apply to the performance of sorting leftovers.

559 In general, and not surprisingly, all participants had a very negative perception of food
560 waste and said they avoided it. The discarded food products are in many ways discredited,
561 either in the experiment or when reporting household practices. When a food item is no
562 longer considered to be edible, its disposal is less associated with waste (Evans 2011).
563 The first criterion that counterbalances waste prevention concerns health: i.e., food that
564 raises doubts may soon be considered inedible and participants throw it away without too
565 much hesitation, considering that it is not worth risking illness. This health criterion is
566 especially important as we selected households with children, and the adults in charge of food
567 preparation are also responsible for keeping their family members healthy. This concern with
568 health risks, to which other studies also attest (Evans, 2011; Watson and Meah 2012), appears
569 to be extremely variable among the participants' households, and derives directly from past
570 experiences. Food poisoning may have made participants more cautious. In some cases,
571 professional knowledge was also used to evaluate products, particularly by those respondents
572 who had worked in the agri-food sector: attention paid to transport and cold chain, or storage
573 conditions, were thus mentioned.
574 Reliance on information from commercial organizations also varies greatly, from those
575 who trust the use-by dates and labels on the packaging to those who consider this information
576 to be doubtful and tend to combine it with other evaluation modes, either to dispose of some
577 food items (even when the date has not passed, an item with a foul smell or suspicious
578 appearance may be discarded) or conversely keep them (some reported overlooking the dates
579 when the appearance of the product seemed fine to them).
580 Furthermore, experimental participants had to deal with products that they had neither
581 bought themselves nor cooked. Some items were discarded with little regret because they did
582 not conform to family habits. Thus, products considered to be "commercial" (such as
583 tabbouleh, grated carrots, or surimi) were sometimes discarded without further ado, or
584 disqualified because of their nutritional composition (too much oil in the carrots). Those likely
585 to have been contaminated by contact with other people, either by touch (slices of ham) or
586 by saliva (opened jars of fresh cream or tomato sauce), were discarded for this reason by some
587 participants. At home, they have more control over the handling of products and are better
588 able to know whether the hygiene rules they consider essential have been respected. Here
589 again, this question sometimes arises from comments about children and the need to teach
590 them proper behavior.

591 Finally, to be considered edible, some products must simply be good and pleasant to
592 eat. This viscerality criterion can disqualify some items, such as the dried slice of pizza or the
593 blackened banana, which are more often discarded because of their expected palatability
594 rather than health risks. The edibility of a leftover is thus based on its harmlessness in terms
595 of health and nutrition, as well as on its conformity to consumer expectations, both in terms
596 of preparation and taste.

597 The main limitations of our study relate to the selection of households implied in the
598 experiment. We purposely selected households with at least two children and two working
599 adults living in Parisian suburbs; given that that parents of young children devote particular
600 attention to health and sanitary issues, this means that consumers less concerned with health
601 preoccupations were probably underrepresented in this study. Domestic spaces in this living
602 area are often small, reducing the overall quantity of household equipment. We also know
603 that time constraints are strong for working households living in this area, with long
604 commutes. To obtain a uniform assessment of the leftovers in the fridge, we also chose to
605 exclude people with food allergies or specific diets (e.g., for religious or other reasons, such
606 as vegans), and this makes a narrower cultural span for participants. Furthermore, the
607 laboratory conditions create a specific context for the sorting, so the observed performances
608 relate to the study setting. The experiment does not so much tell us about what participants
609 do at home—they lack the histories of the foods in the fridge, unlike the products they
610 purchase themselves—yet the laboratory conditions help to reveal some aspects of the
611 sorting process that are usually not made explicit. The discrepancies in equipment also
612 influence the differences between the experimental situation and home cooking, in relation
613 to time: resorting to freezing, which is impossible in experimental situations, could in some
614 cases have prevented waste (e.g., the ground beef could have been frozen as soon as the
615 package was opened). Even with these restrictions, we observed various food-sorting
616 techniques and ways of reusing leftovers.

617 **6. Conclusion**

618 Food waste often appears as the result of a gap between the food purchased and the
619 food eaten that ends up in the garbage can once people are convinced that they will not eat
620 it, either just after a meal, when cleaning up, or sometime later. It is also the outcome of a
621 sorting process, where people assess the edibility or potential use of a given food item. In

order to shed light on this step leading to keep or to dispose of, we adopted a pluridisciplinary approach between sensory analysis and sociology, aiming at articulating sensory perceptions, embodied knowledge, different kinds of concerns about food (health, taste, foreseen usage), all interplaying in the sorting out of leftovers performance. The experimental tasks and subsequent interviews aimed at deconstructing routines that are well known to play a role in food waste (Stancu *et al*. 2016).

Firstly, the experiment enabled us to make more explicit the criteria used to decide whether to keep or discard. In comparison with the products they choose to discard, consumers often take more precautions with the products they keep, so they evaluate them in greater detail. Whenever the products have a use-by date, this is most often considered to be a reliable criterion; but when the benchmarks provided by the market, e.g., packaging and use-by dates, are removed, and even in some cases in addition to these benchmarks, consumers rely heavily on their senses and visceral experiences when evaluating a product. This mobilization of the senses may also be based on past experiences and a memory process (Longhurst *et al*. 2009), which are beyond the scope of the present paper. In some cases, though, such as butter and orange juice, routine predominates and the products are kept without any examination. Secondly, the interviews led us to reembed the sorting of leftovers and surpluses in a broader chain of food-handling practices. The comparison between the experiment and interviews about domestic life shows, in contrast, the importance of some food handling routines in the prevention of food waste (such as putting leftovers in a proper packaging, not storing bananas in the refrigerator, or deep-freezing ground beef). Moreover, the overview of all performances, observed in the experiment and related in the interviews, shows that they greatly vary. Considering each food item, or each participant, we can hardly draw any pattern about the sorting out performance. This high volatility reveals a weak regulation of the practice, that we can interpret as a “compound practice” (Warde 2013). The location of the sorting out practice at the junction of practices situated upstream (storing the leftovers after having cooked some of them) and downstream (foreseeing their taste, their use) explains its engagement with various goals such as food waste prevention, maintaining health, or providing enjoyable family meals. Embodied knowledge appears as crucial in order to foresee how leftovers could be eaten safely or judged as palatable.

Thus, using mixed methods and a practice-theory perspective proved beneficial and should be of interest for future studies on food waste. For instance, such an approach could

be used to compare the practices between household members—between partners, but also between parents and children—and would further our understanding of why food is discarded at home. From a methodological point of view, this combination of methods also proved heuristic in leading people to make explicit their reasoning and elaborate about routinized and embodied performances.

In helping understand the actual practices of consumers, the results of this study could prove useful to policy makers or health professionals for recommendations regarding domestic refrigeration, food storage and assessment practices. Health risks are among the main reasons why people throw away leftovers, however they may not be accurately assessed; inadequate practices may come from an unawareness of pathogens and a minimized health risk that sensory factors cannot assess. An educational campaign giving clear information about how long specific categories of food products should be kept in the fridge—such as raw meat or cooked dishes—may be a way for policy makers to promote food waste prevention not only through sensory assessment, but also through simple temporal benchmarks. More generally, we argue that the common representation of a proper family meal as a meal that should be the same for all and made from scratch is a dominant norm that could be worked on by policy makers and the media, especially food TV shows. An emphasis on leftovers as a valuable and enjoyable component of family meals may be easily emphasized, as a way of avoiding food waste, but also as a way of introducing variety and choice within the meal.

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Authors' contributions

All authors contributed equally to the data collection protocol. X was in charge of the experimental part of the study. She concentrated specifically on the statistical part of the

analysis and on the short interviews following the experiment. Y supervised X's post-doctoral work. W and Z analyzed the in-depth interviews and built the theoretical framework. All authors have contributed to the writing of the paper and have approved the final manuscript.

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832 **Appendix**

833

834 Annex 1: Food products and their characteristics

Food product	Type	Packaging	State	Use-by date*	Amount
Banana	raw	none	blackened	none	2
Butter	processed	wrapping paper	already used	visible	1
Fresh cream	processed	opened plastic pot, no lid	already used	visible	1
Grated cheese	processed	opened resealable plastic pouch	already used and slightly dried	visible	1
Ground beef	processed	individual plastic package closed with cellophane	raw	none	1
Meat in sauce (chicken)	homemade	transparent plastic box	already cooked and used	none	1
Milk	processed	plastic bottle	already used	visible	1
Orange juice	processed	cardboard bottle	already used	visible	1
Pasta	homecooked	transparent plastic box	already cooked and used	none	1
Plain yogurt	processed	sealed	expired used by date (3 days)	visible	4
Shredded carrots	processed	plastic box with lid	already used and slightly dried	visible	1
Slice of chicken	processed	plastic box with lid	already used and slightly dried	none	2
Slice of pizza	processed and re-heated at home	plate covered with aluminium foil	already cooked, used and slightly dry	none	2
Slice of ham	processed	plastic package covered with cellophane	already used and slightly dried	none	2
Surimi	processed	unsealed plastic box	already used	not visible	1
Tabbouleh	processed	plastic box with lid	already used and slightly dried	visible	1
Tomato	raw	none	slightly damaged	none	4
Tomato sauce	processed	glass pot	already used and slightly dried	visible	1

835 * All products with visible use-by dates were not expired, but for the yogurts.

836 Annex 2: Participants to the in-depth interviews

Pseudonym	Age	Age of children	Occupation	Education	Gross household income
Anne	36	11 and 6	accountant	baccalaureate	36-50 000 €
Audrey	37	9 and 7	police officer	baccalaureate	36-50 000 €
Béatrice	46	11 and 9	sales representative	bac + 2	66-80 000 €
Bruno	49	17 and 13	transport warehousing manager	certificate of professional competence *(CAP)*	20-35000 €
Christophe	43	13 and 11	police officer	bac + 3	51-65 000 €
Claire	41	18 and 16	laboratory technician	baccalaureate	20-35 000 €
Fabien	37	18, 14, 5 and 3	computer scientist	baccalaureate	20-35 000 €
Fatima	47	20, 19 and 17	administrative assistant in social service	baccalaureate	less than 20 000 €
Florence	39	13 and 7	entrepreneur	bac + 3	36-50 000 €
Florian	45	15 and 10	technical salesman in stationery	bac + 3	51-65 000 €
Frédérique	41	13 and 13	laboratory technician	bac + 2	51-65 000 €
Hervé	47	20 and 17	sales representative	certificate of professional competence *(CAP)*	*36-50 000 €*
Julia	43	13 and 9	financial manager	master's degree	36-50 000 €
Karima	47	13 and 9	polyvalent officer	junior high school certificate (*brevet*)	less than 20 000 €
Laurent	46	20, 18, 18, 16 and 15	supervisor in Parisian transport	certificate of professional competence *(CAP)*	51-65 000 €
Laurie	46	12 and 9	school life assistant	master's degree	36-50 000 €
Magalie	41	14 and 11	Tupperware culinary advisor	baccalaureate	20-35 000 €
Mylène	37	16 and 13	housewife/jewelry designer	baccalaureate	20-35 000 €
Pauline	35	8 and 8	nurse	bac + 3	20-35 000 €
Richard	42	15 and 10	entrepreneur	baccalaureate	36-50 000 €
Sophie	34	8 and 6	independent direct seller in jewelry	bac + 2	36-50 000 €
Stéphanie	43	17 and 14	sales representative	bac + 2	36-50 000 €
Sylvie	49	16 and 14	housewife	doctorate	51-65 000 €
Tiphaine	43	14 and 6	project assistant	bac + 2	36-50 000 €
Victorine	49	32 and 18	police officer	baccalaureate	66-80 000 €

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