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Perceptions of food waste: is there a numerosity bias?

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Abstract
While individuals are expected to perceive similarly identical quantities, regardless of the used units (e.g., 1 ton or 1000 kg), several scholars suggest that consumers over-infer quantities when they are presented in bigger and phonetically longer numbers. In two experimental studies, we examine this numerosity bias in the context of household food waste. Unlike previous scholars, manipulating numerosity revealed no effect: perceptions of food waste volume and likelihood to reduce it are not influenced by the used numeric value (2500 g vs. 2.5 kg; Study 1) nor the number of syllables (two kilos eight hundred seventy-five grams vs. three kilograms; Study 2).

Keywords: Food waste; framing; heuristics; numbers; numerosity bias; survey experiment
JEL codes: C99; D91; Q18

1. Introduction

Household food waste is increasingly pointed out by several reports as a major issue. The United Nations Environment Program (United Nations Environment Programme, 2024) reported that households were responsible for 60% of the total food wasted in 2022 and that 'on average, each person wastes 79 kg of food annually.' While the literature examined several strategies to reduce food waste like increasing consumers' awareness and adapting portions of food products (e.g., Hamerman, Rudell & Martins, 2018), an overlooked dimension relates to the used numbers and their framing in communications and reports.

For instance, is wasting 1,000 kg of food equivalent to wasting 1 ton? Does a waste of one thousand and eight hundred and fifty grams (1,850 g) more important than a waste of two thousand grams (2,000 g)? For a rational mind, there is no debate: In the first question, the quantity is identical, regardless of the used unit, while in the second one, 1,850 g is obviously lower than 2,000 g. Nevertheless, these seemingly simple situations can be disturbed by the 'numerosity bias,' that is, the human tendency to over-infer quantities when represented with higher numeric values or phonetically longer denominations, that is, they have more syllables (Pelham et al., 1994; Shrivastava et al., 2017; West et al., 2020).

This bias has been studied in various settings such us resource allocation (Pelham et al., 1994; Shrivastava et al., 2017), discounts (Pandelaere, Briers & Lembregts, 2011), money estimation (Raghubir, Capizzani & Srivastava, 2017), and stock splits (West et al., 2020). Nevertheless, while it can be potentially leveraged to design more effective food waste messages, no study has examined its

Table 1. Experimental design

Treatments	S1: Larger number because of a unit change (Testing H1 and H2)	S2: Size of the phonetical denomination (Testing H3 and H4)
T1	2.5 kg	Three kilograms
T2	2500 g	Two kilos eight hundred seventy-five grams

importance in this context. Thus, the objective of this short communication is to fill this gap. First, we test the effect of using a higher numeric value vs. a lower numeric value on individuals' perceptions of an identical food waste quantity (Study 1). Second, following other scholars (e.g., Coulter et al., 2012; Shrivastava et al., 2017), we also test whether a lower food waste quantity presented in a phonetically longer denomination is perceived as higher than a lower quantity presented in a phonetically smaller denomination (Study 2).

The next section develops the conceptual framework and draws hypotheses. Sections 3 and 4 are devoted to Study 1 and Study 2, respectively. Section 5 is devoted to the discussion and implications. Section 6 concludes.

2. Background and hypotheses

The seminal works of Daniel Kahneman and Amos Tversky have demonstrated that perceptions and decision-making are frequently influenced by various heuristics and biases, leading to systematic and predictable errors (e.g., Tversky & Kahneman, 1974, 1981). Actually, because individuals often have a difficulty in processing numeric data, they rely on the numerosity heuristic (Pelham et al., 1994; Shrivastava et al., 2017; West et al., 2020). Accordingly, individuals are influenced by (*i*) larger numbers and distracted by unit manipulations (120 minutes are perceived greater than 2 hours) and (*ii*) phonetically longer numbers that are perceived greater than phonetically smaller ones (two thousand eight hundred seventy-five greater than three thousand). Thus, we formulate the following hypotheses:

- H1. Food waste expressed in a higher numeric value is perceived greater than an equivalent quantity in a lower numeric value.
- H2. Individuals are more likely to reduce food waste when it is framed in a higher numeric value, compared to its lower equivalent.
- H3: Lower food waste expressed with a phonetically longer denomination is perceived greater than a higher food waste with a phonetically smaller denomination.
- H4. Individuals are more likely to reduce food waste when it is framed in a phonetically-longer denomination, compared to a phonetically lower one.

In order to test our hypotheses, we conducted two experimental surveys. In Study 1 (S1), there are two treatments (T1 and T2) with an identical and realistic food waste quantity expressed in different units (2.5 kg in S1T1 versus 2500 g in S1T2). In Study 2 (S2), we compare a higher quantity expressed with few syllables (three kilograms in T1) and a smaller quantity expressed with more syllables (two kilos eight hundred seventy-five grams in T2). Table 1 below depicts the flow across studies.

3. Study 1

3.1. Participants and design

147 participants (73% female, M = 21 years old) from a French school of agricultural engineering received an email invitation to join the experiment via a link. Participation was anonymous, voluntary, and without any compensation.

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Table 2. Mean responses for food waste quantity and likelihood to reduce it

Variable	T1 (2.5 kg) (N = 71)	T2: 2500 g (N = 76)	Wilcoxon test (p value)
This quantity of food waste is high	6.19	6.09	.3894
This statement encourages me to reduce food waste	5.73	5.71	.6316

Table 3. Effect of larger numbers on food waste reduction

Variables	Coefficients and significance (SE between brackets)	
T1 (2.5 kg) (*Ref*)	.	.
T2 (2500 g)	.036 (.238)	2.472 (1.529)
Food waste level	.460*** (.127)	.662*** (.178)
Food waste practice	−.156 (.111)	−.166 (.110)
Age (continuous)	−.038 (.065)	−.047 (.065)
Gender (=1 if female)	−.186 (.271)	−.185 (.270)
Treatment#Food waste level	.	−.396 (.292)
Constant	4.136*** (1.537)	3.125** (1.611)
Observations	147	147
F	3.53***	3.41***
R2	.1112	.1274

*** and **stand for parameter significance at the 1% and 5% levels, respectively.

We designed a between-subjects experimental survey with random assignment across treatments. Specifically, participants read a realistic statement about food waste in France, framed either in a low numeric value (T1: 2.5 kg) or a higher numeric value (T2: 2500 g), precisely:

> According to recent data from the environment and energy management agency (ADEME) and the Ministry of ecological transition and territorial cohesion, food waste in France during the consumption phase is 2.5 kg *[versus 2500 g in T2]* per person per month (https://www.ecologie.gouv.fr/gaspillage-alimentaire).

Participants were then asked to evaluate this quantity of food waste on a 7-point Likert scale (1: very low; 7: very high). They were also asked to indicate whether the statement above encourages them to reduce their food waste (1: does not encourage them at all; 7: strongly encourages them). Finally, in addition to age and gender, individuals were also asked to indicate their own practice in terms of food waste on a 7-point Likert scale (1: I waste very little; 7: I waste a lot).

3.2. Results

Mean responses (Table 2) suggest that perception of food waste volume and likelihood to reduce it were not affected by our numerosity manipulation. Analyzing the effect of the treatment on the likelihood to reduce food waste in a regression controlling for the perceived level of food waste, participants' own practice, age, and gender (Table 3), confirms that H1 and H2 are not supported. Interestingly, individuals who perceive the food waste volume as high are more likely to reduce it, regardless of the treatment (the interaction between the two variables is not significant).

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Table 4. Mean responses for FW quantity and likelihood to reduce it

Variable	T1 (three kilograms) (N = 84)	T2 (two kilos eight hundred seventy-five grams) (N = 61)	Wilcoxon test (p value)
This quantity of food waste is high	6.02	5.81	.0970
This statement encourages me to reduce food waste	5.85	5.62	.2439

Table 5. Estimation of the effect of phonetical denomination on food waste reduction

Variable	Coefficients and significance (SE between brackets)	
T1 (three kilograms) (*Ref*)	.	.
T2 (two kilos eight hundred seventy-five grams)	−.133 (.216)	−1.053 (1.167)
Food waste level	.454*** (.095)	.393*** (.122)
Food waste practice	.088 (.111)	.086 (.111)
Age (continuous)	−.015 (.032)	−.011 (.032)
Gender (=1 if female)	.154 (.242)	.142 (.243)
Treatment#Food waste level	.	.156 (.194)
Constant	3.541*** (1.235)	3.441*** (. 973)
Observations	144	144
F	4.98***	4.21***
R2	.1518	.1558

***stands for parameter significance at the 1% level.

4. Study 2

4.1. Participants and design

144 other participants (74% female, $M_{age} = 21$ years old) were recruited the same way as in Study 1.

We used a similar between-subjects design as in the first study and asked participants to answer the same questions. The only change compared to Study 1 relates to the vignettes that are framed by using phonetically smaller versus longer denominations, precisely:

> According to recent data from the environment and energy management agency (ADEME) and the Ministry of ecological transition and territorial cohesion, food waste in France during the consumption phase is around three kilograms *[two kilos eight hundred seventy-five grams in T2]* per person per month (https://www.ecologie.gouv.fr/gaspillage-alimentaire).

4.2. Results

Unlike our prediction (H3), two kilos eight hundred seventy-five grams of food waste are perceived lower than three kilograms and intentions to reduce food waste do not vary significantly across treatments (Table 4). Examining the effect of the treatment on the likelihood to reduce food waste reveals that H4 is not supported (Table 5).

5. Conclusion

Despite its promising features to address food waste issues, our manipulations based on the numerosity bias failed to change food waste perceptions and raise awareness. Unlike previous studies, we considered the numerosity bias in a domain unrelated to money. In addition, our sample consisted

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of participants with backgrounds in agriculture and environmental matters, likely to hold strong normative beliefs, which may have reduced their susceptibility to numerosity bias related to food waste.

The ineffectiveness of our manipulation may also be attributed to two other key factors.[1] Firstly, the numerosity bias, typically observed in evaluative situations, may not apply to food waste scenarios that focus on divesting rather than assessing value. Interestingly, the domain analyzed in our study pertains to a very concrete 'bad' (Grolleau et al., 2025), whereas previous studies often examined more abstract 'goods' or less negatively connoted items, such as price discounts or sharing. Secondly, food waste is likely associated with disgust – an instinctual reaction that serves as a protective mechanism to avoid potential sickness. Discarded food may evoke feelings of contamination or decay, reinforcing negative perceptions (see, e.g., Davey, 2011; Horberg et al., 2009; Rozin & Fallon, 1987; Rozin et al., 2000). Disgust is often linked to the experience of nausea and prompts a need to expel possible harmful objects, potentially overriding numerosity appraisals. Moreover, when considered through the lens of affects-as-information or as-cognitive feedback models, negative emotions serve as a 'Stop!' signal and significantly influence decision-making (Huntsinger et al., 2014; Schwarz & Clore, 1983, 1988). This mechanism may explain why disgust exerts a stronger influence on food waste judgments than numerosity assessments. In sum, our findings suggest that the numerosity bias may have well-delineated scopes and that strong emotional responses can significantly shape decision-making processes, often superseding more abstract cognitive mechanisms.

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