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Love Food, Hate Waste? Ambivalence towards Food Fosters People's Willingness to Waste Food

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Abstract: Food waste is the origin of major social and environmental issues. In industrial societies, domestic households are the biggest contributors to this problem. But why do people waste food although they buy and value it? Answering this question is mandatory to design effective interventions against food waste. So far, however, many interventions have not been based on theoretical knowledge. Integrating food waste literature and ambivalence research, we propose that domestic food waste can be understood via the concept of ambivalence—the simultaneous presence of positive and negative associations towards the same attitude object. In support of this notion, we demonstrated in three pre-registered experiments that people experienced ambivalence towards non-perishable food products with expired best before dates. The experience of ambivalence was in turn associated with an increased willingness to waste food. However, two informational interventions aiming to prevent people from experiencing ambivalence did not work as intended (Experiment 3). We hope that the outlined conceptualization inspires theory-driven research on why and when people dispose of food and on how to design effective interventions.

Keywords: domestic food waste; ambivalence; date labeling; best before; theory-driven; intervention

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1. Introduction

Although resources are scarce and many people in the world are starving, about 30 percent of food is produced in vain, accounting for 1.3 billion tons of food waste per year [1]. To fight such food waste, plenty of initiatives have been instigated. For example, the "Love Food, Hate Waste" campaign (https://lovefoodhatewaste.com/, accessed on 31 March 2021) combines several approaches in which issues and solutions to food waste are communicated via various media outlets and during several face-to-face activities, like reduction challenges, roadshows, cookery courses, or workshops [2]. Two case studies in the UK demonstrated that such local-intensive campaigning over 3 to 6 months may reduce food waste by 15% (pre to post-campaign). This accounts for approximately 0.4–0.5 kg of wasted food per week and household [2].

Such a change is sorely needed, especially in industrial societies, where domestic households account for 34–52% of food being wasted [1,3]. This way, reductions in domestic food waste could alleviate climate, water, land, and biodiversity issues [4]. For instance, globally 3.3 Gtonnes of CO_2 equivalent are emitted due to edible food being wasted, which almost equals the total greenhouse gases emitted by China or the U.S. [4]. Reductions in domestic food waste could also have immense social implications. That is, only one-quarter of the total amount of food wasted worldwide would be sufficient to nourish all 820 million people that suffer from hunger [5,6].

Unsurprisingly, the United Nations has declared in their sustainable development goals in 2015 (SDG 12.3) that they aim to reduce domestic food waste by 50% until 2030 [7]. In this vein, research on intervention strategies has surged recently to determine how domestic food waste can be successfully reduced [8]. Two types of interventions can be distinguished: (a) structural strategies that aim at changing the situational conditions under which behavior occurs, and (b) informational strategies that aim at educating consumers

in order to change motivations, perceptions, cognitions, and norms [9]. However, there is mixed evidence on which strategies are effective in reducing food waste—especially regarding the easily implementable informational interventions [10,11].

In fact, many interventions claim to successfully reduce food waste although there exists little evidence for their effectiveness [8]. People are, for instance, frequently confused about date labels, misinterpreting *best before* and *use by* labels [12]. Consequently, it may be assumed that labeling knowledge—defined as the knowledge about correct interpretations of date labels—is a good leverage point for interventions to reduce food waste [13]. Intervention studies, however, show that merely informing people about the interpretation of date labels might not be sufficient to change people's preferences for expired food [14].

Such divergencies suggest that more research is needed on why and when interventions are successful [11]. Indeed, a recent review by Reynolds and colleagues revealed that roughly one-third of the studies that investigated how to effectively reduce food waste often do not rely on theory-driven assumptions when designing interventions—and even if they do, studies often do not incorporate previous research and theories as a focal point of their research [8]. Such a theoretical approach is mandatory, however, to understand the underlying processes and boundary conditions that promote food waste; this understanding in turn is a pre-requisite for designing effective interventions [9].

1.1. Understanding Domestic Food Waste via Ambivalence

Here, we propose that food waste behaviors may be theoretically understood via the experience of conflict [10]: On the one hand, people value food and avoid wasting food as it costs money and it is ethically questionable for social and environmental reasons [15]. On the other hand, people may dislike food due to quantity- and quality-related reasons [16]. In fact, the main reason why people dispose of food is its assumed durability. Most often, this is the case if food appears to be spoiled. Other reasons include that it looks unsavory, or just that the best before date has expired [16].

We suggest conceptualizing this conflict as ambivalence towards food. Ambivalence is defined as the simultaneous existence of positive and negative associations towards an attitude object [17]. We argue that associations towards food are typically positive being highly valued initially [18]. Negative associations, however, might arise, for example, when food is stored for a longer period of time. If time passes perceptions of reduced quality, including expectations of bad taste, and increased safety risks arise [19–21]: Fresh perishable foods, like vegetables and fruits, become wrinkly and dry; and semi-perishable foods, like yogurt and milk, or non-perishable foods, like pasta and rice, might pass their best before dates.

1.2. How Ambivalence May Affect Food Waste

These examples illustrate that ambivalence towards food may arise in many situations. For instance, imagine a person (Alex) who buys a pack of eggs to make a cake. At home, Alex does not use all of the eggs, however, and Alex stores the rest of them in the fridge. After a couple of days, Alex rediscovers the eggs but their best before date has expired. In this situation, Alex might think that the eggs could still be tasty and edible—leading to positive evaluations. At the same time, Alex might think that the eggs might taste bad or are not safe to consume—leading to negative evaluations. This opposition of evaluations towards one attitude object is called potential (or objective) ambivalence [17]. Because Alex now faces the decision to dispose of potentially good food or to eat potentially unsavory or spoiled food, potential ambivalence turns into felt (or subjective) ambivalence: Alex feels conflicted being confronted with the opposing evaluations and having to commit to one side [22].

Such felt ambivalence is aversive, and it is thought to affect people's behaviors. According to models of ambivalence [17,22], people initially try to delay their decisions when feeling ambivalent. Thus, Alex might grab some other food and close the fridge. This decision delay may serve two functions: Firstly, it helps people to initially displace the

conflict as the food is out of sight [22]; and secondly, we argue here that because food is perishable, associations towards food change over time, which resolves ambivalence as food is re-evaluated later [20]. That is, negative associations increase (e.g., it is more likely that food is spoiled) and positive associations decrease (e.g., it is less likely that the food is still as nutritious). In line with this prediction, qualitative studies show that people often delay their decisions to eat or dispose of food if they are conflicted about it [23]; and if time passes on, people argue that food has definitely become inedible allowing its disposal without feeling bad or guilty [23]. Thus, food may literally turn from good to ambivalent to bad—and then goes to waste.

Delaying decisions does not (always) resolve ambivalence, though. In fact, people might still experience conflict and negative affect if they face the decision again. So, if Alex discovers the eggs one day later, Alex again ponders whether the eggs are edible or spoiled. In this case, models of ambivalence would predict that Alex will try to deny the responsibility to avoid discomfort when deciding what to do [17,22]. In line with this idea, qualitative studies suggest that people indeed often obviate their responsibility when disposing of food [15,23]: Alex might, for instance, argue that suitable package sizes were not available in the supermarket. This reasoning allows people to reduce negative emotions, like guilt or regret, because it seems like there was no other option than to dispose of the food [22].

Without feeling personal responsibility, people are likely to use heuristic information instead of systematic processing, and they thus make decisions based on peripheral cues [17,22]. According to this idea, Alex might decide to dispose of the eggs based on the expired best before label—interpreting it as if the food has turned bad. However, if people still perceive responsibility and have the capacity to do so, they engage in systematic information processing: They try to weigh pros and cons against each other and gather new information to come to a decision [17,22]. Consequently, Alex might discover the information that one can determine whether eggs are safe to consume by putting them into water. Thus, Alex decides what to do by testing whether the eggs go down or emerge to the surface of the water. In line with this, research on food waste shows that consumption practices either include sensory testing (e.g., seeing, tasting, or smelling) or the direct disposal of expired food. These practices are crucial determinants for avoiding food waste: People who use their senses to sample food before disposing of it waste less [10,21].

1.3. The Present Investigation

In the present investigation, we argue that domestic food waste can be understood as the consequence of ambivalence towards food. In line with the proposed research agenda by Steg and Vlek [9], we aimed in the present investigation (1) to provide evidence that ambivalence is an important factor underlying domestic food waste, (2) to explore boundary conditions that favor the occurrence of ambivalence towards expired food, and (3) to test an effective intervention based on these findings. Thus, we conducted three pre-registered experiments, in which we induced ambivalence towards non-perishable food via best before labels. Then, we assessed people's willingness to waste this food. Additionally, we assessed people's labeling knowledge to explore a possible boundary condition of the effect.

In all experiments, we presented pictures of non-perishable food accompanied by date labels indicating varying shelf life [21]. We chose non-perishable food products as these products would only pose a subjective but not an objective safety risk when expiring. That is, we assumed that the mere perception of safety risk is sufficient to induce ambivalence. In Experiment 1 and 2, we aimed to provide initial evidence that ambivalence fosters domestic food waste. Specifically, we expected that expired best before dates increase ambivalence compared to production dates because their expiration could lead to perceived safety risks [21], but only in people not able to correctly interpret date labels (i.e., low labeling knowledge). In Experiment 3, we then tested an informational intervention strategy that aimed to prevent people from experiencing ambivalence towards expired food. That is, we

tried to increase people's labeling knowledge in one condition, and incrementally raise their awareness about the detrimental consequences of food waste in another condition [14].

Based on the guidelines of the German Research Foundation—suggesting that experiments without deception or high strain for participants do not need ethical clearance [24]—we did not apply for ethical approval for Experiment 1 and 2. However, protocols of all experiments have been approved by the local ethics committee in an application for ethical clearance for Experiment 3 (No. 15/2019). Pre-registrations, materials, data, and analysis scripts for all experiments are available on https://osf.io/xyp86/; descriptive statistics, zero-order correlations, and reliability analyses for multi-trial measures can be found in the Supplemental Materials.

2. Experiment 1

In Experiment 1, we asked participants to indicate their potential and felt ambivalence towards food via self-report. We hypothesized that: (1) if people are confronted with best before dates on food products, ambivalence towards these products is higher because evaluations of these products become more negative than if production dates are shown. This effect occurs only if the best before dates indicate that the food products are already expired. (2) The effect of suggested shelf life on ambivalence of expired food products is moderated by participants' explicit knowledge about date labeling of food products. That is, the higher the knowledge about date labeling, the lower the impact of the best before date on ambivalence towards expired food products. (3) In addition, we hypothesized that increased ambivalence towards expired food products heightens participants' willingness to waste these food products.

2.1. Method

2.1.1. Participants and Design

We recruited 224 participants (164 women, 60 men, M_{Age} = 31.04, age range = 18–69) via online recruitment on a university platform and via different social networks. Students received course credits for their participation; non-students were not compensated for their participation. Experiment 1 was conducted in a 2 (label type [best before date (n = 102), production date (n = 122)]) × 3 (suggested shelf life [long, short, expired]) mixed design with repeated measures on the last factor. Participants were randomly assigned to the between subject factor label type. The required sample size for the hypothesized two-way interaction for our first hypothesis was calculated via G*Power 3.1 [25] and revealed an N = 44 to achieve a power of $1 - \beta = 0.95$ while using a correlation of r = 0.5 for repeated measures, and considering a medium sized effect of d = 0.5—being found for ambivalent food stimuli [26]. Yet, we were not able to select an a priori effect size for Hypotheses 2 and 3 as there was no prior research on ambivalence in food waste. However, we gathered a greater number of participants to achieve accurate effect sizes [27,28]; based on feasibility, we aimed to achieve an N = 220. We achieved this sample; all data analyses were conducted afterward. In the following, we report all measures, manipulations, and exclusions of Experiment 1.

Note, that we sampled four participants more than planned because the online survey was not closed in time. In addition, 47 participants were sampled after the calendar month had changed. For these participants, the best before date suggesting short shelf life was expired. The pattern of results, however, was similar with or without these participants. We provide two filter variables via SPSS syntax on OSF which can be used to rerun the analyses with the respective samples.

2.1.2. Materials and Procedure

Experiment 1 was an online experiment using Questback EFS Survey in May and June 2019. Questions and items were presented in German.

Ambivalence

We measured potential and felt ambivalence towards nine out of 27 non-perishable food products, which related to nine categories: canned beans, canned fruits, vinegar, coffee, tea, noodles, rice, sugar, marmalade. These products were shown either next to a best before or a production date suggesting different shelf life. The date labels either indicated that the product had a long shelf life (i.e., the best before was set to two or three years in the future; the production date was set to the month in which the study was conducted), had a short shelf life (i.e., the best before was set to the month in which the study was conducted; the production date was set to two or three years ago) or that it was expired (i.e., the best before was set to a year ago; the production date was set to three or four years ago). The dates were specified by month and year (i.e., 0x.20xx) and they referred to the real best before dates that are typically used for the products. All pictures were taken from an existing brand with a simplistic design; we retouched the pictures and removed label names and nutritional values.

One picture out of every food category was selected and presented to the participants in random order; participants first answered two questions on potential ambivalence ("How positive (negative) do you evaluate this food product independent of its negative (positive) sides?") [26]. Answers were recorded on a slider from 0 (not positive/negative at all) to 10 (maximally positive/maximally negative). By these two items, a potential ambivalence score can be computed via the following formula: $(P + N)/2 - |P - N|$, where higher scores indicate higher ambivalence [29]. Subsequently, they were asked to answer one question regarding their felt ambivalence ("To what degree do you experience conflicting thoughts and/or feelings regarding this food product") [26]. Again, answers were recorded using a slider from 0 (no conflict at all) to 10 (maximal conflict). One randomly selected item out of each food category was randomly attached to a label suggesting long, short, or expired shelf life; thus, participants answered these questions nine times.

Willingness to Pay and Premeditated Waste

After assessing people's ambivalence, we again presented nine randomly chosen food products (one of each of the nine categories) while stating the original price next to the date labels. Out of the nine food categories, three randomly chosen food products were presented with labels either suggesting short, long, or expired shelf life. Using the methodology by Wilson and colleagues [30], we asked participants to think about their daily consumption and indicate their willingness to pay (WTP), and how much they believe to use from them for each of these products. Answers were assessed on a slider ranging from 0 to 100 percent. We computed a premeditated waste score (PW) by subtracting the percentage that people intended to use from the product from 100. Thus, the PW score indicates how much people would dispose of the food product in percent. By assessing PW through usage intentions, it is supposed to be less prone to social desirability [30].

Regarding expired food products, we believe that both measures provide valuable information. In fact, some stores already sell expired food products, and many people buy such "suboptimal" food (e.g., The Good Food, Cologne, Germany) [31]. Thus, we included the WTP measure to assess whether people would be willing to pay for expired food products and save them from waste [14]. Moreover, we assessed PW as a continuous variable instead of using dichotomous choices ("eat" vs. "dispose" of). Thereby, people had the opportunity to indicate whether they would eat nothing or everything of this product, but this measure also allows to detect more nuanced behaviors. For instance, people could this way indicate that they would try some of the food, but expect to discard the rest. However, similar to many self-report measures in the field, the PW does not provide the opportunity for sensory testing. In reality, people may for instance sample food impacting their decision to dispose of or eat the rest of it.

Note that WTP and PW have been used previously to compute a single willingness to waste score by multiplying WTP and PW [30]. Although we intended to use this score as the dependent variable in Experiments 1 and 2, we realized, that its interpretation is

ambiguous. That is, high WTP and low PW scores (which suggest low intentions to waste) and low WTP and high PW scores (which suggest high intentions to waste) would result in similar willingness to waste scores. Thus, we used WTP and PW as separate indices for the intention to waste in our pre-registered analyses. For Experiment 3, we then pre-registered the separate analyses.

Labeling Knowledge and Demographics

We assessed participants' knowledge about date labeling using a 10-item questionnaire adapted from the European Commission (see Appendix A) [32]. The internal consistency of this questionnaire was satisfying in all studies as indicated by Cronbach's alpha (Experiment 1: $\alpha = 0.76$, scale from 1 to 10; Experiment 2: $\alpha = 0.89$, Experiment 3: $\alpha = 0.76$, scale from -100 to 100). It has to be noted, however, that the labeling knowledge questionnaire might tap into processes beyond knowledge, and all findings regarding it should be interpreted with caution (see limitations in Section 5.2). Afterward, we collected demographic data on participants' sex, age, and profession. We also inserted an open-ended question, asking whether people pay specific attention to their diet. Then, participants were thanked and debriefed.

2.2. Results

2.2.1. Hypothesis 1: The Effect of Date Labeling on Food-Related Ambivalence

First, we examined whether best before dates—giving a reason to believe that food is spoiled—increase ambivalence towards expired food compared to production dates via two 2 (label type [best before date, production date]) × 3 (Suggested Shelf Life [long, short, expired]) repeated measures ANOVAs. If Mauchly's tests indicated sphericity violations we adjusted via Greenhouse-Geisser ($\varepsilon < 0.75$) or Huynh-Feldt ($\varepsilon > 0.75$) correction [33], and reported ε. For potential ambivalence, the analysis revealed a main effect for the factor suggested shelf life, $F(2, 444) = 8.75$, $p < 0.001$, $\eta_p^2 = 0.04$, 95% confidence interval (CI) [0.01, 0.08], indicating greater ambivalence towards food whose date labels suggested that it was expired ($M = -0.02$, $SD = 2.61$) than towards food whose date labels suggested a long shelf life ($M = -0.66$, $SD = 2.54$). However, there was no main effect for label type $F(1, 222) = 1.00$, $p = 0.319$, $\eta_p^2 = 0.00$, 95% CI [0.00, 0.04]; nor was there a two-way interaction, $F(2, 444) = 0.89$, $p = 0.411$, $\eta_p^2 = 0.01$, 95% CI [0.00, 0.04].

As pre-registered, however, we also looked separately at the positive and negative evaluations using a 2 (label type [best before date, production date]) × 3 (suggested shelf life [long, short, expired]) × 2 (valence [positive, negative]) repeated measures ANOVA, to scrutinize how exactly the evaluations of food products change. This analysis revealed a significant main effect of valence $F(1, 222) = 107.65$, $p < 0.001$, $\eta_p^2 = 0.33$, 95% CI [0.23, 0.41], as well as significant two-way interactions valence × suggested shelf Life $F(2, 444) = 18.28$, $p < 0.001$, $\eta_p^2 = 0.08$, 95% CI [0.03, 0.13] and suggested shelf life × label type $F(2, 444) = 3.94$, $p = 0.020$, $\eta_p^2 = 0.02$, 95% CI [0.00, 0.05]. Importantly, these effects were qualified by the expected three-way interaction $F(2, 444) = 9.58$, $p < 0.001$, $\eta_p^2 = 0.04$, 95% CI [0.01, 0.08] (see Figure 1).

Scrutinizing the three-way interaction, Bonferroni adjusted pairwise comparisons indicated that evaluations were more negative for expired food products if best before dates ($M = 4.50$, $SD = 2.65$) instead of production dates were used ($M = 3.66$, $SD = 2.23$; $p = 0.010$). As expected, this suggests that negative associations increase towards food if the best before date was expired. Except for these negative associations, no other pairwise comparisons were significant when comparing best before to production dates (all ps > 0.054). To scrutinize this interaction further, we analyzed the effect of suggested shelf life separately for best before and production dates. Pairwise comparisons indicated that food products were evaluated more negatively, if best before dates suggest that they were expired ($M = 4.50$, $SD = 2.65$), than if they suggest short ($M = 3.17$, $SD = 2.20$; $p < 0.001$) or long shelf life ($M = 2.87$, $SD = 2.12$; $p < 0.001$). Similarly, evaluations got less positive if best before dates suggested that the food is expired ($M = 5.15$, $SD = 2.32$) compared to

best before dates which suggested short (M = 5.95, SD = 2.40; p = 0.001) and long (M = 6.31, SD = 2.16; p < 0.001) shelf life. For production dates, however, there were no effects of suggested shelf life regarding positive or negative evaluations (all ps > 0.111).

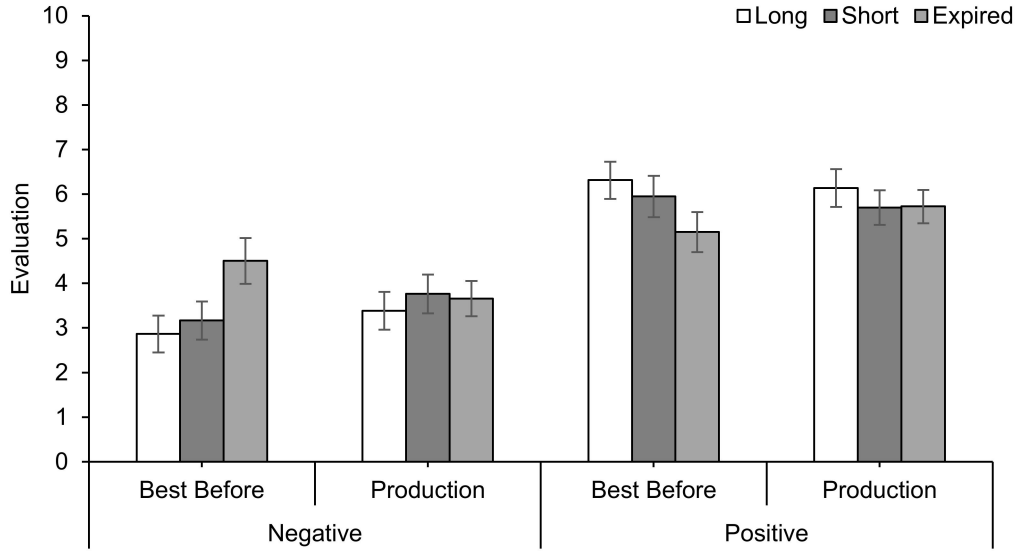


Figure 1. Positive and negative evaluations of food products with different levels of suggested shelf life indicated by best before or production dates. Error bars denote 95% confidence intervals.

We also conducted a 2 (label type [best before date, production date]) × 3 (suggested shelf life [long, short, expired]) repeated measures ANOVA on felt ambivalence which did not reveal significant main effects or a significant two-way interaction (all Fs < 1.19, all ps > 0.306). Taken together, this indicates that people's evaluations changed if best before dates were shown on expired food products in comparison to production dates; however, the results suggest that people did not experience felt ambivalence towards expired food products in Experiment 1—presumably because they were not facing a decision concerning these products.

2.2.2. Hypothesis 2: Labeling Knowledge as a Moderator

Second, we used a hierarchical regression analysis to test whether the effect of best before dates on participants' evaluations of expired food depended on their labeling knowledge (see Table 1). We mean-centered the predictor variables label type and labeling knowledge and used a total evaluation score (subtracting positive from negative evaluations; greater values indicate more favorable evaluations) as the dependent variable. Thereby, we accounted for positive and negative evaluations simultaneously. Note that this score is an index of the favorability of the evaluations (i.e., preference) and not the opposition of the evaluations (i.e., ambivalence). Step one of the hierarchical regression analysis indicated that there was a significant difference between best before and production dates for expired food products, F(1, 223) = 6.11, p = 0.011, accounting for 2.9% of the variance of the total model. When adding date labeling knowledge as a predictor in step two, this explained 1.8% of the variance additionally, F(2, 221) = 5.41, p = 0.005. Notably, and in line with our hypothesis, step three indicated that labeling knowledge moderated the effect of label type on people's evaluations towards expired food products, F(3, 220) = 6.70, p = 0.016, explaining an additional 3.7% of the variance of the total model.

Table 1. Hierarchical regression analysis using evaluations of expired food products as the dependent variable and label type and labeling knowledge as predictors.

	Evaluations			
	B	***SE B***	**β**	**ΔR^2**
Step 1				0.029 *
Label Type	−1.42	0.55	−0.17	
Step 2				0.018 *
Label Type	−1.42	0.55	−0.17	
Labeling Knowledge	0.40	0.20	0.13	
Step 3				0.037 *
Label Type	−1.42	0.55	−0.17	
Labeling Knowledge	0.48	0.20	0.16	
Interaction	1.19	0.40	0.19	

Note. *B*-, *SE B*-, β-, and ΔR^2-values refer to linear regression coefficients. * $p < 0.05$.

We conducted the Johnson-Neyman technique [34] via PROCESS Model 1 to scrutinize the moderation [35]. We identified 7.97 as the transition point of significance (t = 2.00, p = 0.05), pointing to the range of the moderator where simple slopes do not equal zero. Thus, only people with values higher than 7.97 on the labeling knowledge questionnaire were not affected by the best before dates (48.21% of our sample; see Figure 2).

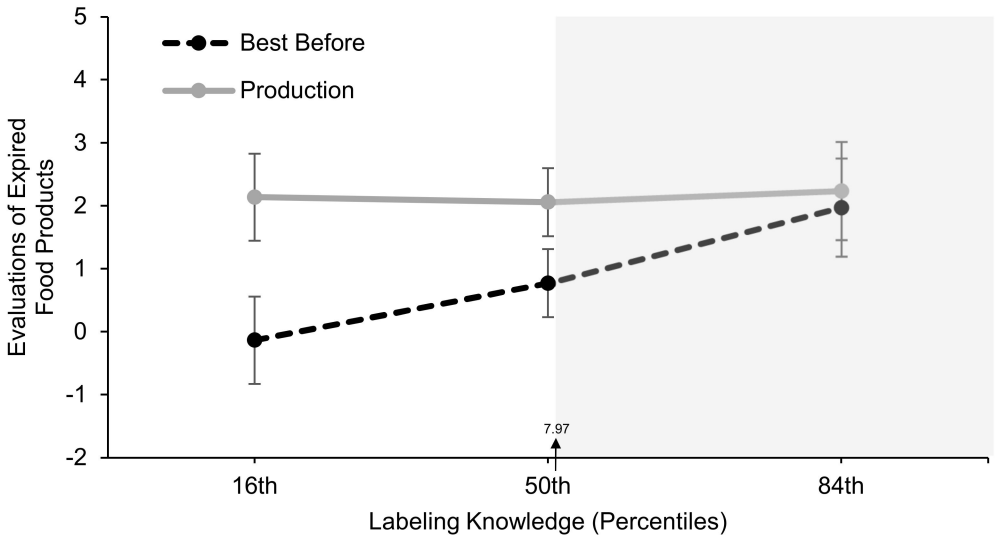


Figure 2. Moderation analysis for labeling knowledge on the effect of label type on evaluations of expired food products. Error bars denote standard errors. The white panel indicates the region of significance. The arrow marks the point of transition on the original scale (0 to 10).

2.2.3. Hypothesis 3: How Evaluations Affect Premeditated Waste and Willingness to Pay

We tested how the evaluations of expired food affected people's willingness to waste via moderated mediation models, separately using PW and WTP as dependent variables (PROCESS Modell 7; [35]). See Figure 3 for a schematic depiction of these analyses. As previously reported, labeling knowledge moderated the effect of the label type on people's evaluations towards expired food, and as more favorable evaluations also led to a decrease in PW (b_{PW} = −1.24, 95% CI [−2.06, −0.42]) and to an increase of WTP (b_{WTP} = 1.02, 95% CI [0.04, 3.01]), both models explained a significant portion of variance (R^2_{PW} = 0.05, F(2, 221) = 6.20, p = 0.002; R^2_{WTP} = 0.03, F(2, 221) = 34.39, p = 0.048). In addition, the indices of moderated mediation (IMM) were significant in both analyses (IMM_{PW} = −1.48, 95% CI [−3.08, −0.30]; IMM_{WTP} = 1.22, 95% CI [0.04, 3.02]). That is, the conditional indirect effects (see Table 2) indicated that best before dates on expired food products affected PW

indirectly if participants had low and medium levels of knowledge about date labeling; similarly, best before dates affect WTP if participants had low knowledge.

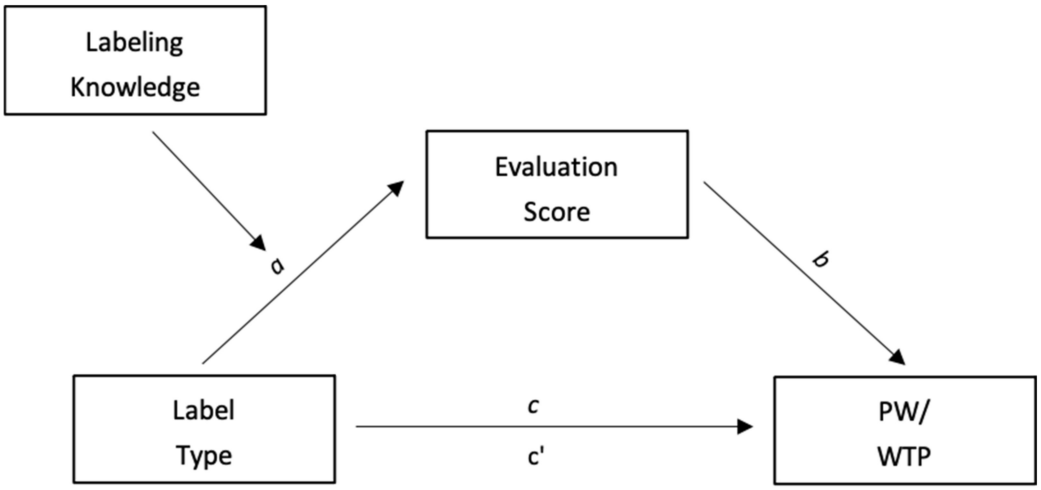


Figure 3. Schematic visualization of the moderated mediation analyses depicting the moderation of the *a*-path (the effect from label type on the evaluation of expired food products) by labeling knowledge as well as the *b*-(the effect of the evaluation on PW/WTP) and the *c*-paths (the total/direct effect of label type on PW/WTP).

Table 2. Conditional indirect effects (*ab*) depending on participants' labeling knowledge for the effect of label type on premeditated waste and willingness to pay for expired food products mediated via evaluations.

	Premeditated Waste (PW)		**Willingness to Pay (WTP)**	
Conditional Indirect Effect	***ab***	***95% CI***	***ab***	***95% CI***
Low Knowledge	3.38	[1.05, 6.51]	−2.78	[−6.11, −0.17]
Medium Knowledge	1.60	[0.89, 3.61]	−1.32	[−3.26, 0.01]
High Knowledge	−0.32	[−2.60, 1.83]	0.26	[−1.47, 2.45]

2.3. Discussion

In Experiment 1, we demonstrated that people who have reason to believe that food may be spoiled (manipulated via best before dates), evaluate expired food less favorably. Investigating the boundary conditions for this effect via hierarchical regression analyses showed that this effect might depend on participants' knowledge about date labeling: People's evaluations of food were more likely to be affected by best before dates if they had lower knowledge about date labeling. In consequence, people with less knowledge reported higher PW and lower WTP for expired food. While these results on the associative structure underlying the ambivalence were consistent with our prediction, we did not find that people's felt ambivalence was affected by the date labels. This may be because, in Experiment 1, participants did not have to decide on the food products, making it less likely that felt ambivalence occurs [17].

3. Experiment 2

In Experiment 2, we further investigated our hypotheses but aimed to elicit felt ambivalence by stressing the evaluative conflict underlying expired food. Thus, we used an ambivalence measurement that requires a dichotomous choice for the evaluation: the Mouse-Tracker paradigm [26]. The Mouse-Tracker paradigm has several advantages for assessing felt ambivalence: First, it forces people to make a decision, increasing the experience of conflict [17]. Second, it relies on the motoric reaction instead of self-report to assess ambivalence. Thus, compared to measures of self-report people do not need to have

introspection on their thoughts or feelings, and their responses are less prone to biases, like social desirability [26]. Especially the latter point is of importance because many people believe that avoiding food waste is the 'right thing to do' [15], which could lead to biased self-reports of conflict due to socially desirable behavior [21]. All other procedures were similar to Experiment 1.

3.1. Method

3.1.1. Participants and Design

Eighty eight university students (71 women, 17 men; M_{Age} = 21.69, age range = 18–29 years) participated in exchange for course credits. Participants were invited into a lab and randomly assigned to the between-subject factor in a 2 (label type [best before date (n = 44), production date (n = 44)]) × 3 (suggested shelf life [long, short, expired]) mixed design with repeated measures on the last factor. Again, the a priori calculation of the required sample size for the hypothesized two-way interaction was calculated via G*Power 3.1 [25], suggesting an N = 44 to achieve a power of $1 - \beta = 0.95$ while using a correlation of r = 0.5 for repeated measures, and considering a medium-sized effect of d = 0.5—being found for ambivalent food stimuli [26]. As Experiments 1 and 2, were conducted parallelly we again did not conduct a power analysis for Hypothesis 2 and 3. Similar to Experiment 1, we aimed to achieve more accurate effect sizes, and decided based on feasibility to sample twice as many participants (N = 88). All analyses were conducted after we attained this sample. In the following, we report all measures, manipulations, and exclusions of Experiment 2.

3.1.2. Materials and Procedure

Ambivalence

To assess felt ambivalence in Experiment 2, we used the Mouse-Tracker paradigm (http://www.mousetracker.org/, accessed on 31 March 2021) [36]. In the Mouse-Tracker paradigm ambivalence can be operationalized as geometrical pull in an evaluation task that includes two response options (positive vs. negative): People are pulled towards the non-chosen option if they have to evaluate ambivalent attitude objects using their computer mouse [26] (see Figure 4). To assess ambivalence, maximum deviation (MD) was used—quantifying the maximum distance between the actual trajectories and an idealized response trajectory (a direct trajectory from the start position to response option). Therefore, the mouse trajectories were recorded on the x-axis (scaled from −1 to 1) and y-axis (scaled from 0 to 1.5). Trials began with a 'start' button presented in the bottom middle (x = 0 and y = 0) and response buttons (positive and negative) at the upper right (x = 1 and y = 1.5) or upper left corner (x = −1 and y = 1.5) of the screen. If participants clicked on the start button, the mouse cursor was reset to a fixed position (x = 0 and y = 0.05) and a picture of a food product appeared in the middle of the screen next to a best before or a production date. Participants had to evaluate this stimulus by clicking on the positive or negative response button (see Figure 4). This reaction was not limited in time, but participants were instructed to move their mouse earlier if their movement was not initiated after 1000 ms. In this case, an instruction appeared on their screen stating: "Please move your mouse earlier, even if you are not sure of your decision yet." To allow comparison, reaction times were normalized using linear interpolations creating data for x and y coordinates at 101 points in time.

To familiarize the participants with the procedure, the Mouse-Tracker paradigm started with five training trials, depicting neutral objects as stimuli. Afterward, 90 trials were conducted using the same stimuli as in Experiment 1 while adding one additional food category (including three non-perishable products made of tomatoes). Trials were administered in three blocks in which each food product was shown once with a date label suggesting either long, short, or expired shelf life, respectively. The allocation of response buttons was counterbalanced between participants.

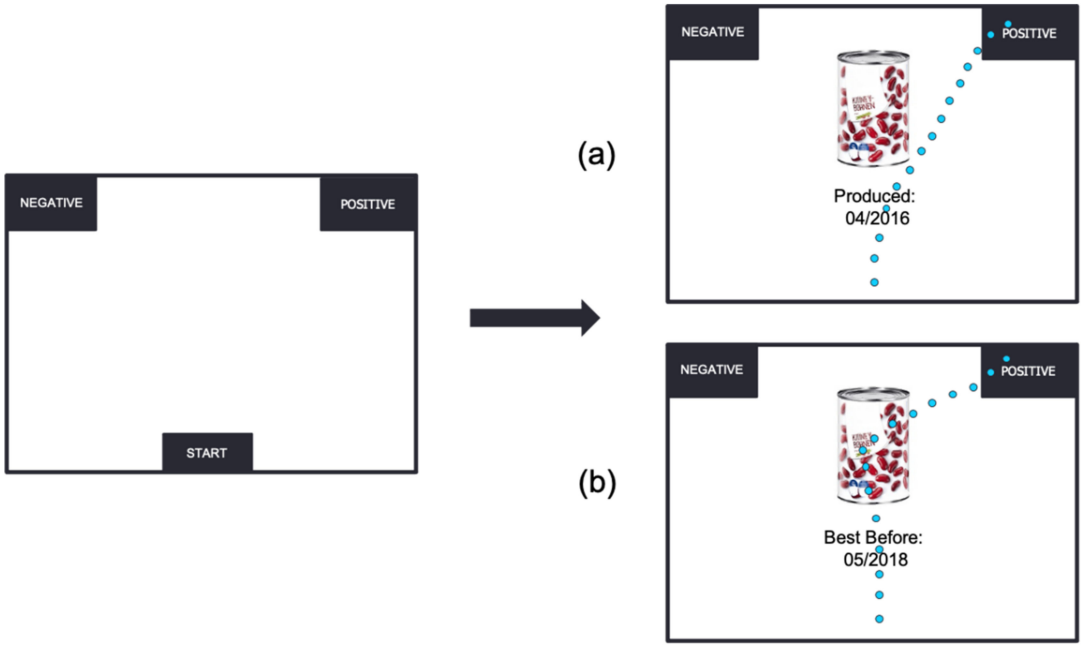


Figure 4. Depiction of a trial with a food product next to a date label indicating expired shelf-life (i.e., the experiment was conducted in 2019). Participants were either asked to evaluate food products with production dates (**a**) or best before dates after pressing a start button (**b**). The blue dots visualize mouse-movements of typical trials with low (**a**) or high (**b**) pull towards the non-chosen option. The dots were not visible to the participants.

Willingness to Pay and Premeditated Waste

After the Mouse-Tracker paradigm, we assessed participants' WTP and PW similar to Experiment 1 via E-prime 2.0 (Psychology Software Tools, Pittsburgh, PA). This time, however, we presented 30 food products in total; the food products out of each category were randomly assigned to the levels of the factor suggested shelf life, and presented next to date labels indicating long, short, or expired shelf life.

Labeling Knowledge and Demographics

Afterwards we assessed labeling knowledge and demographics (see Experiment 1).

3.2. Results

We aimed to investigate whether people actually experience a conflict regarding food products for which date labels shed doubt on their durability. We used MD as the dependent variable for ambivalence. Trials were excluded if participants responded faster than 300 ms or slower than 3000 ms.

3.2.1. Hypothesis 1: The Effect of Date Labels on Food-Related Ambivalence

First, we analyzed whether expired food, being indicated by best before dates, elicits more ambivalence compared to food products with production dates via a 2 (label type [best before date, production date]) × 3 (suggested shelf life [long, short, expired]) repeated measures ANOVA; we again adjusted for possible sphericity violations. No significant main effect of the factor label type $F(1, 86) = 0.40$, $p = 0.531$, $\eta_p^2 = 0.01$, 95% CI [0.00, 0.07], but a significant main effect for the factor suggested shelf life, $F(1.70, 146.25) = 5.28$, $\varepsilon = 0.850$, $p = 0.006$, $\eta_p^2 = 0.06$, 95% CI [0.01, 0.13], was found. In line with our hypothesis this main effect was qualified by the two-way interaction $F(1.70, 146.25) = 9.90$, $\varepsilon = 0.850$, $p < 0.001$, $\eta_p^2 = 0.10$, 95% CI [0.03, 0.19] (see Figure 5).

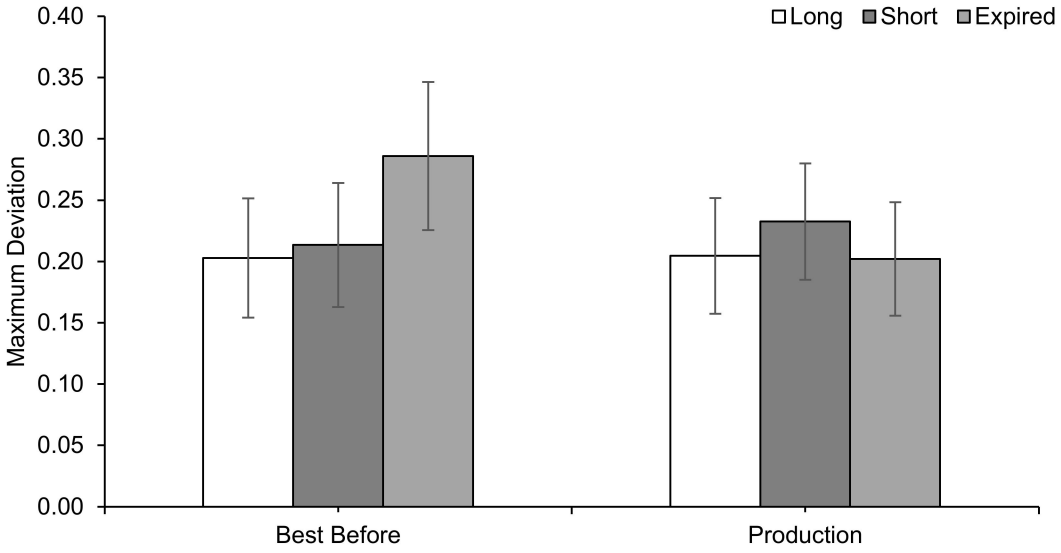


Figure 5. Maximum deviation in the Mouse-Tracker paradigm depicted separately for different levels of suggested shelf life indicated by best before or production dates. Error bars denote 95% confidence intervals.

As predicted, Bonferroni adjusted pairwise comparisons demonstrated that participants experienced more ambivalence towards expired food products if this was indicated by best before instead of production dates ($p = 0.034$; best before: $M = 0.29$, $SD = 0.21$; production: $M = 0.20$, $SD = 0.16$). This was not the case, however, if the dates suggested short ($p = 0.589$; best before: $M = 0.21$, $SD = 0.17$; production: $M = 0.23$, $SD = 0.16$) or long shelf life ($p = 0.959$; best before: $M = 0.20$, $SD = 0.17$; production: $M = 0.21$, $SD = 0.16$). Further pairwise comparisons demonstrate that food elicited more ambivalence if best before dates suggested that these products were not durable compared to dates that suggested short ($p = 0.001$) or long shelf life ($p < 0.001$); in contrast, for production dates there were no differences between expired and short ($p = 0.311$) or long suggested shelf life ($p = 1.000$). See Figure 6 for a depiction of averaged mouse trajectories.

3.2.2. Hypothesis 2: Labeling Knowledge as a Moderator

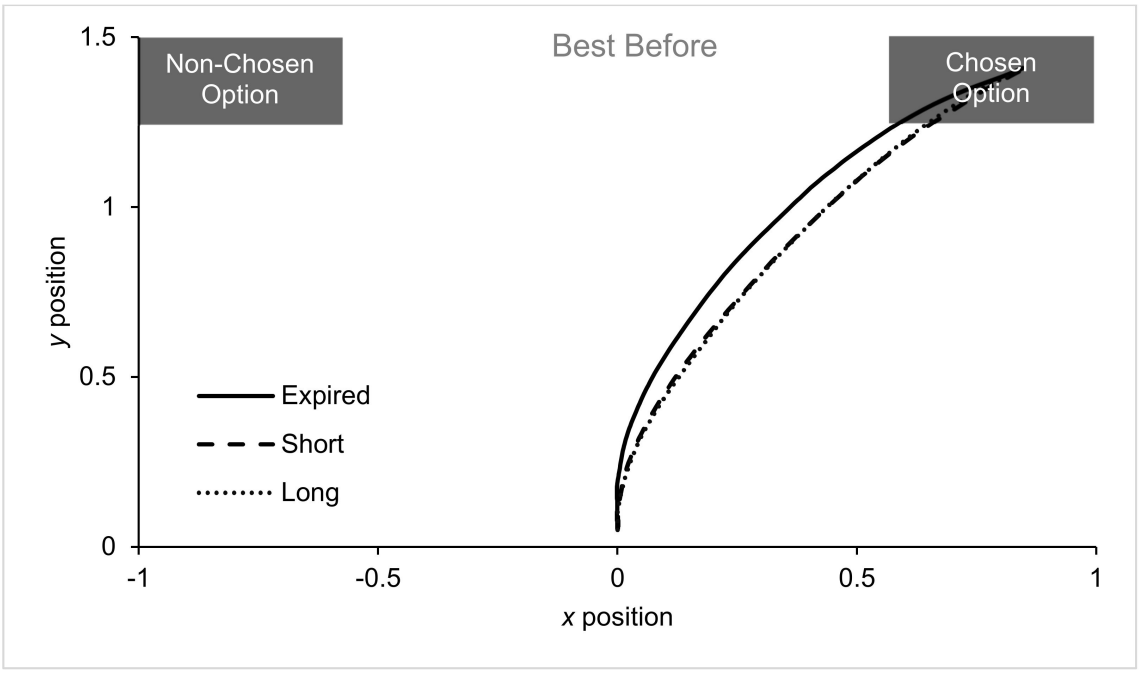
To test whether the effect of best before dates on participants' ambivalence towards expired food depended on knowledge about date labeling, we again used a hierarchical regression analysis using MD as the dependent variable (see Table 3).

Step one suggested that participants experienced more ambivalence towards expired food products with best before instead of production dates, $F(1, 86) = 4.67$, $p = 0.034$, accounting for 5.3% of the variance of the total model. Surprisingly, the inclusion of labeling knowledge as a predictor in step two did not explain significantly more variance (2.5%), although the total model stayed significant $F(2, 85) = 3.54$, $p = 0.033$. The same was true for the addition of the interaction term in step three which explained only 1.2% of additional variance, $F(3, 84) = 2.74$, $p = 0.049$, even though descriptive statistics indicated that people with less labeling knowledge experienced more ambivalence towards expired food products with best before dates (see Figure 7).

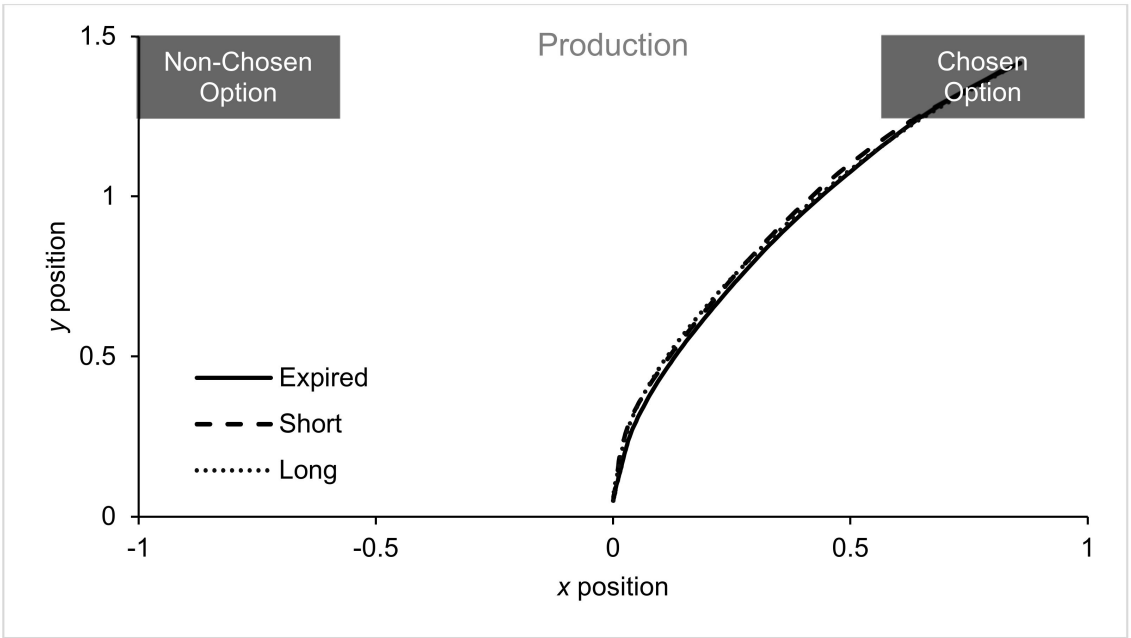
3.2.3. Hypothesis 3: How Ambivalence Affects Premeditated Waste and Willingness to Pay

Although we did not find a moderation of labeling knowledge, we wanted to assess how ambivalence towards expired food products affected people's willingness to waste. Thus, we conducted simple mediation analyses (PROCESS Model 4) [35]. Figure 8 shows these mediation analyses which were based on 10,000 bootstrap samples. The analysis on PW suggested that due to the presentation of best before dates, participants' ambivalence increased ($a_{PW} = 0.08$, 95% CI [0.01, 0.16]); this ambivalence in turn was associated with an increase in their PW ($b_{PW} = 31.31$, 95% CI [9.95, 52.58]). Thus, there was an indirect effect ($ab_{PW} = 2.63$, 95% CI [0.16, 6.37]) which suggests that participant's heightened PW

results from an increase of ambivalence. Independent of this indirect effect, the date labels did not affect PW (c_{PW}' = −6.05, 95% CI [−13.95, 1.85]). In contrast, for WTP, we did not find an indirect (ab_{WTP} = −0.52, 95% CI [−4.21, 2.63]) but a direct effect of label type (c_{WTP}' = −19.79, 95% CI [−31.32, 8.25]).



(**a**)



(**b**)

Figure 6. Averaged mouse trajectories in the Mouse-Tracker paradigm are depicted separately for the levels of suggested shelf life indicated by best before (**a**) or production dates (**b**).

Table 3. Hierarchical regression analysis using ambivalence towards expired food products as the dependent variable and label type and labeling knowledge as predictors.

	Ambivalence			
	B	***SE B***	***β***	**ΔR^2**
Step 1				0.051 *
Label Type	0.083	0.04	0.227	
Step 2				0.025
Label Type	0.083	0.039	0.225	
Labeling Knowledge	−0.001	0.001	−0.160	
Step 3				0.012
Label Type	0.083	0.039	0.226	
Labeling Knowledge	−0.001	0.001	−0.114	
Interaction	−0.001	0.001	−0.111	

Note. *B*-, *SE B*-, β-, and ΔR^2-values refer to linear regression coefficients. * $p < 0.05$.

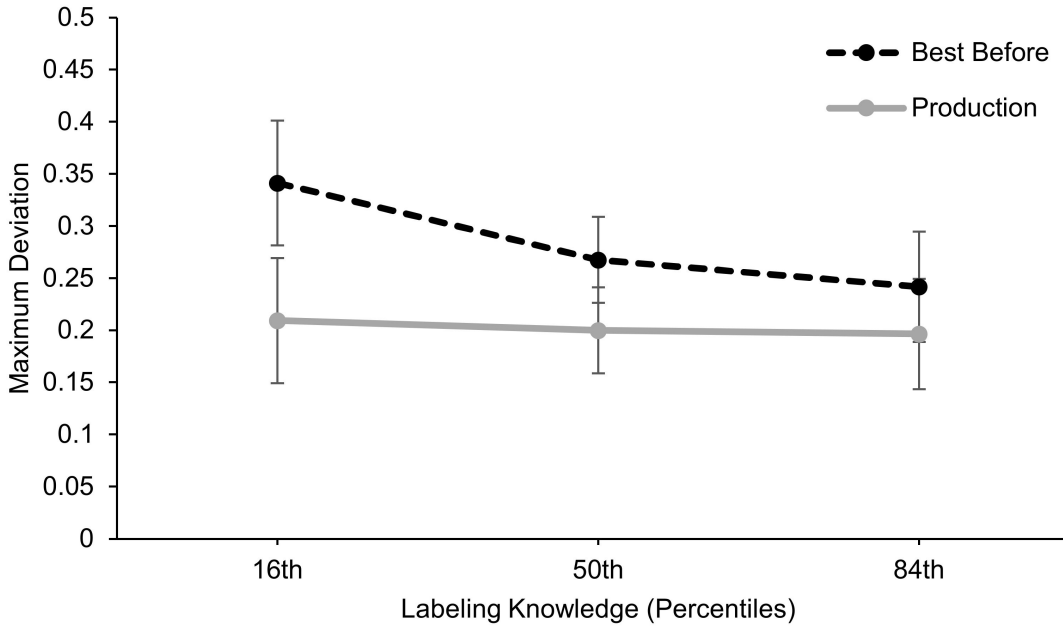


Figure 7. Moderation analysis for labeling knowledge on the effect of label type on ambivalence towards expired food products. Error bars denote standard errors.

3.3. Discussion

In Experiment 2 we replicated some of the findings of the previous experiment. Going beyond these results, however, and by using an improved methodology, we also showed that people experienced felt ambivalence towards expired food when its durability is in doubt, and that this ambivalence increases their PW. However, the moderation analysis did not yield significant effects although the descriptive statistics looked similar to Experiment 1. Thus, the results regarding the labeling knowledge as a boundary condition remain inconclusive, especially because the power of the moderation in Experiment 2 was low ($1 - \beta = 0.11$). Besides, there was a dissociation of how ambivalence was associated with WTP and PW. While participants' ambivalence towards food predicted a lower PW, there was no association between ambivalence and people's WTP.

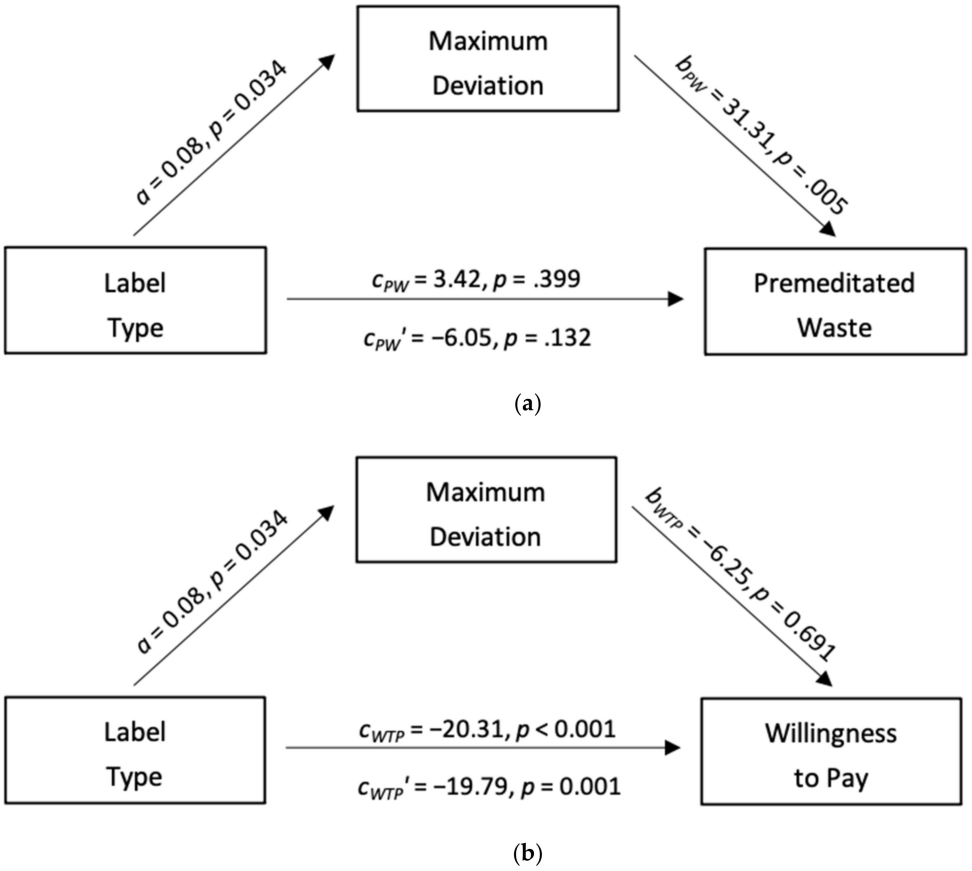


Figure 8. Simple mediation analyses depicting the effect of the label type (0 = Production; 1 = Best Before) on premeditated waste (**a**) and willingness to waste (**b**) via ambivalence in Experiment 2.

4. Experiment 3

In Experiments 1 and 2, we demonstrated that ambivalence towards food is an important factor that contributes to people's willingness to waste food. We also scrutinized whether labeling knowledge is a boundary condition of the effects. Yet, the results regarding the moderating effect of labeling knowledge were inconclusive. In the next experiment, we intended to test how ambivalence-driven food waste can be reduced [9]. That is, we tested whether an informational intervention strategy on the interpretation of date labels can be used to reduce ambivalence-driven food waste intentions or whether it needs additional information to do so.

Therefore, we used a previously employed intervention by Collart and Interis who demonstrated that people's WTP for expired food products could be increased by providing information about date labeling and the environmental consequences of food waste; however, information on date labeling alone did not have the same effects [14]. In line with the findings by Collart and Interis [14] we hypothesized that (1) if people are informed about the interpretation of date labels and the environmental consequences of food waste, their ambivalence towards expired food products decreases compared to a control condition with no information, but that mere information about the interpretation of date labels would not be sufficient to reduce ambivalence. Moreover, we predicted that (2) decreased ambivalence towards expired food products reduces participants' PW and increases their WTP for these food products. Note that we also pre-registered another hypothesis on labeling knowledge, which we could not test based on Experiment 3 (for the sake of completeness we report the pre-registered analyses in the Supplemental Materials).

4.1. Method

4.1.1. Participants and Design

In total, 110 university students took part in the study receiving course credits for their participation. Two participants had technical issues with the experiment, however, resulting in a final sample of 108 participants (88 women, 19 men, 1 non-specified; M_{Age} = 21.53, age range = 18–38 years). Participants were randomly assigned to the intervention condition in a 3 (information intervention [control condition (n = 36), date labeling information (n = 36), date labeling + environmental information + (n = 36)]) × 3 (suggested shelf life [long, short, expired]) mixed design with repeated measures on the last factor. An a priori calculation of the required sample size for the hypothesized two-way interaction via G*Power 3.1 [25] indicated that an N = 36 is sufficient to achieve a power of $1 - \beta = 0.95$ when assuming a correlation of r = 0.684 for repeated measures (as in Experiment 2) and a medium-sized effect of d = 0.5 [26]. Again, an effect size for Hypothesis 2 could not be derived from previous research. As in the previous experiments, however, we aimed to increase the stability of the effect sizes and decided to gather three times as many participants due to feasibility (N = 108). All analyses were conducted after the final sample was reached. In the following, we report all measures, manipulations, and exclusions of Experiment 3.

4.1.2. Materials and Procedure

Experiment 3 was similar to Experiment 2 with one notable exception: We did not manipulate label types, i.e., all participants responded to food products with best before labels attached; instead, we manipulated the information given in an intervention prior to the experimental procedure that was conducted as in Experiment 2.

Intervention

We stuck closely to the intervention designed by Collart and Interis [14] and realized three conditions: In the control condition, participants did not receive information prior to the experimental procedure; in the date labeling information condition, they received information on how to interpret best before and use by labels (see Appendix B); and in the date labeling + environmental information condition, they received information of how to interpret best before and use by labels but then additionally received information how this causes food waste and how this affects the environment (see Appendices B and C). Participants were instructed to carefully read the texts on one (date labeling information) or three separate slides (date labeling + environmental information). There were no time restrictions and participants were able to proceed with the experiment by pressing the space bar. We adapted this information for the German study context referring to regulations on date labels by the German Bundestag [37] and information on environmental food waste issues in Germany outlined by Noleppa and Cartsburg [38].

4.2. Results

4.2.1. Hypothesis 1: The Effects of the Information Interventions on Food-Related Ambivalence

We tested whether the intervention conditions had an effect on felt ambivalence. Specifically, we hypothesized that if people are informed about the interpretation of date labels and about the environmental consequences of food waste, their ambivalence towards expired food products decreases compared to a control condition with no information. Therefore, we conducted a 3 (information intervention [control condition, date labeling information, date labeling + environmental information]) × 3 (suggested shelf life [long, short, expired]) ANOVA with repeated measures on the second factor, adjusting for possible sphericity violations. This analysis revealed the expected main effect, $F(1.39, 145.56) = 27.83$, $\varepsilon = 0.693$, $p < 0.001$, $\eta_p^2 = 0.21$, 95% CI [0.10, 0.32]. As in Experiment 2, Bonferroni adjusted pairwise comparisons showed that ambivalence towards food with long (M = 0.17, SD = 0.16) and short (M = 0.18, SD = 0.18) suggested shelf life did not differ

(p = 1.000), while ambivalence towards both was significantly lower than towards food with expired suggested shelf life (M = 0.27, SD = 0.21; both ps < 0.001). The main effect for the information intervention, $F(2, 105) = 0.67$, $p = 0.935$, $\eta_p^2 = 0.01$, 95% CI [0.00, 0.07] and the interaction $F(2.77, 145.56) = 2.73$, $\varepsilon = 0.693$, $p = 0.051$, $\eta_p^2 = 0.05$, 95% CI [0.00, 0.12] were not significant. See Table 4 for the descriptive statistics on MD, PW, and WTP depending on the experimental conditions.

Table 4. Means and standard deviations for maximum deviation, premeditated waste, and willingness to pay regarding long, short and expired shelf life depending on the information intervention conditions.

	Control Condition			**Date Labeling**			**Date Labeling + Environmental**		
	MD *M(SD)*	PW *M(SD)*	WTP *M(SD)*	MD *M(SD)*	PW *M(SD)*	WTP *M(SD)*	MD *M(SD)*	PW *M(SD)*	WTP *M(SD)*
Long	0.20(0.15)	48.78(24.06)	81.29(17.83)	0.15(0.14)	44,08(27.48)	78.33(19.35)	0.17(0.19)	40.78(21.95)	74.73(21.22)
Short	0.17(0.14)	50.34(23.07)	71.80(21.78)	0.18(0.17)	44.73(26.69)	71.12(20.14)	0.18(0.22)	43.64(22.18)	69.32(20.37)
Expired	0.25(0.17)	58.35(17.74)	52.98(25.19)	0.30(0.24)	54.95(23.87)	49.80(28.33)	0.25(0.21)	55.73(20.71)	51.52(25.18)

4.2.2. Hypothesis 2: How Ambivalence Affects Premeditated Waste and Willingness to Pay

Next, we tested how experiencing ambivalence towards expired food would affect people's willingness to waste. Therefore, we conducted two simple mediation analyses (PROCESS Model 4) using the information intervention conditions (compared to the control condition) as a multi-categorical predictor, ambivalence as the mediator, and WTP or PW as the outcome, respectively [35]. Both analyses were based on 10,000 bootstrap samples and can be seen in Figure 9. Similar to the repeated measures ANOVA, the mediation analyses suggested that the information intervention conditions did not affect participants' ambivalence towards expired food (labeling information: a = 0.06, 95% CI [−0.04, 0.15]; labeling + environmental information: a = 0.00, 95% CI [−0.10, −0.10]). There was also no direct effect of the manipulations on PW (labeling information: $c'_{PW} = -4.95$, 95% CI [−14.47, 4.56]; labeling + environmental information: $c'_{PW} = -2.63$, 95% CI [−12.09, 6.82]) or WTP (labeling information: $c'_{WTP} = -1.26$, 95% CI [−13.22, 10.70]; labeling + environmental information: $c'_{WTP} = -1.45$, 95% CI [−13.38, 10.43]). As in the previous experiments, however, ambivalence was, associated with an increase in people's PW (b_{PW} = 27.42, 95% CI [8.51, 46.23]) and WTP ($b_{WTP} = -34.00$, 95% CI [−57.64, −10.35]). This suggests that ambivalence towards expired food is associated with an increased willingness to waste although we did not find direct or indirect effects of the information intervention conditions on PW (labeling information: $ab_{PW} = -1.92$, 95% CI [−6.11, 1.43]; labeling + environmental information: $ab_{PW} = -0.01$, 95% CI [−3.27, 3.65]) or WTP (labeling information: $ab_{PW} = -1.92$, 95% CI [−6.11, 1.43]; labeling + environmental information: $ab_{PW} = -0.01$, 95% CI [−3.27, 3.65]).

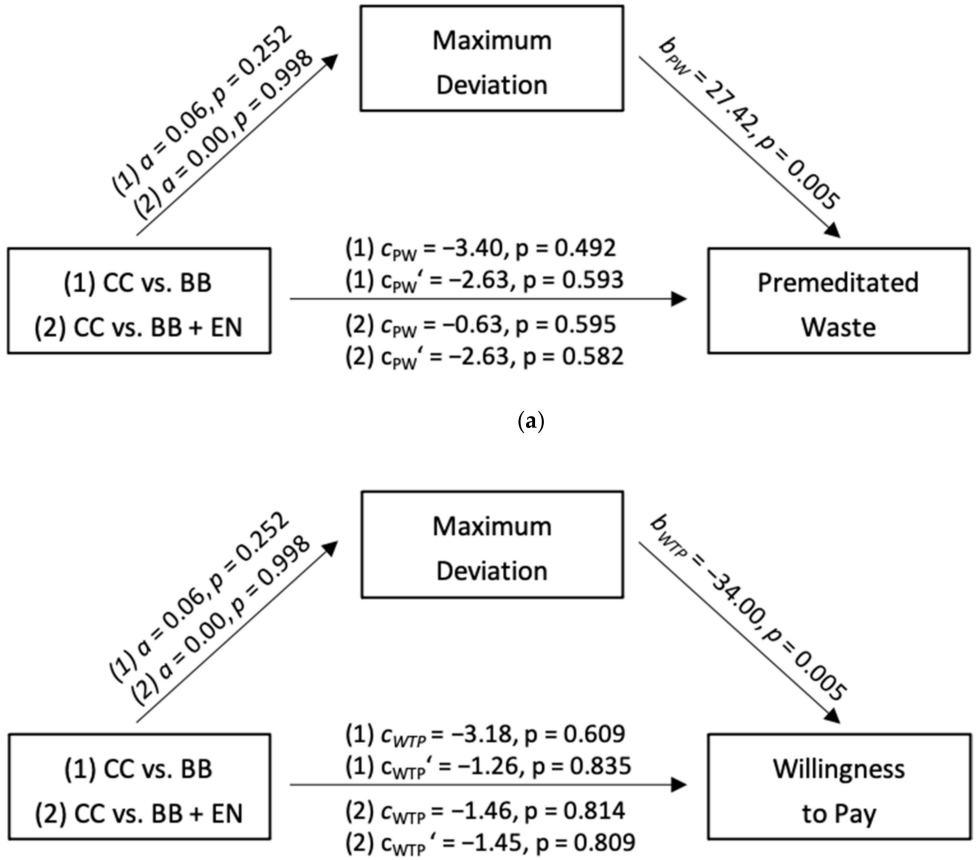


Figure 9. Simple mediation analyses depicting the effect of the information intervention conditions on premeditated waste (**a**) and willingness to waste (**b**) via ambivalence in Experiment 3.

5. General Discussion

In the present investigation, we argue that food waste may be understood via the concept of ambivalence—the presence of positive and negative associations towards one attitude object at the same time. In three pre-registered experiments, we demonstrated that ambivalence towards food is indeed an important factor that promotes people's willingness to waste expired food. In line with our hypotheses, participants' self-reported evaluations of food became less favorable (Experiment 1), and their felt ambivalence towards food increased (Experiment 2) if a best before instead of a production date was attached to expired food. Due to such food-related ambivalence, participants were more inclined (Experiment 1–3) to waste and were less willing to pay (Experiment 1 and 3) for food products whose best before dates indicated that they were expired.

In line with the suggestions by Steg and Vlek [9], we also aimed to investigate a boundary condition for this process. Thus, we investigated how people's labeling knowledge affects ambivalence towards expired food—and thereby their willingness to waste such food. Experiments 1 and 2 provided mixed evidence for the moderating role of labeling knowledge. That is, inferential statistics suggested that only people with low labeling knowledge were affected by the presence of expired best before dates in Experiment 1 but not in Experiment 2. However, the achieved power for the test of the moderation in Experiment 2 was low ($1 - \beta = 0.11$) [25], and descriptive statistics showed a similar pattern in both experiments. Therefore, the results for labeling knowledge as a boundary condition for the emergence of ambivalence towards expiring food are inconclusive.

Moreover, two informational interventions aiming to reduce ambivalence towards expired food products by educating participants' about date labeling and environmental

consequences of food waste were not successful [14]. At first, it might be argued that the provided information on date labeling might not really affect participants' decisions, at least while assessing ambivalence or PW. That is, participants were told that the products are safe to consume—after checking for taste and smell. Yet, they had no opportunity to test these sensory properties. Thus, they might still have experienced ambivalence towards expired food and could have been inclined to waste it just because they could not apply their acquired knowledge.

However, even without this opportunity, people's WTP should be affected by such information. In reality, people do not have the opportunity to sample expired food before buying it. Despite this, we neither find direct or indirect effects of the interventions on WTP. This stands in contrast to the investigation by Collart and Interis whose findings suggest that labeling and environmental information increase people's WTP [14]. While we provided similar information, we deviated from the procedure by Collart and Interis by not asking participants to recall the information and by not correcting wrong answers. By this, we wanted to provide a more realistic situation of how informational campaigns are actually perceived. This could have rendered our manipulations less effective because participants may not have paid attention to the information. In any event, future interventions might want to move beyond simply providing information and instead educate consumers in more interactive settings, for example, in face-to-face communication such as in the "Love Food, Hate Waste" campaign [2]. This way, campaigners may consider personal viewpoints and reservations to motivate people to change [39,40].

In fact, several psychological factors are associated with food waste behavior. For instance, the highly cited Theory of Planned Behavior [41,42] has been applied to predict consumption of expired food [21]. According to the theory, behavior results from intentions. These intentions are in turn influenced by subjective norms, perceived behavioral control, and attitudes toward the behavior [41]: A subjective norm refers to the social pressure to act in accordance with a normative expectation; perceived behavior control captures the influence of past behavior as well as expected ease or difficulty to perform the behavior; attitudes result from the sum of favorable or unfavorable evaluations or appraisals about the behavior. These and other theories suggest that food waste and other environmentally relevant behaviors are complex. Interestingly, research has shown that ambivalence moderates the attitude-intention relationship predicted by the theory of planned behavior [43–45]. We therefore suggest that ambivalence is an important piece to this puzzle: Experiencing positive and negative evaluations at the same time may constitute a weaker attitude [46]. Thus, ambivalent attitudes could be less predictive of intentions and behavior [47].

5.1. Implications for Interventions on Food Waste

Taking ambivalence processes into account, it can be derived which structural or informational interventions may be successful to change behavior. For instance, it is sometimes recommended to remove best before dates for non-perishable food to avoid food waste [12]. According to the present findings, this might be a double-edged sword: On the one hand, people perceived less ambivalence towards technically expired food products if there is a production instead of best before date attached to it; on the other hand, evaluations of food were more favorable prior to expiring if a best before was attached to it instead of a production date. This implies that best before dates may provide a sense of security until the date of expiry but suggest insecurity afterward—even if food is non-perishable. Thus, when removing best before labels from such food, it has to be clearly communicated that these products do not perish.

Although the present investigation was concerned with date labeling, ambivalence towards food may foster food waste in a variety of situations. For instance, proper use of leftovers is an important pathway to reducing domestic food waste [13]. However, people are often conflicted about leftovers [10]: On the one hand, leftovers are positive as eating leftovers saves resources such as money and time [20]; on the other hand, people perceive food safety risks when eating leftovers [48], and eating them is seen

as a sacrifice [49]. Conceptualizing this conflict as ambivalence may help designing interventions: Interventions should promote positive associations and decrease negative associations. A good example of such an intervention is the love your leftovers campaign (https://lovefoodhatewaste.co.nz/reduce-your-waste/leftovers/, accessed on 31 March 2021). This campaign stresses the positive sides of leftovers, like saving time and money; and it aims to avoid negative sides, like safety risks, from arising by providing storage guidelines, for example.

While these implications are based on the idea that negative associations and resulting ambivalence towards food should be avoided in the first place, interventions may also focus on how people cope with the discomfort arising from food-related ambivalence. A major obstacle for preventing food waste is, for instance, the tendency that people procrastinate when facing difficult decisions about food; thus, food definitely spoils over time when people delay their decisions [20,23]. While it is not known whether people use this strategy deliberatively or accidentally [20], interventions should try to focus on this decision delay and motivate people to eat food in doubt right away.

Another major barrier to avoiding food waste is people's inclination to deny the responsibility for their food waste behavior [15]. Based on ambivalence research [17], it may be argued that people who do so, do not process information systematically, for instance, by smelling or tasting food [10]. Thus, people should be motivated to take the responsibility for their actions, for instance, by reminding them on packages that it is their individual decision whether they dispose of the food. If this fails, unambiguous peripheral cues that allow informed decisions should be readily available to consumers. Therefore, intelligent date labels that change in color when food perishes may be used to guide people's decisions [12].

5.2. Limitations

Our experimental research was designed to make a theoretical contribution and provide initial evidence that ambivalence is an underlying process of food waste behavior. Due to the nature of these studies, we were, however, only able to measure the willingness to waste food and not actual behavior. As such intentions do not necessarily translate into behavior [50], the effects of ambivalence on actual food waste behavior remain to be tested. This is especially important because intention measures are limited in mimicking real life. For example, our PW measure does not offer the opportunity to taste some of the food before deciding whether to dispose of the food or eat the rest of it. This sensory testing is a crucial factor, however, for reducing food waste [10,21]. Noentheless, the present research offers a starting point that may inspire theory-driven research on food waste.

Moreover, in our research, we investigated non-perishable food. Yet, non-perishable food products are among the least wasted products [51]. Thus, the direct applicability of our findings for interventions might be limited. Research showed, however, that WTP also decreases for (semi-)perishable products, like vegetables, dairy, or meat if their best before dates approach [19]: With decreasing shelf-life WTP decreases not only linearly but exponentially for food products with higher safety risks [19]. Similarly, research on dairy products showed that people who perceive increased health risks from eating expired food products are less willing to eat them [21]. We therefore assume that people also experience ambivalence towards food which may pose objective and not only subjective safety risks upon expiration.

In this vein, it has to be noted that people may not only experience ambivalence towards expired food products or leftovers because of safety concerns. Instead, people might feel ambivalent due to reduced food quality, for example, in terms of bad taste [19,20]. This becomes apparent when looking at the definitions of specific date labels. We used the German "Mindesthaltbarkeitsdatum" [At least durable until], which has a similar definition to the best before date and is often treated as an equivalent [21]. Such date labels are defined via the point in time until which specific food properties regarding taste, smell, or consistency preserve (see Appendix B). This could imply that people feel ambivalent

towards expired food because they believe that it tastes bad. Future research should thus consider using manipulation checks to disentangle different triggers of ambivalence.

Lastly, it might be discussed that the labeling knowledge questionnaire might rather assess a general inclination to eat expired food. That is, some of the items in the questionnaire may assess attitudes, intentions, or behavior rather than knowledge. If the questionnaire would indeed mostly assess an inclination to eat expired food, the assumed moderator would conceptually overlap with the outcome variables WTP and PW: People who are inclined to eat expired food intend to waste less expired food. Because it may be uncertain what the questionnaire really measures, our results regarding labeling knowledge as a boundary should be interpreted with care. Importantly, however, the main results are not affected by these doubts: In all experiments expired best before dates affected participants' willingness to waste via ambivalence even without taking labeling knowledge as a moderator into account.

6. Conclusions

Love food, hate waste? In reality, people often seem to love food and hate food at the same time. Indeed, our findings demonstrate that ambivalence towards food is an important factor that might promote domestic food waste. That is, expired best before labels increased people's ambivalence towards food and made them more willing to waste it. Thereby, we offer a theoretical explanation of why and how the perceived value of food decreases over time until it is disposed of [18,19]. We hope that this parsimonious conceptualization and the ascribed methods will promote theoretically-driven research on the driving factors and boundary conditions of food waste. This way, intervention strategies can be designed that hopefully succeed to convince people to love food and hate waste.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su13073971/s1, Figure S1: Serial mediation analyses depicting the effect of the information intervention conditions on premeditated waste (**a**) and willingness to waste (**b**) via labeling knowledge and ambivalence in Experiment 3; Table S1: Descriptive statistics for Experiment 1; Table S2: Zero-order Pearson's correlations for Experiment 1; Table S3: Descriptive statistics for Experiment 2; Table S4: Zero-order Pearson's correlations for Experiment 2; Table S5: Descriptive statistics for Experiment 3; Table S6: Zero-order Pearson's correlations for Experiment 3; Table S7: Split-half reliabilities for all measures across Experiments 1–3 (sampling using multiple iterations); Table S8: Internal consistencies (Cronbach's alpha) among the ten non-perishable food categories for all multi-trial measures in Experiments 2 and 3.

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Appendix A

Table A1. Questionnaire on date labeling knowledge based on the Euro Flash Barometer 425.

No	Item
1	I would not eat food past its best before date. [a]
2	It is important, that even imperishable food like rice, pasta, coffee or tea are labeled with a best before date. [a]
3	Food can still be eaten when its best before date has expired even though it probably is not at its best quality anymore.
4	Imperishable food like rice, pasta, or sugar can be eaten even though its best before date has expired.
5	The best before date is the same as the use-by date. [a]
6	As soon as the best before date has expired, food should not be eaten anymore. [a]
7	Best before means that the food will be safe to eat up to this date but should not be eaten past this date. [a]
8	I would eat food even though its best before date has expired if the packaging is not damaged and the food still looks all right.
9	I would throw away a pack of spaghetti if it is not labeled with a best before date and I can not remember when I bought it.
10	I would use a package of rice even though it is not labeled with a best before date and I can not remember when I bought it. [a]

Note. [a] denotes inverted items.

Appendix B

Information regarding date labeling (German Bundestag, 2019)

- In Germany, the best before date is generally mandatory. However, there are exceptions for certain foods. The best before date is determined by the responsible food business operator to the best of his knowledge and belief on the basis of studies or with the help of experts.
- The best before date indicates the minimum date up to which a packaged food can be stored and consumed without losing specific properties, i.e., smell, taste, texture, nutritional value, and color. If stored correctly, food can be consumed beyond this date—after checking the smell and taste.
- A distinction must be made between the best before date and the use-by date. The use by date indicates the date at which a food product should be disposed of; it concerns perishable foods such as minced meat and poultry. After this use by date, these foods may no longer be offered for sale and should not be consumed due to existing health hazards caused by germ contamination.

* Source: German Bundestag: Best before date, national regulatory scope and scientific discussion.

Appendix C

What are the ecological consequences of food waste?

Every year, millions of tons of edible food are thrown away in supermarkets, restaurants, or by private individuals because these products are close to their consumption or best before date. Worldwide, but also in Germany, about one-third of all food is wasted in this way. A study by WWF Germany [38] shows the drastic effects of food waste on the environment. In the following we have summarized some facts for you:

- Looking at the entire value chain including the consumer, over 18 million tons of food are lost in Germany.
- According to recent estimations, 10 million tons of this waste could be avoided; and with almost 5 million tons, the greatest avoidance potential lies with the end consumer.

- Thus, in Germany, it is mainly private consumers who are responsible for food waste: Every person disposes of an average of 80 kg edible food per year.
- The production of the 10 million tons of lost food, takes up an agricultural area that is larger than Mecklenburg-Vorpommern [a German federal state].
- Agricultural land is scarce. Therefore, natural and often unique habitats are converted into farmland or pasture. This way, food waste threatens biodiversity.
- By reducing their food waste, individuals could save about 227 kg CO_2 equivalents. This corresponds approximately to a distance of 1360 km that could be covered by a middle-class car.

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