

Article

The Smell of Sustainability: Understanding Consumers' Acceptability of Recycled Plastic Packaging with an Off-Odor

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Abstract: This study investigates consumers' acceptance and perceptions of post-consumer recycled (PCR) plastic packaging with an off-odor, and the effect of a sustainability claim thereupon. We utilized a mixed design to examine the influence of the percentage of PCR, packaging color, and the presence of a sustainability claim on consumer perceptions. Participants were presented with vignettes describing a scenario involving the purchase of shampoo bottles with or without a sustainability claim and asked to smell and rate the odor qualities of the bottles, as well as their acceptability and willingness to buy. The study found a main effect of the percentage of PCR and color on acceptability and willingness to buy and a main effect of the percentage of PCR on the perceived odor properties. However, the presence of a sustainability claim did not significantly affect consumer perceptions. The findings provide valuable insights for stakeholders in the sustainable production and consumption sector and offer recommendations for future research to further explore the impact of sustainability claims in shaping consumer acceptance of sustainable packaging with suboptimal sensory properties.

Keywords: post-consumer recycled (PCR) plastic; consumer acceptability; sustainable packaging; odor; color; multisensory perception



Citation: Di Cicco, F.; Loos, M.; Vos, I.; Gibson, R.; Naidoo, Y.; Gifford, S.; Smeets, M.A.M. The Smell of Sustainability: Understanding Consumers' Acceptability of Recycled Plastic Packaging with an Off-Odor. *Sustainability* **2024**, *16*, 4896. <https://doi.org/10.3390/su16124896>

Academic Editor: Lester Johnson

Received: 17 May 2024

Revised: 4 June 2024

Accepted: 5 June 2024

Published: 7 June 2024



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1. Introduction

The current global economic system is largely based on a linear model, such that products are made, used, and discarded, causing the depletion of non-renewable raw materials and the accumulation of waste in the environment. Plastic is among the most problematic materials, especially in packaging, its biggest application, accounting for 44% of its global consumption [1]. Packaging has become essential to our daily life, allowing to protect and elongate products' lifetime from transportation to shelf-life. In this regard, plastic seems to be the ideal material, cheap, durable, versatile, lightweight, and resistant, explaining why its production has increased 20-fold in the last 50 years and is expected to double over the next 20 years [2]. The problem with plastic packaging, however, is that its material flow is short-lived. In Europe, only 14% of plastic packaging is recycled, mostly in lower-value applications, and 95% of its material value is lost after the first use [2]. The plastic that ends up in landfills can penetrate the soil as micro- and nano-plastics, toxic substances that later enter our food chain. Because more than 90% of plastic is produced from virgin fossil resources [1], limited and non-renewable, the production of plastic according to the current rate is no longer sustainable, and plastic waste represents a clear threat to human and animal health and the environment.

1.1. The Role of Consumers' Acceptability and Willingness to Buy

A possible solution to this problem is the transition toward a circular economic model in which plastic is not discarded after one use and dispersed into the environment but re-enters the closed-loop cycle of production, use, reuse, and recycling. Employing post-consumer recycled (PCR) plastic is one option that is gaining popularity among manufacturers, resulting in an increase of 15% in the use of PCR for new products in Europe between 2018 and 2020 [3]. However, the widespread adoption of PCR plastic is currently hindered by a series of factors across all the stakeholders involved in the lifecycle of plastic packaging, including consumers' rejection and skepticism. Consumers play a key role in the successful transition to circular packaging, in a variety of ways and at different consumption times, i.e., purchase, use, and disposal [4]. While packaging made from PCR plastic is appreciated for its environmental benefits [5], negative cognitive and affective responses can also arise [6], facing consumers with a trade-off [7–10]. Products made from recycled materials are often considered to be inferior in terms of quality, safety, aesthetics, functionality, and sensory experience compared to new materials [11]. Such negative perceptions can affect consumers' responses by decreasing acceptability, and without consumer acceptability, the use of PCR packaging cannot be implemented, impeding the associated environmental benefits. As noted by Fischer and Reinders [12], the meaning of 'consumer acceptability' may vary across different disciplines. Acceptability can be defined as "a favorable opinion" about a product or emerging technology in risk analysis [12–14]. Similarly, it can be interpreted as "the quality of being satisfactory, agreeable, or pleasing" in food sensory science [15], while in marketing it is intended as having sold a product to enough consumers to make it profitable [12]. The definition of 'acceptability' used in this paper is not concerned with sales data and profitability, but neither it is limited to a 'favorable opinion'. Here, we define consumers' acceptability as a favorable evaluation of the product that would ultimately lead to its purchase. For this reason, in addition to acceptability, we measured willingness to buy, a variable commonly used in consumer science to measure preferences and purchase intentions, and consistently shown in the literature to positively correlate with consumers' acceptability [16–18].

As this study is not meant to be a behavioral intervention, which would require a long-term evaluation of its efficacy and durability, we used pro-environmental preferences (PEPs) [19] as a proxy of pro-environmental behavior (PEB). PEPs investigate the likelihood that a certain product is preferred over another, rather than the actual consumption behavior. PEPs will be operationalized as the level of acceptability and willingness to buy the PCR packaging.

1.2. Packaging Design for Sustainability

While consumers' acceptability is pivotal for adopting more sustainable packaging solutions, it is important to note the equally crucial role of design in implementing sustainable practices. The design phase of products and packaging needs to be attentive to the so-called "design for and from recycling" [20]. Design guidelines for recycling act as a preventive measure to maximize the recyclability of the product after use [21], but the concept of design from recycling allows to close the loop. Because recyclates, such as PCR plastics, are of lower quality compared to their virgin counterpart due to contamination and degradation, design from recycling is concerned with tackling the different aspects of material quality, both technical [22] and sensorial/emotional [20], to ensure reuse in high-grade applications. These sensory guidelines, however, are mostly focused on visual appearance and less on odor properties.

1.2.1. Odor Perception of PCR Packaging

The current study focuses on consumers' acceptability and willingness to buy packaging made from PCR plastic with suboptimal sensory properties, specifically its odor. Unexpected or undesirable odors in PCR products, ascribable to the methods of waste separation and collection and the recycling process, constitute one of the main barriers to

its widespread production and adoption [23–26]. While research has focused on odor characterization and minimization [27–31], knowledge of consumers’ acceptability of odorous PCR for non-food packaging applications is still missing.

While consumers’ acceptability can relate to different aspects of the product lifecycle, such as safety, environmental footprint, fair labor, or price, sensory properties are central to driving expectations, choice, acceptability, and repurchase. The relevance of the sense of smell for consumer behavior has already been acknowledged within the framework of sensory marketing and embodied cognition [32], especially concerning memories and emotional connections [33]. However, sensory marketing research on smell perception has mostly focused on the effect of ambient scenting on consumers’ moods and purchase intentions [34–37], while little attention has been given to the effect of the packaging scent [38]. In this study, we investigate the relationship between the percentage of PCR included in the bottles, their odor qualities, i.e., pleasantness, familiarity, and intensity, and consumers’ PEPs. Based on the research efforts to deodorize PCR to broaden its application [27–31], we expect that an increased percentage of PCR will decrease odor pleasantness and familiarity and increase odor intensity, which will relate to a decrease in acceptability and willingness to buy.

1.2.2. The Effect of Sustainability Claims

Besides fulfilling the original functions of transportation and storing, packaging has become pivotal in driving consumer behavior, serving the role of a “silent salesman” [39,40], and brands capitalize on packaging features as the ultimate communication tool at the point of purchase. Leveraging the properties of packaging can help steer consumers’ attention, evaluation, and choice. Researchers have investigated the cues and drivers of sustainable packaging purchases [41–44] and consumers’ understanding of sustainability, which often fails to match objective measures, such as lifecycle assessment [45,46].

Consumers’ acceptability of sustainable packaging materials, such as PCR or bio-based plastics, is part of a complex decision-making process [47] that can be further hindered by a lack of information and false beliefs [6,48–51], the effect of which is exacerbated by the cognitive overload of the shopping environment [41,52–54]. Studies have shown that packaging claims and labels are among the most effective strategies for communicating the sustainability of products compared to other structural and sensory cues [8,52]. Especially in the case of PCR plastics, which closely resemble the appearance of their virgin equivalents, it is difficult for consumers to recognize and judge their level of sustainability [55]. A sustainability claim explaining that the packaging is made from recycled plastic can help with consumers’ perception and inference of otherwise invisible properties [41,52,55]. Therefore, this study aims to understand whether consumers’ acceptability and willingness to buy shampoo bottles made from PCR plastics that present an off-odor is related to the presence of a sustainability claim informing them that the plastic is recycled.

1.2.3. Color Perception of PCR Packaging

In this study, we tested two different kinds of PCR plastics against virgin plastic. These three types of plastics differed not only in odor profile but also in color, where the virgin plastic was white and the two PCR plastics were creamy and grey, respectively. Packaging color has been long recognized as one of the main visual cues to attract consumers’ attention [38], support brand identification [56–58], and communicate products and packaging characteristics [59–62]. As a result, the color of the packaging can set expectations and needs to be congruent with the product to increase acceptability and willingness to buy [63]. Moreover, colors and odors are often associated, indicating that certain colors are deemed more appropriate for certain odors, as a form of cross-modal correspondence [64]. For the product under investigation, shampoo, fragrance is one of the most important sensory properties, which can also affect the perceived quality and functional properties of the product [65]. It is, therefore, important to understand the effect of a less conventional packaging color, such as grey, on consumers’ acceptability of shampoo, considering that

color is another critical barrier to the widespread use of PCR plastics [25]. The variety of pigmented plastics entering the waste stream makes the recycling process more difficult and less efficient, restricting the color choice of new packaging made from PCR to mostly yellowish or grey shades.

1.3. The Influence of Environmental Concern and Motivation

It is important to note that pro-environmental behavior and green consumerism rely on complex cognitive processes [47], where the presence of sustainability claims might not be enough to enable them and could even face backlash if received with skepticism. The positive effect of a sustainability claim and package appearance will depend, among other factors, on the personal predisposition to seek information [44], and the previous attitudes and beliefs of each consumer [55,66]. In the current study, we accounted for the individual levels of environmental concern (EC) [67] and environmental motivation (EM) [68] as moderators of the PEPs under investigation. Consumers who are more concerned about the environment are more likely to pay more attention and make use of sustainability information more intentionally to steer their purchasing choice toward the more environmentally friendly option [44,55,66,69–72]. We, therefore, hypothesized that consumers with higher environmental concern and motivation would find the shampoo bottles more acceptable and would be more willing to buy them if provided with information about the sustainability of the packaging.

To summarize, we hypothesized a three-way interaction between the presence of a sustainability claim, the percentage of PCR, and the color of the bottles on both the odor perception of the packaging and the PEPs for the product.

H1. *The interaction of high (low) percentages of PCR, the colors grey and cream (white), and the absence (presence) of the environmental claim will significantly decrease (increase) product acceptability and willingness to buy and will negatively (positively) affect perceived odor pleasantness, familiarity, and intensity of PCR plastics.*

H2. *The magnitude of these effects will be moderated by the level of EC and EM of participants.*

H3. *The perceived odor qualities of the packaging (pleasantness, familiarity, and intensity) will predict the acceptability and willingness to buy the product.*

While some studies have explored the effect of extrinsic packaging cues, such as labels and color, on consumers' acceptability, and others have looked into PCR plastics' odor, this is the first study, as far as we are aware, that combines these elements. In doing so, we address a critical aspect of sustainable consumption, i.e., understanding the drivers of acceptability of the 'ugly' properties of sustainable materials, to ultimately accelerate the transition toward a more circular consumption system.

2. Materials and Methods

2.1. Participants

We recruited 62 participants following the recommended sample size of 40–100 participants to detect significant differences in consumer testing [73]. Of these, 2 participants were removed for failing the attention check, 1 was removed for failing the manipulation check, and 1 was removed for not completing the experiment, resulting in a final sample size of 58 participants. Post hoc power analysis (G*Power 3, [74]) revealed that a sample size of 58, with power = 0.9 and $\alpha = 0.05$, would allow us to detect a medium effect size ($f = 0.22$).

Inclusion criteria for participants included being 18 years of age or older, identifying as female or non-binary, and having normal color vision and normosmia. Self-reported presence of a head cold, sinus infection, and/or allergy, and identifying as male were used

as exclusion criteria. We controlled for gender because we expected a gender effect on consumers' responses and perception of the bottles.

Data were collected from a convenience sample of university students: 57 participants identified as female and 1 as non-binary. The age range was 18–44 ($M = 23.5$; $SD = 3.9$). Participants were recruited through the SONA system (participant pool recruitment system for Utrecht University), online advertisements on social media platforms, and flyers posted on campus. Of the 58 participants, all used shampoo regularly, and 55 indicated also purchasing their own shampoo.

2.2. Stimuli

The stimuli used in the study were shampoo bottles of commercially available shampoo made from post-consumer recycled (PCR) plastic. Two kinds of PCR plastics were used, which differed in composition, resulting in different odors and colors (grey vs. creamy). The selection of PCR materials was based on a pretest in which a trained sensory panel evaluated a large number of PCR pellets. The final selection of the two PCR materials, conveniently referred to as grey and creamy, was made based on their sensory attributes being on opposite ends of the sensory continuum. Shampoo bottles were manufactured especially for the present research by Unilever to cover the ranges between 100% virgin (i.e., 0% PCR included) to 100% PCR in steps of 10%, for each color/material, respectively. In the present study, four different levels of PCR were included for each kind (specifically 0%, 10%, 50%, and 100%). We created two groups of stimuli according to the type of PCR (creamy vs. grey), resulting in eight bottles in total. The bottle made from virgin plastic (0%) had a white color because 100% virgin in our case was white by definition. The choice of percentages of PCR to include in the experiment was based on a previous test that revealed a shallow slope in a function linking percentage of PCR included, ranging from 0 to 100% in steps of 10, and perceived odor intensity. The selected stimuli were the most different among all percentages of PCR tested.

The bottles were filled with unscented shampoo to increase the ecological validity of the stimuli. There were no labels or logos on the bottles (see Figure 1) to minimize brand identification, although we could not avoid it completely since the shape of the bottles is typical of the brand. We controlled for this variable by asking participants if they recognized and could identify the brand, and whether they use the brand themselves.

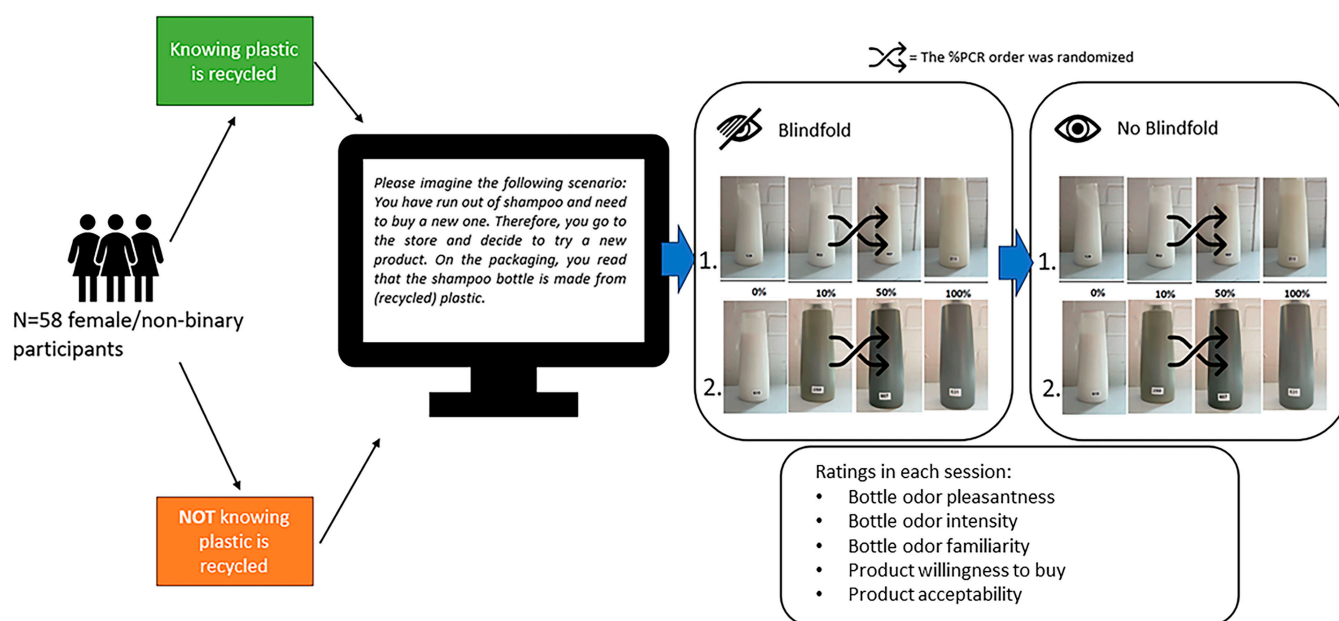


Figure 1. Visualization of the study procedure.

2.3. Procedure

The study was conducted in agreement with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Social and Behavioral Sciences of Utrecht University (under number 22-0518). The current study, including hypotheses and an analysis plan, was preregistered (osf.io/tf3yr) before starting data collection. Informed consent was obtained from all subjects involved in the study.

The study had a $2 \times 4 \times 2$ mixed design, with packaging color (2 levels: seeing vs. not seeing) and percentage of PCR (4 levels: 0%, 10%, 50%, and 100%) as within-subjects variables, and sustainability claim (2 levels: present vs. absent) manipulated between subjects.

Before starting the experiment, participants were tested for normosmia using the three-item odor identification test [75], and for color blindness via an online Ishihara test ([76] the test was conducted on the website: <https://www.colorlitelens.com/ishihara-test.html>, accessed on 1 May 2023). All participants were normosmic and had normal color vision.

The procedure of the study is visualized in Figure 1.

Participants were randomly assigned to one of the two sustainability claim conditions (present vs. absent). For the first part of the study, participants were asked to wear a blindfold to avoid seeing the color of the bottles. Before starting the sensory task, participants smelled the bottles with 0% and 100% grey and creamy PCR in a random order to create a frame of reference for themselves. The smelling, in this explorative phase and throughout the rest of the study, was carried out by having one of the researchers place the bottle circa 1–2 cm away from the nostrils of the participant and informing them that the cap was about to be opened and that they should take a sniff. The researcher gently squeezed the bottle to release some air when opening the cap.

Depending on the experimental condition, participants were presented with one of two vignettes (i.e., “a short, carefully constructed description of a person, object, or situation, representing a systematic combination of characteristics” [77]). The situation described in the vignette was:

‘Please imagine the following scenario: you have run out of shampoo and need to buy a new one. Therefore, you go to the store and decide to try a new product. On the packaging, you read that the shampoo bottle is made from plastic [sustainability claim absent]’. OR ‘On the packaging, you read that the shampoo bottle is made from recycled plastic [sustainability claim present]’.

After reading the vignette, participants were instructed to wear the blindfold to start the sensory task. They smelled and rated each of the 8 bottles for pleasantness, familiarity, and intensity of the odor of the bottle, plus acceptability and willingness to buy the product. Ratings were conducted on a 100-point visual analogue scale (VAS). The bottles were presented in two blocks, first the creamy block, followed by the grey block. The order of percentage of PCR was randomized within each block, while the order of presentation of the blocks was kept constant for all participants. After a break of three minutes, participants repeated the whole experiment without the blindfold (including the vignette) to measure the effect of color on odor perception and PEPs.

After the sensory task, we tested whether the manipulation of the environmental claim was perceived as intended by asking, “What material was the packaging made from?” Participants were further asked whether they considered the odor of the bottle in the judgment of product acceptability and their willingness to buy it, and how they thought it affected their choice. To control for potential brand knowledge or recognition from the shape of the bottles, brand familiarity was assessed using the item, “Did you recognize the brand of shampoo? If yes, can you tell us which one it is?”

Finally, participants’ environmental attitude was measured via the Motivation Towards the Environment Scale (METS) (refs. [68,78] $\alpha = 0.89$ – 0.93) and the Environment Concern Scale (ref. [79] $\alpha = 0.88$). We included an attention check within these questions, asking participants to select ‘somewhat disagree’ as one of the answers. When participants were

filling out these questionnaires, the researcher left the testing room to avoid biases of social acceptability in the answers.

The experiment took around 40 min and participants received EUR 10 compensation for their participation.

3. Results

3.1. Agreement between Participants

Intraclass correlation coefficients (ICC) were calculated to measure the rating agreement between participants. ICC estimates and their 95% confidence intervals were calculated using the irr package in R [80], based on a mean-rating, consistency, two-way random effects model [81]. All ICC values were significantly different from 0 (see Table 1). Subjects showed substantial to almost perfect agreement [82] on the judgment of all rated attributes.

Table 1. ICC values based on a mean-rating, consistency, two-way random effects model with 95% confidence intervals (C.I.) and F values. *** = $p < 0.001$.

Attributes	ICC	F Value	95% C.I.
Acceptability	0.9	$F(15, 705) = 9.8$ ***	0.81–0.96
Willingness to buy	0.91	$F(15, 705) = 11.3$ ***	0.84–0.96
Pleasantness	0.93	$F(15, 705) = 13.9$ ***	0.87–0.97
Intensity	0.8	$F(15, 705) = 4.9$ ***	0.62–0.92
Familiarity	0.78	$F(15, 705) = 4.7$ ***	0.6–0.9

3.2. Correlation between Attributes' Ratings

We computed Pearson's correlation for the attributes' ratings to explore to what extent they were related to each other.

In both cases, there was a high, positive, and significant correlation between odor pleasantness and product acceptability ($r = 0.69$, $p < 0.001$ for the creamy bottles; $r = 0.72$, $p < 0.001$ for the grey bottles), and between odor pleasantness and willingness to buy ($r = 0.78$, $p < 0.001$ for the creamy bottles; $r = 0.89$, $p < 0.001$ for the grey bottles). As expected, product acceptability was also highly positively correlated with willingness to buy ($r = 0.76$, $p < 0.001$ for the creamy bottles; $r = 0.8$, $p < 0.001$ for the grey bottles).

Odor familiarity showed a moderate but significant positive correlation with all the attributes, including odor intensity, which did not correlate with any other attribute besides familiarity (the range of correlations was $r = 0.31$ – 0.38 , $p < 0.01$ for the creamy bottles and $r = 0.26$ – 0.43 , $p < 0.05$ for the grey bottles).

3.3. Three-Way Mixed ANOVA Creamy PCR

A three-way mixed ANOVA was performed to determine whether an interaction effect existed between our three independent variables on the rated attributes. In other words, we aimed to understand how the odor perception of the bottles and their acceptability and willingness to buy changed between participants knowing vs. not knowing that the bottles were made from recycled plastic, over the different percentages of PCR depending on seeing vs. not seeing the color.

For the creamy bottles, we did not find a statistically significant three-way interaction between the presence of the sustainability claim, seeing the color of the bottles, and the percentage of PCR, for any of the attributes.

3.3.1. Effect on Acceptability and Willingness to Buy

We found a main effect of the percentage of PCR ($F(2.4, 136.4) = 19.1$, $p < 0.001$) on acceptability. A post hoc pairwise t -test comparison with Bonferroni adjustment showed that 0% and 10% PCR were significantly more acceptable than 100% for both sustainability claim conditions and independent of seeing the color (Figure 2).

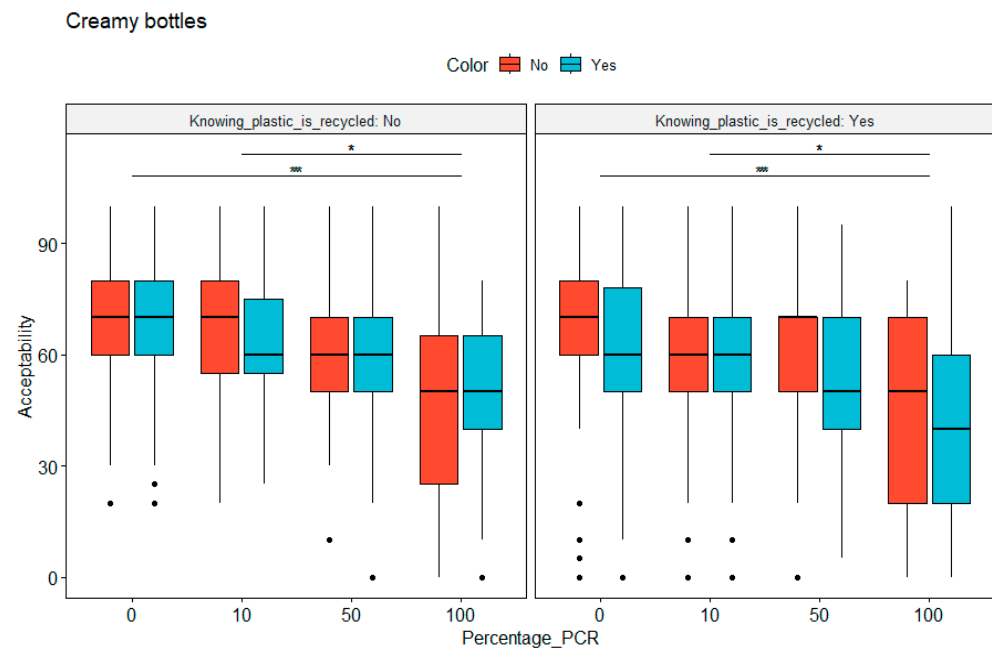


Figure 2. Box plots of the effect of the percentage of PCR and color on the acceptability of the creamy bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $*** = p < 0.001$) effects from the Bonferroni-corrected post hoc tests.

There was also a main effect of the percentage of PCR on willingness to buy ($F(3, 168) = 26.1$, $p < 0.001$). Post hoc pairwise comparison showed that willingness to buy was significantly higher for 0% PCR than 10%, 50%, and 100%. The effect was also significant between 10% and 100% PCR in the no-claim condition. In the claim condition, all percentages of PCR were significantly higher in willingness to buy than 100% (Figure 3).

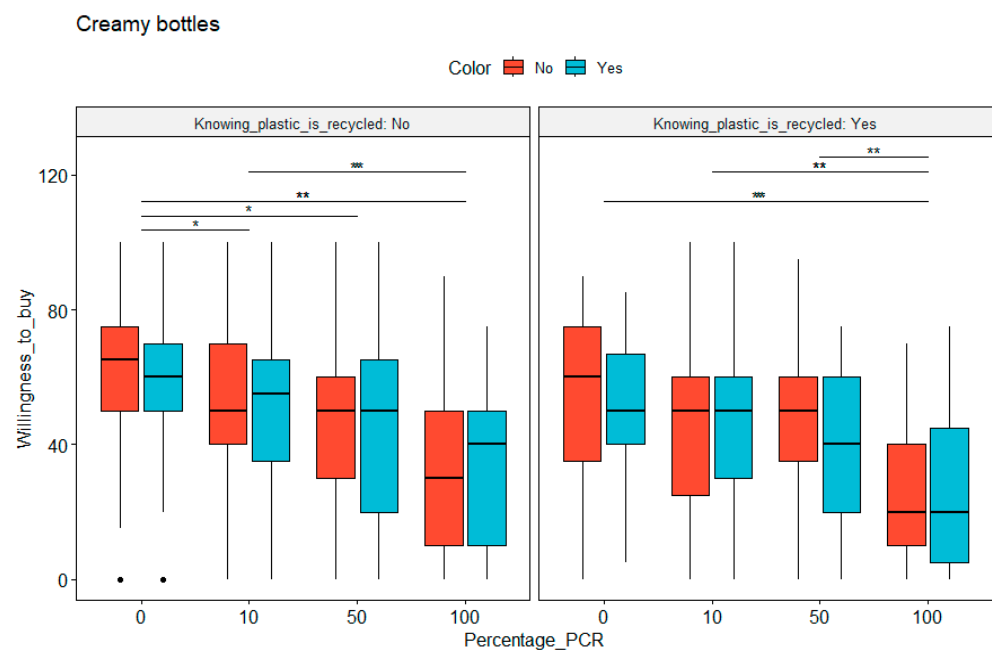


Figure 3. Box plots of the effect of the percentage of PCR and color on the willingness to buy the creamy bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$) effects from the Bonferroni-corrected post hoc tests.

Overall, we found that the bottles made from virgin plastic were judged more acceptable than the bottles made of 100% creamy PCR, and any inclusion of PCR decreased the willingness to buy compared to the virgin plastic.

3.3.2. Effect on Odor Perception: Pleasantness, Familiarity, and Intensity

For pleasantness perception of the odor, there was a main effect of both the percentage of PCR ($F(3, 168) = 29.4, p < 0.001$) and seeing the color ($F(1, 56) = 4.7, p < 0.05$). Grouping the effect of percentage of PCR and color for each level of sustainability claim showed that the effect of percentage of PCR was statistically significant for both levels of sustainability claim ($F(3, 84) = 21.2, p < 0.001$ for claim absent; $F(3, 84) = 10.5, p < 0.001$ for claim present), while the effect of color was significant only when the sustainability claim was present ($F(1, 28) = 4.3, p < 0.05$).

Further pairwise comparison, Bonferroni-adjusted for the effect of PCR, showed that with no environmental claim and when both seeing and not seeing the color, 0% was significantly more pleasant than 50% and 100%, and 10% was significantly more pleasant than 100%. With the environmental claim and when not seeing the color, 0%, 10%, and 50% were all significantly more pleasant than 100%.

Finally, when seeing the color, 0% and 10% were more pleasant than 100%. Pairwise comparison for the effect of the color showed that 50% PCR, with the sustainability claim present, was perceived as significantly more pleasant with the blindfold on, so when the color was not seen (Figure 4).

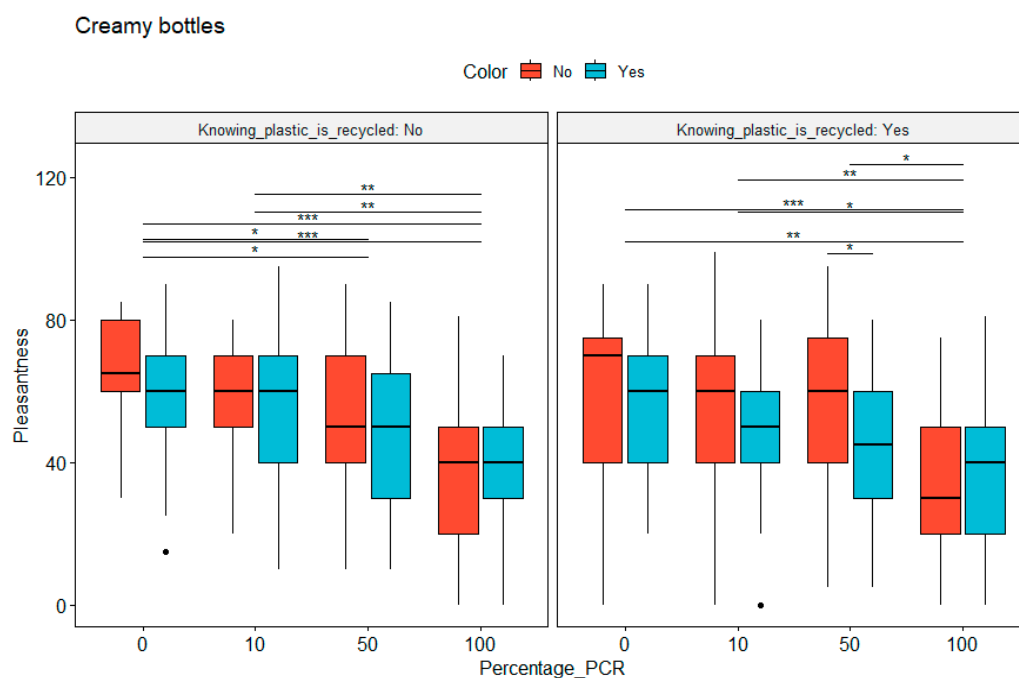


Figure 4. Box plots of the effect of the percentage of PCR and color on the odor pleasantness of the creamy bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$) effects from the Bonferroni-corrected post hoc tests.

For odor familiarity, there was a main effect of the percentage of PCR ($F(3, 168) = 12.3, p < 0.001$). Bonferroni-adjusted pairwise comparison showed that with no claim and when seeing the color, 0% PCR was more familiar than 50% and 100%. With the environmental claim and not seeing the color, the odor of 0% PCR was judged significantly more familiar than 100% (Figure 5).

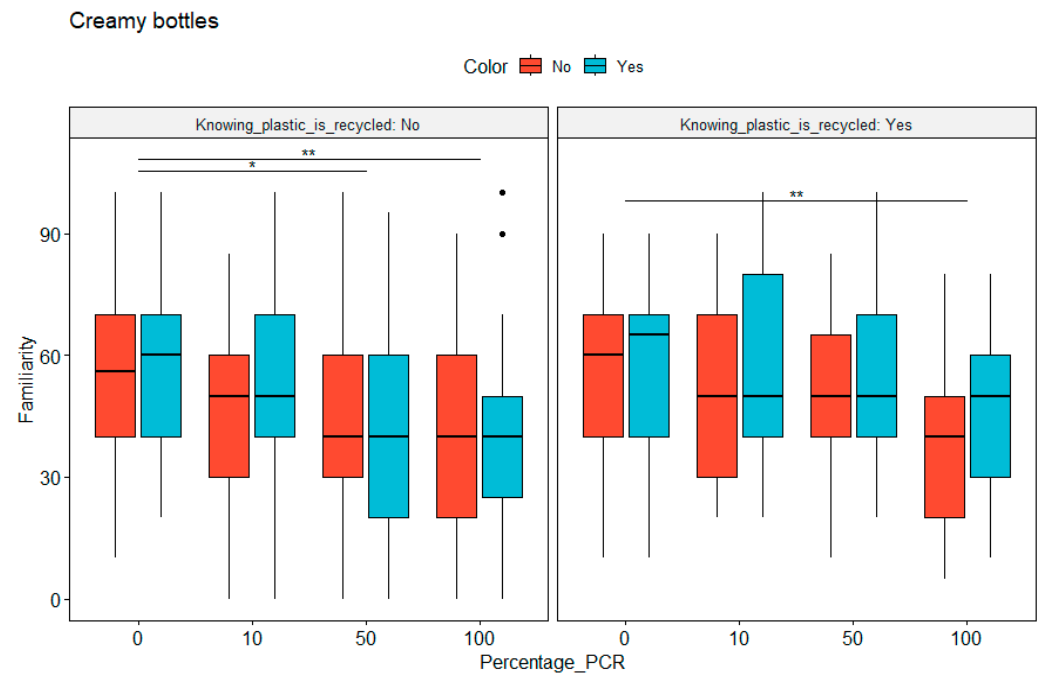


Figure 5. Box plots of the effect of the percentage of PCR and color on the odor familiarity of the creamy bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $** = p < 0.01$) effects from the Bonferroni-corrected post hoc tests.

For odor intensity, there was no significant effect of any of the variables (Figure 6), meaning that the odor intensity of these bottles did not differ significantly between the different percentages of PCR, and it was not affected by seeing the color of the bottle nor by the sustainability claim.

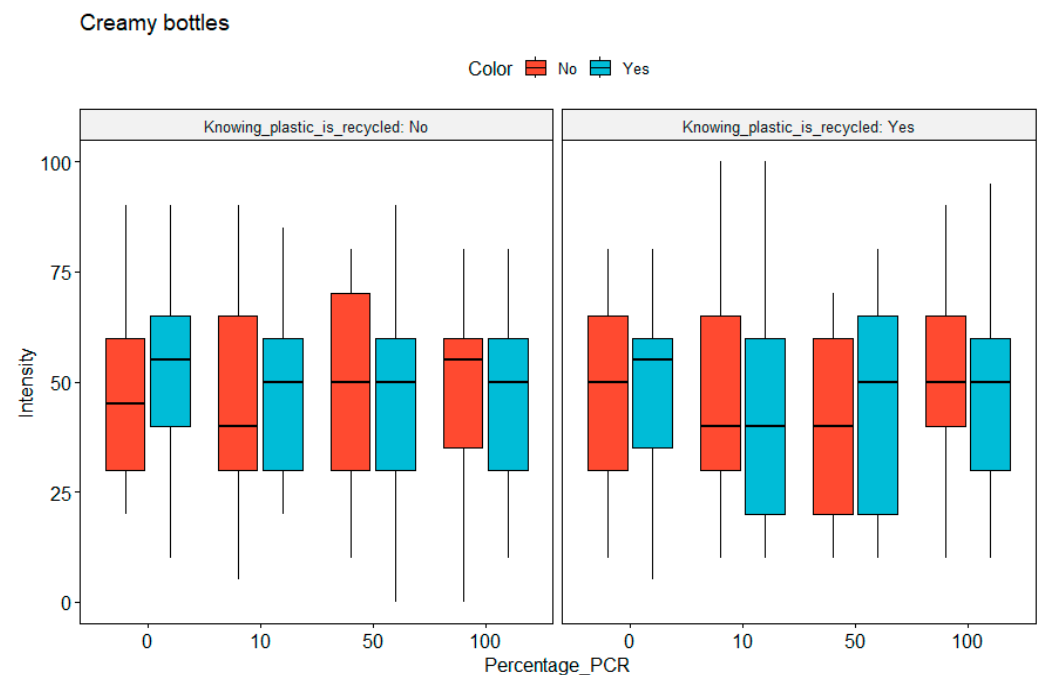


Figure 6. Box plots of the effect of the percentage of PCR and color on the odor intensity of the creamy bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points.

To summarize, the inclusion of any percentage of creamy PCR significantly decreased odor pleasantness compared to the virgin plastic. Odor familiarity was also negatively affected by increasing the percentage of PCR, while odor intensity did not change. Seeing the creamy color of PCR further decreased odor pleasantness.

3.4. Three-Way Mixed ANOVA Grey PCR

For the grey bottles, the three-way mixed ANOVA also did not reveal any statistically significant three-way interaction between the presence of the sustainability claim, seeing the color of the bottles, and the percentage of PCR for any of the attributes.

3.4.1. Effect on Acceptability and Willingness to Buy

For acceptability, we found a main effect of the percentage of PCR ($F(2.15, 120.15) = 21.9$, $p < 0.001$) and seeing the color ($F(1, 56) = 8.5$, $p < 0.001$). Grouping the effect of the percentage of PCR and color for each level of the sustainability claim showed that the effect of the percentage of PCR was statistically significant for both levels of the sustainability claim ($F(2, 57.2) = 14.4$, $p < 0.001$ for claim absent; $F(2, 62.7) = 8.9$, $p < 0.001$ for claim present), while the effect of seeing the color was significant only when the sustainability claim was present ($F(1, 28) = 8.3$, $p < 0.05$).

Bonferroni-adjusted pairwise comparison for the effect of PCR showed that 0% was significantly more acceptable than all percentages of PCR considered (10%, 50%, and 100%), independent of seeing the color without the sustainability claim, and with the presence of the sustainability claim only when seeing the color, 0% was significantly more acceptable than 50% and 100%. Pairwise comparison for the effect of color showed that 50% PCR, with the sustainability claim present, was perceived as significantly more acceptable with the blindfold on, so when the color was not seen (Figure 7).

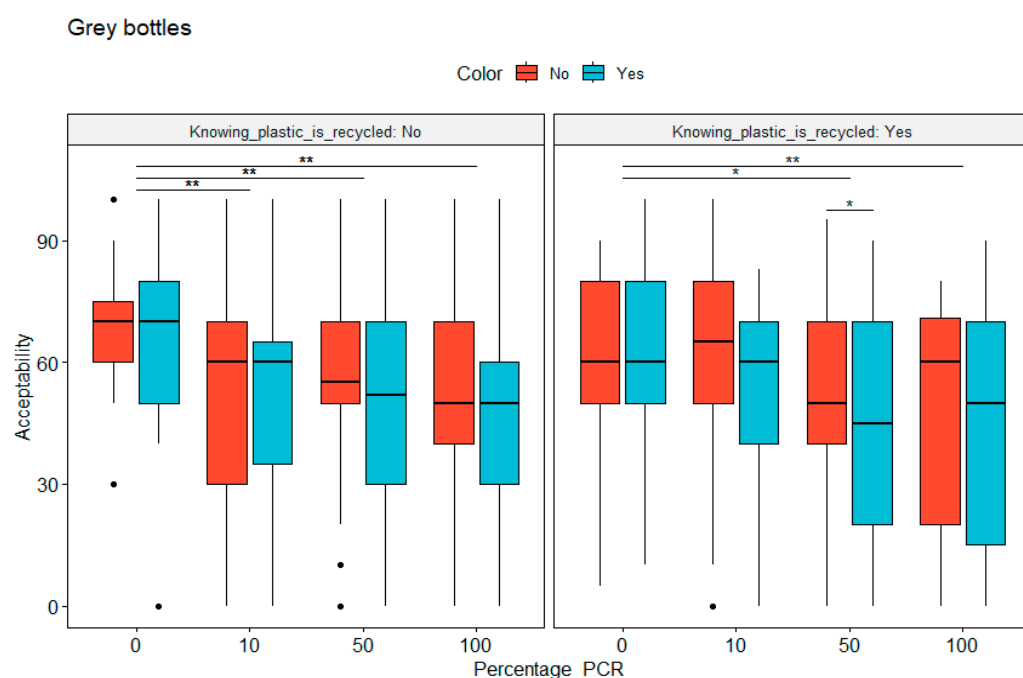


Figure 7. Box plots of the effect of the percentage of PCR and color on the acceptability of the grey bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant (* = $p < 0.05$, ** = $p < 0.01$) effects from the Bonferroni-corrected post hoc tests.

Similarly to acceptability, we found a main effect of the percentage of PCR ($F(2, 114) = 28$, $p < 0.001$) and color ($F(1, 56) = 7.8$, $p < 0.001$) on willingness to buy. The effect of the percentage of PCR was significant in both conditions of the environmental claim ($F(2.2, 62.4) = 17.6$,

$p < 0.001$ for claim absent; $F(1.8, 50.6) = 10.9$, $p < 0.001$ for claim present), whereas the effect of seeing the color was only significant with the presence of the sustainability claim ($F(1, 28) = 7$, $p < 0.05$).

A Bonferroni-adjusted pairwise comparison for the effect of the percentage of PCR showed that, with no sustainability claim, the willingness to buy 0% was significantly higher than 10%, 50%, and 100%, both when seeing and not seeing the color. With the sustainability claim present, the willingness to buy 0% was significantly higher than 50% and 100% while seeing the color, and 0% was significantly different from 50% while not seeing the color. The Bonferroni-adjusted pairwise comparison for the effect of color showed that for the 50% PCR, seeing the color significantly decreased the willingness to buy with the sustainability claim present (Figure 8).

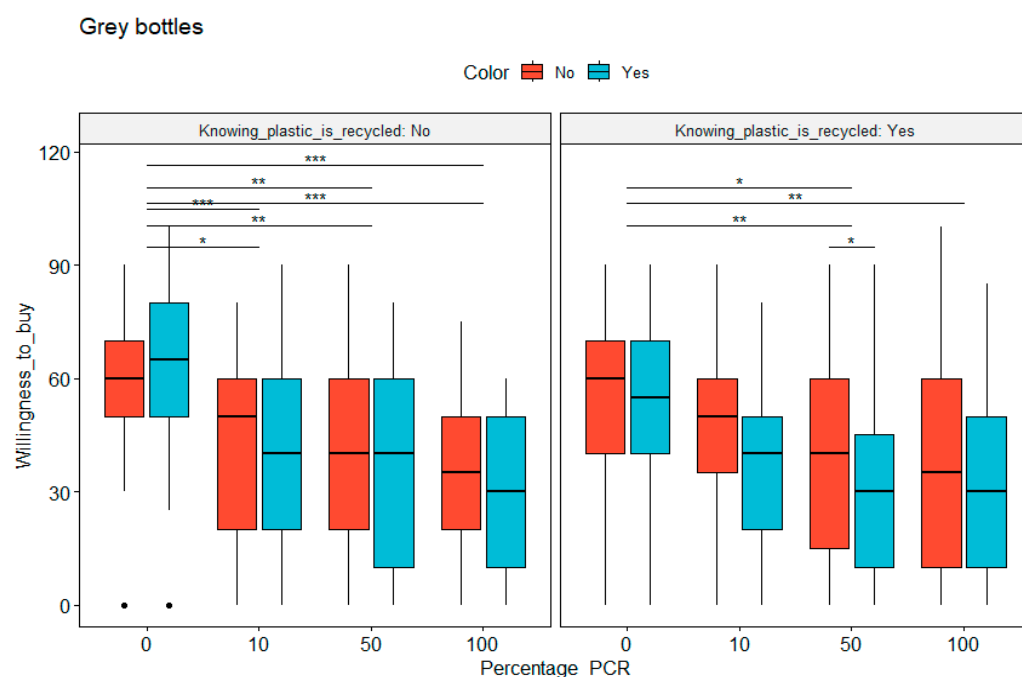


Figure 8. Box plots of the effect of the percentage of PCR and color on the willingness to buy the grey bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $** = p < 0.01$, $*** = p < 0.001$) effects from the Bonferroni-corrected post hoc tests.

For both acceptability and willingness to buy, the effect of color did not reach significance for 10% and 100% PCR, but from the box plots in Figures 7 and 8, it is apparent that they followed a similar trend, meaning that seeing the grey color when knowing that the plastic is recycled significantly decreased the acceptability and willingness to buy.

In general, any inclusion of the grey PCR significantly decreased the acceptability and willingness to buy compared to virgin plastic. Both attributes were further decreased by seeing the grey color of the plastic.

3.4.2. Effect on Odor Perception: Pleasantness, Familiarity, and Intensity

For odor pleasantness, we found a main effect of the percentage of PCR ($F(2, 113.4) = 33$, $p < 0.001$). A pairwise comparison, Bonferroni-adjusted, showed that with no sustainability claim, the odor of 0% PCR was perceived as significantly more pleasant than 10%, 50%, and 100%, independent of seeing the color. Moreover, when seeing the color, the 10% PCR was significantly more pleasant than 100%.

When the environmental claim was present, 0% was more pleasant than 50% and 100% when seeing the color, and there was a significant difference only between 0% and 50% when not seeing the color (Figure 9).

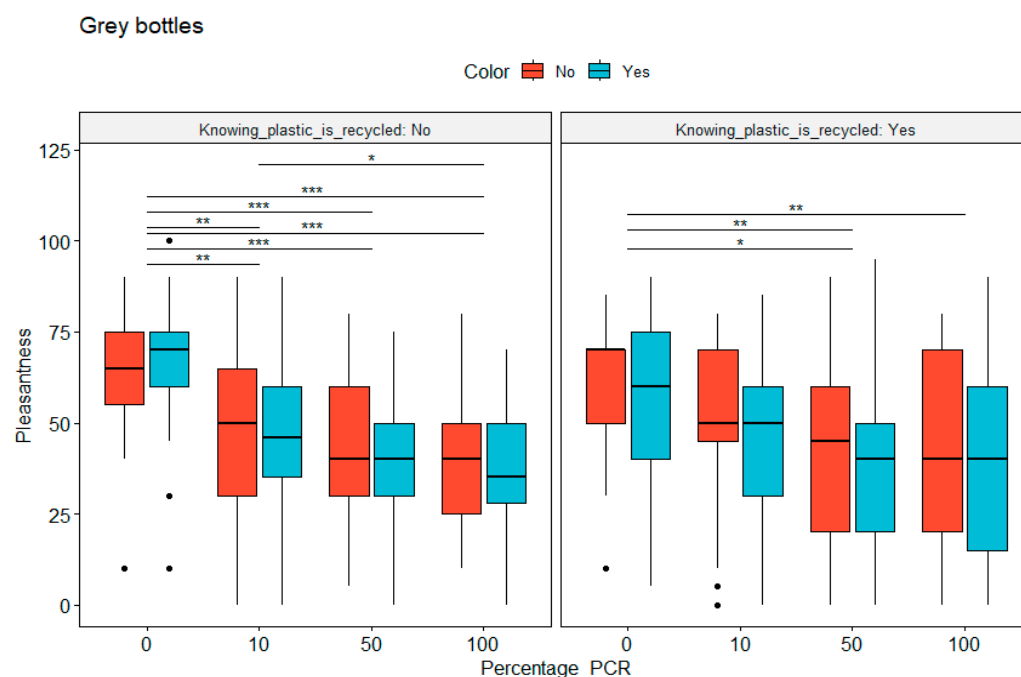


Figure 9. Box plots of the effect of the percentage of PCR and color on odor pleasantness of the grey bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant (* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$) effects from the Bonferroni-corrected post hoc tests.

Additionally, for odor familiarity, we found a main effect of percentage of PCR ($F(2.3, 128.9) = 9.3$, $p < 0.001$) and a two-way interaction between color and percentage of PCR, only for the condition without the sustainability claim ($F(3, 84) = 2.88$, $p < 0.05$). From the post hoc pairwise comparison, we found that with no environmental claim, the odor of 0% PCR was perceived as significantly more familiar than 10%, 50%, and 100% PCR when seeing the color.

When knowing that the plastic was recycled, we found only a significant difference between perceived odor familiarity of 0% and 10% while seeing the color. For the effect of color, odor familiarity for 100% PCR was significantly higher when not seeing the color, in the absence of the sustainability claim (Figure 10).

Finally, odor intensity was also significantly affected by the percentage of PCR ($F(2.6, 144) = 9.2$, $p < 0.001$). The Bonferroni-adjusted pairwise comparison showed that the effect occurred for the odor of 10% PCR, which was perceived as significantly less intense than 50% and 100%, with the environmental claim present and when not seeing the color (Figure 11).

Overall, we found that an increase in the percentage of grey PCR decreased odor pleasantness and familiarity while increasing odor intensity. Seeing the grey color further decreased odor familiarity.

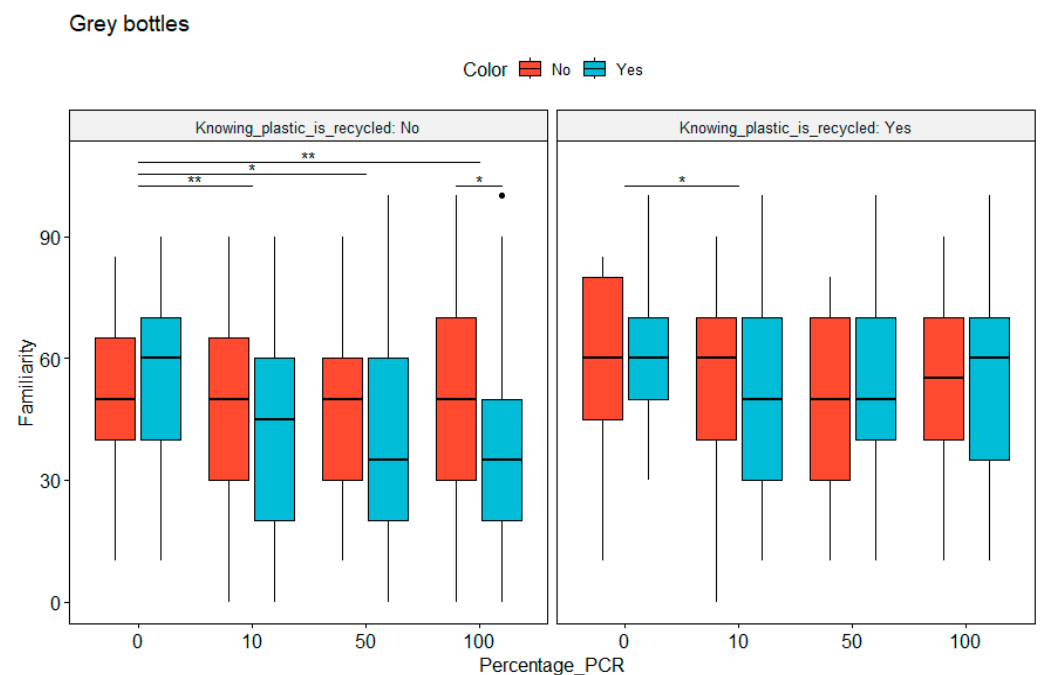


Figure 10. Box plots of the effect of the percentage of PCR and color on odor familiarity of the grey bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$, $** = p < 0.01$) effects from the Bonferroni-corrected post hoc tests.

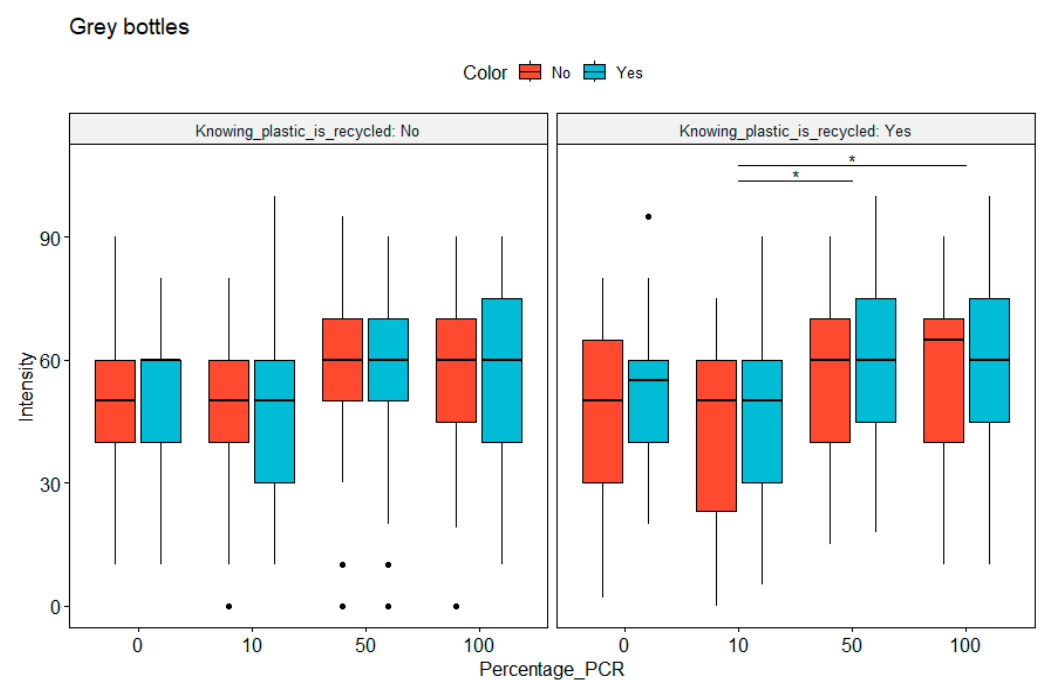


Figure 11. Box plots of the effect of the percentage of PCR and color on odor intensity of the grey bottles. The central line in each box denotes the median, the boxes contain the first and third quartiles, and the whiskers mark the lowest and highest data points. The asterisks indicate significant ($* = p < 0.05$) effects from the Bonferroni-corrected post hoc tests.

3.5. Packaging Odor Qualities as Predictors of Acceptability and Willingness to Buy

We conducted a multiple linear regression to test whether ratings of product acceptability and willingness to buy could be predicted by the perceived odor qualities of

the packaging. For the creamy bottles, we found that odor pleasantness and familiarity were significant and positive predictors of both acceptability and willingness to buy (Equations (1) and (2)), while there was no effect of odor intensity.

As shown by the adjusted correlation coefficients (R^2_{adj}), these models explained 54% of the variance for acceptability and 66% for willingness to buy:

$$\text{Acceptability} = 13.7 + 0.8 \text{ Pleasantness} + 0.1 \text{ Familiarity}, (R^2_{adj} = 0.54) \quad (1)$$

$$\text{WtB} = 7.3 + 0.8 \text{ Pleasantness} + 0.17 \text{ Familiarity}, (R^2_{adj} = 0.66). \quad (2)$$

Acceptability of the grey bottles was predicted by odor pleasantness and intensity, where the contribution of pleasantness was positive, while intensity was a negative predictor (Equation (3)). The explained variance for this model was 58%. For the willingness to buy the grey bottles, a regression model including all the odor attributes explained 78% of the variance (Equation (4)):

$$\text{Acceptability} = 19.7 + 0.8 \text{ Pleasantness} - 0.1 \text{ Intensity}, (R^2_{adj} = 0.58) \quad (3)$$

$$\text{WtB} = 2.2 + 0.9 \text{ Pleasantness} + 0.11 \text{ Familiarity} - 0.07 \text{ Intensity}, (R^2_{adj} = 0.78). \quad (4)$$

3.6. Moderation Analysis

We further aimed to test whether the effect of the presence of a sustainability claim on the acceptability and willingness to buy the PCR shampoo bottles would be higher for individuals with higher levels of environmental concern and environmental motivation. In other words, we aimed to test if environmental concern and motivation acted as moderators in the relationship between the sustainability claim and PEPs.

Because we found a significant positive correlation between environmental concern and motivation ($r = 0.62$, $p < 0.001$), we tested for a moderated moderation effect, i.e., when the two moderators interact with each other. Moderated moderation analysis was conducted using the PROCESS macro in R, model 3 [83], with a biased-corrected bootstrapping procedure using 10,000 samples. The 95% confidence interval of the indirect effect of environmental concern and motivation and their interaction on both acceptability and willingness to buy included zero, indicating that the moderated moderation effect of environmental concern and motivation was not significant for acceptability nor willingness to buy.

3.7. Open-Ended Questions

Finally, we analyzed, both quantitatively and qualitatively, the answers to the open-ended questions. Here, 10.3% of participants reported that they recognized the brand of the shampoo bottles, however, this factor had no significant effect on any of the ratings.

After the ratings, participants were asked whether they considered the odor of the bottles in their judgment of acceptability and willingness to buy. Only 17.2% of participants replied no to this question, while the majority (82.8%) replied yes. To the follow-up question, "How do you think the odor of the bottles affected your judgment?" two of the participants who replied no to the previous question reported that pleasantness and intensity could make them more or less willing to buy, while the rest of the participants who replied no said that the odor did not influence their choice. Among the 82.8% of participants who replied that they considered the odor in their judgments, pleasantness was mentioned 10 times, liking the odor was mentioned 10 times, intensity as a negative attribute was mentioned 5 times, the fact that the bottle smelled like plastic/artificial was mentioned 3 times, concerns about themselves smelling like the odors tested was mentioned 2 times, memories and familiarity were mentioned 1 time each, and finally, there was 1 mention of concern of the odor migrating from the plastic of the packaging to the product ("because of the bad odor of the bottle I feel like the odor of the product itself was bad too").

4. Discussion

The present study investigated consumers' acceptability of PCR plastic packaging with an off-odor. Considering that the smell of PCR plastic is one of the main barriers to its widespread adoption, it is important to understand how to increase its acceptability. Previous studies on sustainable packaging have mostly focused on cues' availability and consumers' understanding of such cues to drive their purchase intentions [8,10,41,46,84,85].

Such cues usually include sustainability information [52,72] and elements of visual appearance, such as color, shape, material, and graphics [10,86,87], intentionally added during the design phase to appeal to consumers. On the other hand, the effect of unintended cues, which inevitably result from sustainable processes (e.g., recycling), such as increased opaqueness of transparent plastics, decreased color variety, increased uniformity toward yellow, grey, and dark colors [88], and off-odors, has been mostly overlooked in literature (however, see [7] on decreased transparency). Arguably, these cues are more concrete indicators of sustainability and should be marketed as such, where the 'ugly' sensory properties of the packaging demonstrate its sustainable origin.

This study investigated consumers' acceptability and willingness to buy shampoo bottles made from two types of PCR plastics, with different odors and colors. We tested the effect of a sustainability claim, stating that the package was made from recycled plastic, both on PEPs (acceptability and willingness to buy the product) and odor perception, depending on the percentage of PCR and the color of the bottles.

4.1. The Effect of the Percentage of PCR and Odor Qualities

A three-way mixed ANOVA revealed no interaction effects between the percentage of PCR, the color, and the presence of the environmental claim. For the creamy bottles, we found a main effect of the percentage of PCR on both PEPs and odor attributes, except for odor intensity. Overall, the bottles with 100% PCR differed significantly for all attributes from the virgin plastic (0%) across the sustainability claim conditions and the color conditions. Increasing the percentage of PCR resulted in a decrease in acceptability and willingness to buy the product, and in decreased odor pleasantness and familiarity.

For the grey bottles, the percentage of PCR showed a main effect both on PEPs and all the odor attributes, including odor intensity. In general, increasing the percentage of PCR to 50% and 100% significantly decreased the product acceptability and willingness to buy, and showed a negative effect on odor pleasantness and familiarity, while increasing the odor intensity.

For both types of PCR, we found that increasing the percentage of recycled plastic included in the packaging, i.e., increasing the concentration of the odorous material, had a negative effect on the judgment of the products. This finding is in agreement with previous studies aiming to characterize and minimize odorants in PCR, reporting PCR odor as one of the main barriers to consumers' acceptability [27–31]. Ruokamo et al. [88] surveyed Finnish consumers and found that they would be more willing to accept visual irregularities (color and surface) in products made from recycled plastic rather than odor.

Such an effect of PCR packaging odors could be explained in terms of one of the three main functions of the human olfactory system, i.e., the avoidance of environmental hazards by acting as a warning system through the detection of airborne pathogens [89]. Olfactory perception is an implicit process that generally takes place without actively paying attention to it, as long as the odorant molecules do not deviate, either positively or negatively, from expectations and habits [90–92]. Stimulus novelty activates specific brain regions devoted to novelty detection and processing, to steer attention and improve memory [93]. When it comes to packaged products, it could be assumed that any odor that is not recognized as the scent of the product deviates from expectations, causing a potential threat signal and triggering avoidance behavior [89]. This is especially true in personal care products, such as shampoo, that come in contact with the skin, making safety one of the priorities among the drivers and barriers to the acceptability of PCR plastics [94]. It is indeed expected that the effect of off-odor on the acceptability of products made from recycled plastic would be

product-dependent [11,95]. The use of recycled plastic in apparel production was shown to be more acceptable for products that do not come in close contact with the skin, e.g., bags, compared to clothing items such as t-shirts [96]. Insights from research on the acceptability of refurbished products showed that ensuring renewal of the parts of the product that come in contact with the skin has more influence than price on the willingness to pay [97]. For the use of recycled plastic in the packaging of fast-moving consumer goods, Magnier et al. [11] showed that purchase intentions were higher for dishwashing soap compared to hand cream, considering that the former is not meant to be absorbed by the skin, therefore, decreasing the perception of contamination.

In the case of hair and body care product categories, the off-odor might not only trigger avoidance due to fear of contamination but also because of the primary role that odors play in the choice and acceptability of scented products, such as shampoo [65,98]. We found a high, significant positive correlation of acceptability and willingness to buy with odor pleasantness and a moderate positive correlation with odor familiarity for both types of PCR plastic. Furthermore, multiple linear regression of the odor attributes showed that pleasantness and familiarity were significant predictors of acceptability and willingness to buy in the case of creamy PCR, whereas, for the grey PCR, pleasantness and intensity significantly predicted acceptability and a combination of all the odor attributes predicted willingness to buy. In all cases, the odor attributes explained more than 50% of the variance, indicating the importance of odor cues in purchasing choice of hair care products. Note that odor intensity contributed only to the grey PCR, and in a negative direction. Indeed, we found that increasing the percentage of PCR for the creamy bottles did not affect the perceived odor intensity, but it significantly increased for the 50% and 100% of the grey PCR. Efficiency measures of odor removal in the deodorization processes of PCR plastic are usually operationalized in terms of reduced perceived odor intensity [24,29–31]. However, the effect of odor intensity is not always so straightforward. Intensity can be either positively or negatively correlated with odor pleasantness [99], or it can also show no correlation, as in our case. Odor familiarity was found to be an important factor in the acceptability and willingness to buy the two types of PCR plastics. The role of odor familiarity in smell perception is to recognize odors (not) encountered before (categorical novelty) or the (un)fitting of odors in certain situations (contextual novelty) [99]. Familiarity was found to correlate positively not only with PEPs but also with pleasantness, as expected from the literature [100–103] since more familiar odors are considered more pleasant. Familiarity can also increase odor intensity [104], as we found in our correlations, and this can indirectly affect odor pleasantness [99].

Moreover, contextual expectations and anticipation can alter odor perception [105–108], and the degree of discrepancy between expectations and perception is one of the main barriers to consumer satisfaction and acceptability. This has been widely studied in food choice and consumption [109–112], but not as much in hair and body care products. By providing participants with a vignette of the situation of buying shampoo, we created expectations, which each participant filled with their own experience, of what shampoo bottles should smell like. The more neutral smell of the virgin plastic bottle was likely in higher agreement with such expectations, making the product more acceptable and increasing the willingness to buy, compared to both types of odorous PCR plastics.

The relevance of the odor was also directly acknowledged by the participants. The open-ended questions about how they used the odor information in their judgments revealed positive hedonic characteristics, such as pleasantness and liking the odor, as the most recurring answers, in agreement with previous studies on the importance of odors in hair care products [65,98]. Negative properties of the odor, such as intensity, an artificial smell, and fear of smelling like the bottles, were also mentioned, supporting not only the role of odor valence but also the avoidance of contamination.

4.2. The Effect of Color

Because the two types of PCR differed not only in odor profile but also in color, and since color is one of the main appearance barriers in the adoption of recycled plastic [25], we also tested the effect of color for the creamy and the grey PCR plastics, by asking participants to rate all the attributes while wearing a blindfold and then repeating the ratings after removing the blindfold so that they could see the colors.

From the three-way mixed ANOVA, we found a main effect of color for the creamy bottles on odor pleasantness of the 50% PCR in the environmental claim condition. Odor pleasantness rated without seeing the color was significantly higher than when seeing the color, indicating that the creamy color had a negative effect on the valence perception of the bottle. Cross-modal perception research into color–odor interactions consistently suggests that appropriate and congruent pairings of colors and odors affect odor identification and discrimination, as well as judgments of odor intensity, familiarity, and pleasantness [113,114]. In cosmetic products, for which odor plays a pivotal role [115], it is important to ensure that the color is congruent with the (expected) odor to increase pleasantness and acceptability. When testing color–odor matching for fragrance packaging, Schifferstein and Tanudjaja [116] found a mediating role of the pleasure of colors and odors on the degree of fit between the two, even though, in a follow-up study, Schifferstein and Howell [117] found that consumers' buying intentions were not related to the color–odor matching of the packaging, but rather to how much participants liked the fragrance.

In our case, we could speculate that the creamy color of PCR might have affected odor pleasantness because the color–odor matching was not appropriate and/or unexpected. This hypothesis could be tested in future studies to further investigate why the effect was significant only for the 50% PCR and not for the other percentages. Note, however, that the aim of the present study was not to understand the cross-modal interaction between packaging color and odor perception. Hence, the study design used here is not suited to make inferences about this effect because there was no systematic variation of color between the different percentages of PCR, and we did not measure the perceived appropriateness of the color–odor pairs. Moreover, while understanding the mechanism of cross-modal interactions between colors and odors has interesting marketing applications [64,116,117], for the case of implementing the use of PCR in packaging, we do not recommend changing the color to increase the pleasantness of the odor. First, because packaging color is one of the main cues for brand identification [56–58] and, therefore, for building consumer trust and driving purchase choices [118–120]. Second, and most relevant to the aim of this paper, adding colorants to PCR would result in a higher environmental impact, not only due to the use of new resources to carry out the dyeing process but also because the packaging would be more difficult to separate and be recycled again [121,122]. On top of that, color–odor associations are an intercultural phenomenon [123], meaning that the most suitable color to counteract the odor will depend, among other things, on the country where the product is sold.

For the grey PCR, we found a main effect of color on acceptability and willingness to buy, which was significant only for the 50% PCR but showed a similar trend for the other percentages as well. This result could be partly explained by the restrictions on the gender of our participant sample. Since we used male identity as an exclusion criterion, 98.3% of our sample was composed of participants with female gender identity and 1.7% non-binary identity. Products and their packaging are designed to target and appeal to a certain gender, to the point that they even define what is masculine or feminine [124]. Consumers grow to recognize the stereotypical color of their gender identity through associative learning [125] and set expectations on 'acceptable' colors. Research on the factors influencing purchase intentions and acceptability of male grooming products found that masculine colors, such as grey, blue, or black, are considered even more important than a label "for men" if paired with a feminine color [126]. It is, therefore, arguable that the grey PCR packaging failed to meet the color expectations of our prevalently female sample, thus decreasing the acceptability and willingness to buy. Since we expected the effect of

color on purchasing intentions to be gender-dependent, by removing the gender exclusion criterion, future studies could investigate potential packaging applications of the grey PCR in the male market. It is worth mentioning that the effect of the packaging color on product choice does not rely solely on gender segmentation, but it also depends on other factors, such as emotional and symbolic associations and personal preferences [63,125,127].

It should also be noted that in this study, the bottles were shown without labels to limit the effect of brand recognition; however, future studies could investigate the combined effect of the grey background of the bottles with imagery, pictorial elements, labels, and text. Such visual properties of the packaging design have been shown to attract attention and increase preference and liking [128–131].

The grey color also significantly decreased odor familiarity for the 100% PCR bottle. This finding could be again explained via cross-modal association and the (in)appropriateness of the color–odor pairing. However, as for the creamy PCR, conclusive interpretations would require a dedicated experiment.

4.3. *The Effect of the Environmental Claim*

Product expectations are not only set by prior experience but are also derived from product extrinsic properties, such as labels and claims [132]. We, therefore, hypothesized that the presence of a sustainability claim, informing participants that the plastic was recycled, would have had a significant effect on product acceptability, willingness to buy, and odor perception. However, we did not find any significant difference between the two conditions. This result could have several explanations. One might be a limitation of our experimental design, where the environmental claim was only provided as one sentence as part of the story, which could have made it not salient enough to have an effect. We found, however, that all participants, except for one whose data were screened out, answered the manipulation check correctly, i.e., they knew whether the plastic was recycled or not, according to the condition they were assigned to. What we do not know, however, is whether they also used this information in their judgment. In future studies, this could be tested both explicitly and implicitly, by asking participants whether and how much they found the sustainability information relevant to their choice (explicit) and by measuring the response time to these questions (implicit). A quicker response time could indicate a stronger connection to sustainability [133] and, therefore, an increased potential use of the information in the decision-making process. These measurements could be coupled with the addition of an actual label on the packaging for participants to read, to increase the salience of the information and the ecological validity of the study.

Our results align with the findings of Atkinson and Rosenthal [134] on the effect of general vs. detailed eco-labels, where general eco-labels were found to be inadequate to support consumers' choice and sustainable behavior, while more substantial claims increased trust and positive attitudes toward the product. Moreover, following one of the guidelines proposed by Polyportis et al. [135] to ensure trust in the environmental impact of products, it would be insightful to test how substantiating the label with concrete details on the effect of recycling on odor and how odor represents a cue for sustainability would affect consumers' perception. Highlighting the environmental benefits of the packaging would also increase consumers' awareness of the symbolic design attributes of the product. These, together with the functional attributes of a product, have been shown to be predictors of purchase intentions [136].

4.4. *The Effect of Environmental Concern and Motivation*

Consumers are often segmented according to their level of environmental concern (EC) and environmental motivation (EM) to explain sustainable behavior in general [69,137] and acceptability of environmentally friendly packaging and products in particular [55,84,138]. Magnier and Schoormans [55] found that when the packaging has a conventional appearance (i.e., non-sustainable), as was the case for our PCR plastic shampoo bottles, while showing an environmental claim, participants with high EC trusted the claim and showed

a positive attitude toward the packaging. On the other hand, participants low in EC did not trust the incongruent combination of information of the conventional-looking packaging with a sustainability claim, which led to a decrease in their purchase intentions, likely due to skepticism and suspicions of greenwashing [139].

We expected that the acceptability and willingness to buy PCR packaging when knowing that the plastic is recycled would be higher for participants who cared more about the environment and would, therefore, be more prone to accept the sensory trade-offs of sustainable materials. In other words, we hypothesized that the levels of EC and EM would act as moderators on the effect of the sustainability claim on the PEPs' ratings. A moderated moderation analysis revealed no such effect. This might be due to a range restriction, one of the issues that can arise when performing moderation analysis, namely that the data were not representative of the entire range of possible scores of the variables [140]. A low sample variance decreases the power of the moderating effect, making it more difficult to be detected. Such low variance was what we observed in our sample. On average, we found high scores for both EC ($M = 6.1$, $SD = 0.7$, on a 7-point scale) and EM ($M = 4.4$, $SD = 0.6$, on a 5-point scale), meaning that consumers with low EC and EM were not adequately represented in our sample. Future studies should account for such a limitation by pre-screening participants on their levels of EC and EM in order to acquire a more representative sample. The range restriction problem applies to and should be addressed also for the demographic characteristics of our sample, namely, age and gender, two variables that are known to affect environmental concern [137,141,142].

Kim and Lee [143] examined the effect of environmental consciousness, divided into environmental concern, environmental knowledge, and perceived consumer effectiveness, on sustainable buying intentions and behavior. They found that environmental concern did not show a significant effect on purchasing intentions, while environmental knowledge and perceived effectiveness did. The authors suggested that environmental concern by itself is not sufficient to trigger sustainable behavior and should, therefore, be complemented with detailed knowledge of the environmental benefit of the product and the environmental impact of the consumer choice [143]. Measuring the effect of environmental knowledge and perceived consumer effectiveness on the acceptability of PCR packaging with an off-odor would bring valuable insights for future studies.

Regarding environmental motivation, it is important to distinguish in future studies between autonomous (or intrinsic) and controlled (or external and introjected) motivation, since the former has been shown to positively influence green purchase intentions, and the latter negatively [144].

5. Conclusions

Compared with other studies on PCR plastics focusing on odor characterization and removal, here, we investigated which factors contribute to consumers' pro-environmental preference for PCR plastic packaging with an off-odor. We found that increasing the percentage of PCR had a significant negative impact on the acceptability and willingness to buy, as well as on the odor attributes of the shampoo bottles. Contrary to our hypothesis, we found that the presence of a sustainability claim did not have a significant effect on these ratings, and the relationships were not moderated by the level of environmental concern and motivation. We identified limitations in the experimental design and sample representation to explain these findings, suggesting the need for future research to address these issues. For the grey PCR bottles, we observed that the color played a significant role in decreasing PEPs and odor familiarity. These results contribute to sensory marketing research, indicating the need to explore how multisensory and cross-modal perception could be used to influence sustainable behavior.

For key stakeholders, such as product manufacturers and marketers, this study suggests that detailed eco-labels and concrete information on the environmental impact of PCR plastic packaging may be more effective in influencing consumer perceptions and behaviors than general sustainability claims. For future research, it is recommended to

explore the effect of environmental knowledge and perceived consumer effectiveness on the acceptability of PCR packaging with an off-odor. Behavioral interventions in the form of boosts [145,146], aiming at promoting consumers' literacy of topics, such as sustainability, could be coupled with intrinsic and extrinsic cues of sustainable packaging design. Furthermore, future studies could investigate the impact of actual labels on PCR packaging and the salience of sustainability information in consumer decision-making processes, as well as test and expand the ecological validity of the findings by conducting field studies at the point of purchase in supermarkets, and during product use at home. Moreover, it would be important to include relevant variables for consumers' choice that we did not account for in this study, especially the product price and socioeconomic status of consumers, since the literature on the willingness to pay for environmentally friendly products is not yet unanimous [147–149]. These insights could provide valuable guidance for developing more effective strategies for promoting the adoption of sustainable packaging and influencing consumer behavior.

This study further contributes to extending the guidelines for design from recycling [20] by highlighting the importance of olfactory sensory properties and perception in the use of recyclates. Because we used unscented shampoo to isolate the odor of the PCR bottles, future studies should look into the perceived interaction between the scent of the product and the odor of the packaging. As a general recommendation, we advise designers and key stakeholders to work together on leveraging the environmental value of the odor of PCR plastic, while creating a framework penalizing the lack of odor of virgin plastic.

This study aimed to advance the research in the field of sensory perception and consumer behavior toward sustainable packaging, and advocates for more future research efforts to normalize the 'ugly' properties of PCR as proof of its sustainability.

Author Contributions: Conceptualization, F.D.C. and M.A.M.S.; methodology, F.D.C.; validation, S.G.; formal analysis, F.D.C.; investigation, M.L. and I.V.; resources, R.G., Y.N. and S.G.; data curation, F.D.C.; writing—original draft preparation, F.D.C.; writing—review and editing, F.D.C. and M.A.M.S.; visualization, F.D.C.; supervision, M.A.M.S.; project administration, F.D.C. and M.A.M.S.; funding acquisition, M.A.M.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Unilever.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Utrecht University (protocol code 22-0518 and date of approval 17 November 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author, F.D.C., upon request.

Conflicts of Interest: Unilever provided financial support for participants' remuneration and materials by supplying the PCR unlabeled shampoo bottles (test product). R.G., Y.N., S.G. and M.A.M.S. are employees of Unilever. The remaining authors (F.D.C., M.L., I.V.) declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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