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HOW CONSUMERS PERCEIVE DIFFERENT MATERIALS, PACKAGING, AND WASTE: A PLASTIC-FOCUSED ANALYSIS

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ABSTRACT

Plastic pollution is a topic that increasingly concerns consumers all over the world. Policymakers and industry practitioners are also called upon to work on solutions. One strategy to fight those amounts of plastic is recycling, which can only be achieved if consumers are convinced of the value and importance of plastic. Two online questionnaires with consumers were conducted in Austria, where separate collection infrastructure is well established, but recycling targets for plastic packaging are still unsatisfactory. The perception of the material itself, the material as waste, and the material as packaging was investigated. Results show that plastic is perceived as significantly worse than other materials (i.e. glass, paper, and metal) in various dimensions (perception as valuable, good, important, and natural). However, when asked if it is convenient, plastic comes close to the good evaluation of the other materials. The overall negative perception was also supplemented by participants' free associations, whereby an apparent dissonance between glass and plastic was identified. While plastic was associated with an overwhelming amount of waste and as "unnecessary," glass creates more ambivalent associations: although the higher weight is perceived as unfavorable, positive associations such as "recyclable" and "sustainable" predominate. Researchers, companies, and policymakers need to take this dissonance seriously and work to reconcile public perception by responsibly using and designing plastic packaging and enhance convenience during the disposal stage. This must be accompanied by clear consumer education, so that plastic is perceived as valuable material that consumers consider important to recycle.

1. INTRODUCTION

Recycling is one of the lower-rated principles in the waste hierarchy, yet it is seen as a major instrument to decrease plastic pollution and an essential step towards a circular economy which aims at reducing resource depletion and unsustainable waste management (Ellen MacArthur Foundation & McKinsey & Company, 2016). In this context, the consumer perspective is an essential component of a thriving circular economy (Kirchherr et al., 2017) since consumers not only influence which materials are consumed, but also decide how these materials are disposed-of when they become waste (Klaiman et al., 2016; Thoden van Velzen et al., 2019). However, the potential of consumers in enhancing the sustainability of the plastics value chain has not yet been fully harnessed (Johansen et al., 2022; Nemat et al., 2020).

A significant discrepancy exists between consumer perceptions of packaging sustainability and scientifically validated assessments of its environmental impact. As early as 1996, Van Dam found that glass was perceived as the most environmentally friendly material and plastic the least environmentally friendly when a particular product was presented in different packaging to randomly selected participants, despite life cycle analyses proving it different. This has been proven repeatedly in recent years through studies in which students were asked about the packaging of liquid goods (drinks, beer, oil, etc.) (Boesen et al., 2019;

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De Feo et al., 2022). Steenis et al. (2017), who used a specific product (tomato soup), even describe this discrepancy between consumer perception and the scientifically proven results of life cycle assessments (LCA) as a "threat to sustainable development" (p.294). Processed tomatoes were also used in a choice experiment study with young German consumers, confirming this discrepancy between perceived and LCA-based sustainability of packaging materials (Bock & Meyerding, 2023). Moreover, questions about food packaging, without using a specific product, revealed that Swedish (high-income) consumers tend to have a negative attitude towards plastics and rely heavily on the material itself, without considering sustainability as a combination of product and packaging, and their life stages (Lindh et al., 2016). A qualitative interview study involving participants from multiple countries confirmed that, particularly among Germans, the material composition serves as a key criterion for evaluating the environmental impact of packaging (Herbes et al., 2020). However, this material-based assessment approach was also observed among French and American participants (ibid.). Further studies show that the material is one of the most important clues for consumers to assess whether the packaging is classified as sustainable (Ketelsen et al., 2020; Magnier & Crié, 2015; Nguyen et al., 2020). While packaging is the shaped material used to contain, protect, transport, or present a product until it reaches the consumer, material refers to a substance used to make a product or a packaging (European Commission, 2025). As a result, packaging (made from a specific material) ends up in the hands of consumers, with waste being defined as something that needs to be disposed of after use (European Commission, 2018a). Therefore, assessing materials, packaging and waste is essential for understanding consumer behavior.

This insight enables more effective strategies for guiding responsible and sustainable consumer actions. As this study focuses on perceptions of materials, packaging and waste rather than on the physical or technical properties, it offers a clearer view of how consumers interpret and respond to material choices in various contexts.

1.1 Theoretical background

Regarding recycling actions, consumers are confronted with a number of barriers, which can be divided into macro-environmental factors (political, economic, sociological, technological, ecological, and legal factors), micro-environmental factors (situational factors such as perceived condition, perceived convenience, etc.), and personal factors (Ertz et al., 2023), which are interlinked and influence each other. Aligning with studies by Stoeva and Alriksson (2017) and Tonglet et al. (2004), it can be argued, however, that despite external factors like adequate waste management, as it is provided in Austria (Schuch et al., 2023), a positive intrinsic attitude towards recycling remains essential, emphasizing the importance of their personal attitudes. Generally, attitudes, subjective norms, and perceived behavioral control were found to predict intentions to perform behavior and represent the three major pillars of the TPB (theory of planned behavior) (Ajzen, 1991, 2020). The TPB is commonly used as a theoretical framework to predict recycling behavior and is extended in various forms (Botetzagias et al., 2015; Cheung et al., 1999; Khan et al., 2019; Stoeva & Alriksson, 2017; Tonglet et al., 2004; Yuriev et al., 2020). Attitude is the subjective perception or belief regarding a certain behavior. Subjective norms reflect the perceived social pressure to perform a behavior that is considered expected, whereas perceived behavioral control describes the perception of opportunities to perform the behavior, e.g., based on sufficient time, space, facilities, and convenience (Ajzen, 2020). While proper waste management is in progress in the EU (European Commission, 2023), the severe influence of subjective perceptions was shown by a study conducted in the UK by Dunant et al. (2017), where misperceptions and miscommunication contributed to increased costs and impeded recycling efforts. This underscores the need to prioritize the study of attitudes that reflect perceptions.

1.2 Focus, key contributions and relevance of the study

In its early warning assessment reports (European Commission, 2023) on the recycling targets for municipal waste and packaging waste, the European Environment Agency (EEA) found that many countries are at risk of missing the recycling rate targets as defined in the Waste Framework Directive (European Commission, 2018a) and the Packaging and Packaging Waste Directive (European Commission, 2018b). When it comes to packaging materials, plastics are considered to be the material that poses the greatest challenges in terms of achieving recycling targets, with Austria also at risk of failing to meet its targets. For instance, in Austria, only minor proportions of glass (18%) and paper (17%) packaging are not separately collected, in contrast, 47% of plastic packaging is disposed of in mixed wastes, and therefore hinders recycling (Lipp & Lederer, 2025). To get to the bottom of this challenge, attitudes towards the material itself were examined, as it was assumed that this also hinders attitudes towards recycling. This attitude is determined through two anonymous online questionnaires.

Considering the vast impact of consumer perceptions on recycling and the limited attention given to the consumer perspective, it is critical to positively steer those perceptions. Hence, to effectively influence consumer perceptions, it is essential to first thoroughly understand and investigate them. Thus far, research has primarily focused on the perception of a material within the context of its application in packaging. However, the perception of a particular packaging material can be product-specific (Schifferstein, 2009). Along with the fact that the materials used in packaging are also evaluated for their environmental impact, it is crucial to thoroughly investigate this issue. Further, as the material is such an essential part of the packaging, producers, designers, and recyclers should all be able to relate to it. Therefore, the urgency arises in assessing the perception. Comparing common packaging materials is of substantial interest to gain a comprehensive understanding of how consumers perceive the material itself and what differences arise between plastic and

alternative materials in terms of the attributes assigned to them.

Additionally, to draw conclusions on the disposal step also the state as "waste" is of interest. Especially in regard to plastic associations with "plastic food packaging" in the product stage show that it is already then considered as "waste" (Koenig-Lewis et al., 2022), which leads to the vital question of how materials and waste change in perception, which, to our knowledge, has not been investigated to date, as it is aimed for in this article.

Therefore, this study aims to investigate consumer perceptions of the material itself, the material as waste, and as packaging, using the case study of Austria to answer the question: Do materials retain value after becoming waste? In contrast to previous studies, a representative sample of the Austrian population in terms of gender and age, with a well-distributed proportion of different levels of education, was used. In addition, by utilizing a within-subject and an in-between subject design, findings are validated.

Two online surveys were conducted: The first, carried out as within-subject design in 2021, assessed the perception of paper, glass, plastic, and metal across five dimensions (valuable, convenient, good, important, and natural). This was followed by the second survey which was conceptualized as a between-subject design to compare plastic and glass using the same dimensions in 2022. The results are discussed in comparison to scientific literature in order to draw comprehensive conclusions for the scientific community, producers and designers of packaging materials, policymakers, and society.

2. METHODS

2.1 General study design

In the following, two surveys are presented. In Survey 1, an anonymous online questionnaire with a within-subject design was applied. A within-subject design uses multiple stimuli, equal for all participants. In this case, the participants were presented with the most important materials, which are also used in packaging (plastic, glass, metal, and paper). Survey 2 used an anonymous experimental online questionnaire with a between-subject design, meaning the participants (155 each) were randomly exposed to one of the two between-subject conditions, namely either glass or plastic. This allows a comparison between the different stimuli (either plastic or glass). The focus was on glass in comparison to plastic, as both are used for similar packaging applications due to their barrier properties suitable for liquid (Deshwal et al., 2019). Additionally, glass was the dominant material for such food packaging until plastic partly replaced it (Bolanča et al., 2018), and according to recent results, glass is preferred over plastic due to a higher perceived sustainability (Hallez et al., 2024).

The two different survey designs were chosen to increase the statistical power and validity, and to reduce the potential for unfavorable response effects (Charness et al., 2012). In addition, an attention check was performed in both surveys to ensure data quality, with the aim of reducing the error variance and increasing statistical significance (Oppenheimer et al., 2009). The attention checks instructed participants to ignore the displayed question and instead select a specific response option. The instruction read: "We are interested in your honest opinion and therefore ask you to read our questions carefully. Otherwise, some of your responses may be unusable for us. To verify your attention, please ignore the question shown below and instead click on the answer option 'Stowe/Kaiserschmarrn.' Thank you very much!" Participants who failed this check were shown the item again, up to two additional times, accompanied by a note reminding them to read the instructions carefully. If the check was not passed on the third attempt, the survey ended automatically. No further exclusions were made.

Participants for both studies were recruited via a market research agency, a common practice in consumer research (c.f. Geissmar et al., 2023; Hofstetter et al., 2024; Sokolova et al., 2023). It was asked to recruit a representative sample of Austrian citizens through its online panel, and the questionnaire was distributed via an online link and included sociodemographic questions to identify the characteristics of the sample (Table 1).

The characteristics of both samples correspond well with the 2021 overall population of Austria in terms of gender and age (M_{age}= 43.2, 50.7% female) according to the Austrian census (Statistics Austria, 2024b). The educational background also matches the Austrian population in 2021 very well, with the largest proportion (32.6%) of the Austrian population having completed vocational training.

TABLE 1: Procedural and sociodemographic characteristics.

Characteristics	Survey 1	Survey 2
Research Design	Within-subject	Between-subject
Data collection period	01/2021	01/2022
Attention check passed	81.87%	92.96%
N	316	310
Mean Age	M_{age} = 41.73 years SD_{age} = 13.77	M_{age} = 42.46 years SD_{age} = 13.06
Gender	49.69% female, no one diverse	48.39% female, one person diverse (0.32%)
Education	Vocational training: 42.72% Secondary school: 16.14% Higher education entrance qualification: 16.14% Academic degree: 16.14% Compulsory school: 8.86%	Vocational training: 47.10% Secondary school: 15.16% Higher education entrance qualification: 14.84% Academic degree: 17.10% Compulsory school: 5.81%

Secondary school and higher education entrance qualifications are counted together and account for 30.4%, while 19.7% have completed higher education and 17.3% have compulsory schooling as their highest level of completed education (Statistics Austria, 2024a). No post-stratification weighting was applied.

2.2 Survey 1: Within-subject design

Consumers' perceptions were examined with semantic differentials to measure meaning (Osgood, 1952). For this purpose, participants were asked to evaluate (1) different materials (plastic, paper, glass, metal) and (2) the corresponding waste (plastic waste, paper waste, glass waste, metal waste). The question was formulated as follows: "Plastic/ Paper/ Glass/ Metal as a material is for me …" The participants could then choose answers on a 5-point Likert scale with semantic differentials (valuable – valueless, convenient – inconvenient, good – bad, important – unimportant, natural – unnatural). This was followed by similarly worded questions on the topic of waste: "Plastic/ Paper/ Glass/ Metal waste is for me …" using the plural of waste in German and the same semantic differentials as before with a 5-point Likert scale. Further variables were assessed as well as the original expressions can be found in Section S1 of the Supplementary material. However, since this article focuses on evaluating the materials and the corresponding waste, the results of questions like for example on waste separation are not presented.

2.3 Survey 2: Between-subject design

Survey 2 was built on the results of Survey 1 in January 2022. Free associations to plastic/glass packaging were assessed at the beginning of the questionnaire with the question: "What comes to your mind spontaneously on the subject of 'plastic/glass food packaging'?". Followed again by a 5-point Likert scale with the same semantic differentials (valuable – valueless, convenient – inconvenient, good – bad, important – unimportant, natural – unnatural) as in Survey 1, to ask about the opinion on plastic or glass, respectively. Further variables which were assessed but are not presented in this study can be found in Section S2 of the Supplementary material.

After data collection, the free associations were rated as positive, negative, or neutral by two authors of the article applying qualitative content analysis (Mayring, 2010; Schreier, 2012). The entire answer was rated, such that if a participant mentioned a positive and a negative association, both associations were considered. Additionally, any reasons provided for their associations were systematically coded into categories. Finally, the ratings were compared. Disagreement between the two raters was not systematic, and the raters subsequently discussed each statement until an agreement was reached.

2.4 Comparison of survey results to the separate collection rate

In order to better understand the survey results with the physical basis of a circular economy, the respective separate collection rate (SCR) is displayed for indicative comparison with the survey results, based on values from Lipp and Lederer (2025) for the year 2020. The reason for displaying the SCR and not the recycling rate is that the SCR gives information on the share of waste that is collected and disposed of separately by consumers. Thus, the SCR represents a consumer decision. Contrary to that, the recycling rate shows the share of waste actually recycled. This value differs substantially from the SCR for plastic and metal packaging. In the case of plastic packaging, the difference is due to sorting losses in sorting plants, resulting in lower recycling rates than SCRs. For metals, the recycling rate is higher than the SCR since metals recovered from mixed municipal solid waste and waste incineration bottom ashes can be added to the recycling rate according to European Commission (2019a). In both cases, the recycling rate is then not only a result of the consumer decision, but of sorting technology. For a comparison, the recycling rates of packaging wastes in Austria shown in the Eurostat data in the year 2020 were 80% for paper, 25% for plastics, 66% for metals, and 82% for glass, whereas the SCR were in the same year 83% for paper, 53% for plastic, 55% for metals, and 82% for glass (Lipp and Lederer, 2025; Eurostat, 2024a). The metal SCR is calculated based on the mass-weighted quantities SCR of iron and aluminum packaging in combination (Lipp & Lederer, 2025).

3. RESULTS

3.1 Survey 1: How do consumers perceive different materials?

The perceptions of plastics as material are clearly the worst compared to all the materials questioned in our study. A repeated multivariate analysis of variance (MANOVA) showed significant results comparing the consumers' perception of the different materials (plastic, paper, glass, and metal) on the respective dimensions (valuable, convenient, good, important, natural) Pillai´s Trace=0.681, $F(15,3774)=73.92$, $p<0.001$ (Section S3, Supplementary material).

As shown in Figure 1, plastic consistently achieves the lowest mean values of the dimensions if compared to the other materials. The only exception was convenience. Mean values and standard deviations can be found in Section S4 of the Supplementary material.

The analysis revealed a significant difference in how valuable the materials were perceived, $F(3,313)=177.78$, $p<0.001$, $\eta_p^2=0.630$. The remaining materials seem to be perceived as very valuable as the mean of paper, glass, and metal were all above 4 on the 5-Point Likert scale.

Likewise, in the case of convenience a significant difference is shown $F(3,313)=39.35$, $p<0.001$, $\eta_p^2=0.274$. Furthermore, a significant difference between the materials perceived as good, $F(3,313)=252.63$, $p<0.001$, $\eta_p^2=0.708$, and important is found $F(3,313)=102.61$, $p<0.001$, $\eta_p^2=0.496$. Finally, a significant difference was found between the materials in terms of whether they were perceived as natural or unnatural $F(3,313)= 466.38$, $p<0.001$, $\eta_p^2=0.817$ by Austrian consumers. The Bonferroni-adjusted post hoc tests confirmed a significant difference between plastic and the respective materials, except for metal in the dimension of

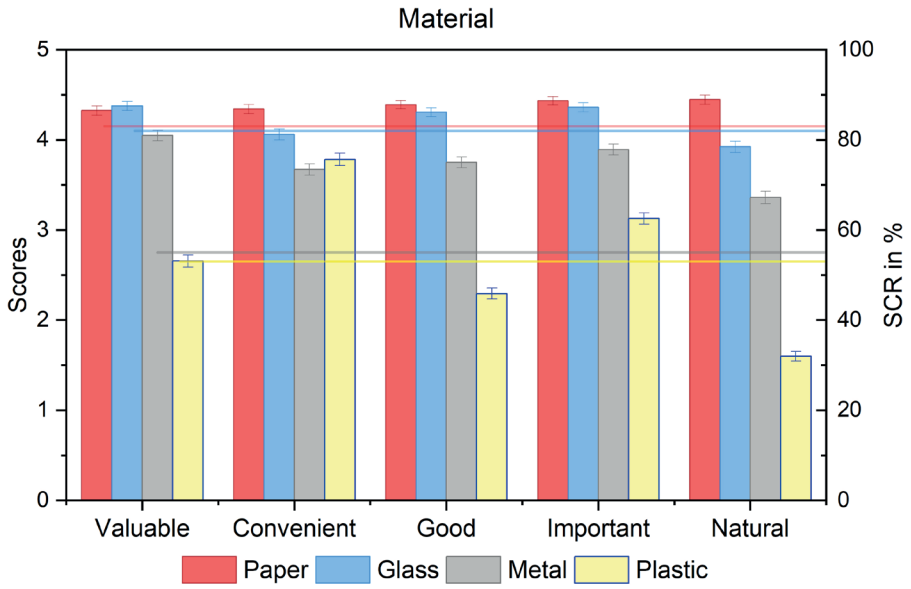

FIGURE 1: Mean and standard errors of the perception of the different materials (paper, glass, metal, and plastic) in the dimensions valuable, convenient, good, important, and natural (N = 316). The respective Austrian separate collection rate (SCR) is displayed for information purposes as a line (right axis) containing the same colors and starting at the bar regarding the material.

convenience, see Section S4 of the Supplementary material.

To sum up, except for convenience, plastic is significantly less positively perceived than paper, glass, or metal. It is perceived as the least valuable, good, important, and natural material; only when asked about the convenience, it ranges closer to the others and even before metal. Paper was perceived as the most valuable and important material alongside glass but more convenient and natural than glass. Additionally, the SCR (shown as light lines) were inserted into the graph to show that there is a similarity regarding the high and similar results for paper and glass, while for plastics the lowest SCR is seen. Although there is no causality this is another indication for an interaction between perception and collection intention.

3.2 Survey 1: How do consumers perceive different waste?

The perception of the waste of the material revealed a similar result as the perception of the materials, as shown in Figure 2. The relation between the dimensions is similar when asked for the material. A repeated multivariate analysis of variance (MANOVA) showed significant results com-

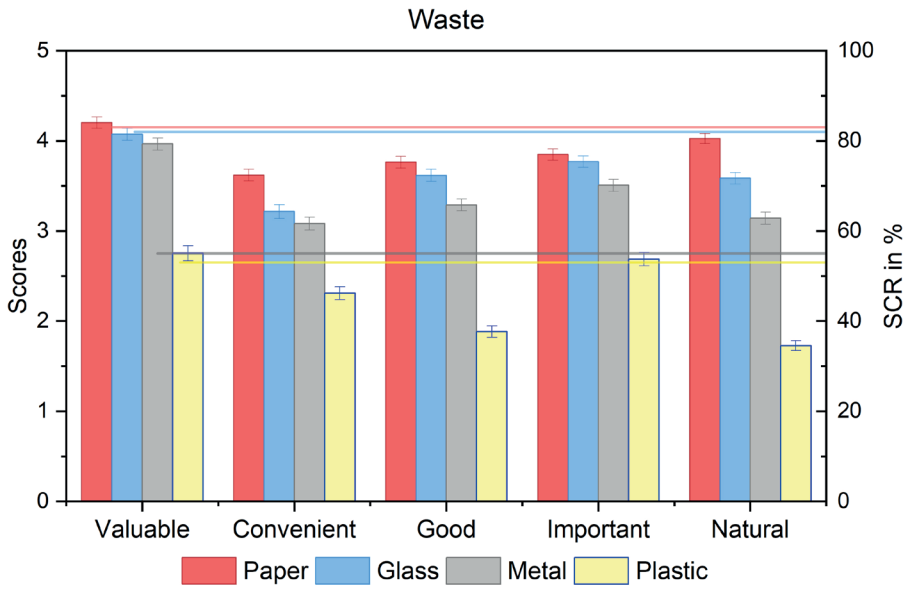

FIGURE 2: Mean and standard errors for the perception of the disposed of material (paper, glass, metal, and plastic) in the dimensions valuable, convenient, good, important, and natural (N = 316). The respective Austrian SCR is displayed for information purposes as a line (right axis) containing the same colors and starting at the bar regarding the material.

paring the consumers' perception of the different waste materials (plastic waste, paper waste, glass waste, metal waste) on the respective dimensions (valuable, convenient, good, important, natural): Pillai´s Trace=0.462, F(15,3774)= 45.75, p< 0.001 (Section S3, Supplementary material).

The analysis revealed significant differences in the consumers' perception of how valuable the waste materials are, F(3,313)=101.44, p<0.001, η_p^2=0.493. Further, a significant difference between the waste materials was found for convenience F(3,313)=75.06, p<0.001, η_p^2=0.418 and the dimension good F(3,313)=188.58, p<0.001, η_p^2 =0.644 and important F(3,313)=68.78, p<0.001, η_p^2=0.397. Finally, a significant difference was found between the waste materials in terms of whether they were perceived as natural or unnatural F(3,313)=295.55, p<0.001, η_p^2=0.739.

It can be seen that paper and glass waste are still regarded as valuable, good, and important, followed by metal waste. Plastic waste, on the other hand, is consistently rated significantly lower than other materials. This is also proven by the Bonferroni-adjusted post hoc tests, see Section S4 in the Supplementary material for more information. Here, too, there is no causal connection, but the comparable trend remains with paper and glass displaying high results in perception and SCR while metal follows with a still high perception followed by a significantly less positively perceived plastic, both displaying intermediate SCR.

3.3 Survey 2: How do consumers perceive packaging?

The negative perception of plastics in comparison to glass across different dimensions (valuable, convenient, good, important, natural) is also reflected in Survey 2, as shown in Figure 3. A one-way ANOVA revealed significant results using the material plastic/glass as the independent variable and the respective dimensions (valuable, convenient, good, important, natural) as dependent variables. As packaging material, glass is viewed positively - as valuable, good, important, and natural. In each of these dimensions, it receives approval ratings of at least 4 on the 5-Point Likert scale, demonstrating a clear contrast to plastic packaging. Only for the dimension convenience, no significant differences could be found F(1,308)=0.043, p=0.837, coinciding with the results from survey 1 and the SCR displayed as light lines for illustrative purposes. Mean, standard deviation, F-tests, p values, and η_p^2 for all dimensions can be found in Table 2.

The results of the free association part reveal vast differences in the perceptions of plastic and glass among participants. Plastic was mainly viewed negatively (see Section S5 in the Supplementary material), with 71% of participants expressing purely negative associations ("Too much plastic packaging. Sometimes completely unnecessary or even double and triple packaged" or "Should be abolished!") compared to only 5% who had solely positive associations ("convenient, protection from dirt" or "I think it's good") and 7% neutral ("is ok" or "bottles"). A total of 14% of participants expressed mixed sentiments about plastics, providing responses that included a combination of negative, positive, and/or neutral elements ("Makes very long-lasting, simple, but massively harms the environment" or "Convenient, protection, too much, waste in nature, microplastics"). In contrast, 36% of participants held purely positive associations for glass ("hygienic, recyclable, good for stacking in the cupboard" or "sustainable, reusable"), and 16% expressed purely negative views ("expensive, heavy, greenwashing" or "Heavy, fragile, takes up a lot of space"). In general, glass exhibited more ambivalent perceptions, with participants frequently stating conditions, e.g., glass being more sustainable only if a deposit-return system (DRS) is in place, equaling 25% of statements con-

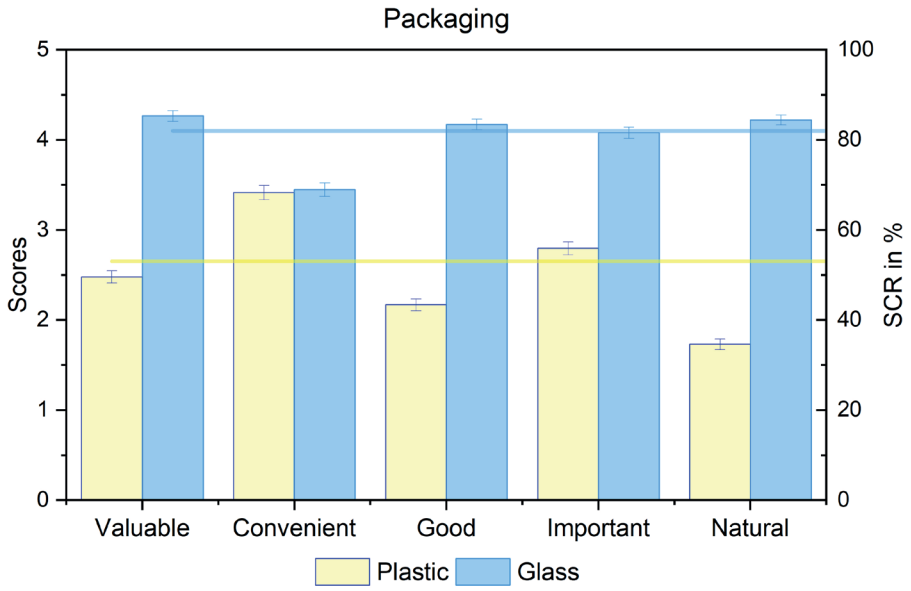

FIGURE 3: Mean and standard errors of the perception of glass and plastic packaging (between-subject design) across the dimensions valuable, convenient, good, important, and natural (N = 310). The respective Austrian SCR is displayed for information purposes as a line (right axis) containing the same colors and starting at the bar regarding the material.

TABLE 2: Mean and standard deviation for the perception of plastic and glass packaging (between-subject design) across the dimensions valuable, convenient, good, important, and natural (N=310).

Dimension	$M_{plastic}$	$SD_{plastic}$	M_{glass}	SD_{glass}	F test	p value	η_p^2
Valuable	2.48	1.20	4.26	1.04	196.1	<0.001	0.389
Convenient	3.41	1.39	3.45	1.36	0.043	0.837	0.000
Good	2.17	1.19	4.17	1.05	246.5	<0.001	0.445
Important	2.79	1.26	4.08	1.13	89.33	<0.001	0.225
Natural	1.73	1.04	4.22	0.98	472.7	<0.001	0.605

sisting of a combination of positive, negative, and neutral ("great if deposit glass otherwise useless and no better than plastic" or "basically a good idea. But if I then have to pay 20 cents more for the milk, it's a rip-off in my eyes and I'll go back to the usual tetra pack [beverage carton].")

Various categories as displayed in Figure 4 on the vertical axis, could be derived from the participants' associations, which led to one or more categories per person. A total of 269 associations were divided into 21 categories for plastics and 280 associations into 22 categories for glass. The categories were classified as positive, negative, or neutral, with a minority of cases showing multiple simultaneous classifications, e.g., a DRS for glass was considered positive as well as negative. For further information, see Section S5 in the Supplementary material.

Several key categories reflecting participants' negative perceptions of plastic packaging were derived from their associations. Figure 4 (a) shows the general rated distribution of the association given in categories. Predominant concerns included the perceived overwhelming quantity of plastic products and waste, the environmental pollution associated with it, and the underutilized availability of alternative materials (paper, glass, no packaging at all). Moreover, plastic packaging was recurrently deemed "unnecessary," and negative emotions such as bad, terrible, deceptive, and annoying dominated. In contrast, plastic was associated with convenience and hygiene, frequently mentioned as advantages.

For glass, the categories behind negative perceptions were primarily related to its physical characteristics: participants mentioned its weight, fragility, and higher costs, see Figure 4 (b). The positive attributes associated with glass emphasized its reusability, recyclability, and perception as a sustainable and environmentally friendly option. Many participants explicitly noted that glass was viewed as superior to plastic or an unknown alternative (category called "better"), and many participants associated it with positive emotions such as good, great, or aesthetically pleasing.

4. DISCUSSION

4.1 Discussion and interpretation of consumers' perception of plastic

The negative perception of plastic has been confirmed in various studies, primarily in relation to packaging (Heidbreder et al., 2019). However, the present study demonstrates that plastic as a material itself is not perceived as valuable, important, good, nor natural. The only exception is in terms of convenience, where plastic is rated more similarly to other materials by this sample. This reflects its widespread use out of convenience, such as when consumers forget to bring their own bags (Mühlthaler & Rademacher, 2017). Furthermore, convenience is demanded of the packaging itself, for example, a possible closure for the use-phase influences the purchase (Rokka & Uusitalo, 2008) or the lightweight and transparency (Teck Kim et al., 2014) advocates for plastic and could explain the better rating for convenience as a material. However, perceived convenience also plays a crucial role in disposal. Factors, such as adequate storage space at home and a short distance to collection points, which should have a clean appearance and be strategically located (Knickmeyer, 2020), influence recycling behavior. Some packaging types, like meat trays, which might leak or develop unpleasant odors, are particularly inconvenient to store for recycling (Nemat et al., 2022).

Recycling "on the go" presents further challenges. When only mixed municipal solid waste bins are available, it is indeed inconvenient to recycle properly. Furthermore, consumers often choose them as the "safe" option as it is often unclear how and where to recycle waste properly (Hartl & Hofmann, 2024). Summarizing, since the correct disposal step requires consumers' intrinsic motivation, knowledge, feeling of easy access to infrastructure and physical action (Botetzagias et al., 2015; Tonglet et al., 2004), the desire for convenient disposal seems not to be reflected in the perception of plastic waste which is likely to hinder increasing collection rates. Nevertheless, glass proves easy access to recycling does not represent the only decisive element: it displays recycling rates around 75% in the EU (Eurostat, 2024b) although the majority of the EU Member States has a bring system implemented, which is usually less convenient for consumers (Seyring et al., 2016). In Austria, glass is collected exclusively through a bring system, while plastic is often collected more conveniently, often comingled, and as a door-to-door or bring system (Schuch et al., 2023; Seyring et al., 2016). Indeed, glass has a long reuse and recycling history (Busch, 1987), while plastic was introduced as a disposable material with little regard for recycling (Cosgrove, 2014; Meikle, 1995).

This discrepancy could be explained by a higher perceived value of glass as confirmed in this study. From Survey 1, which compared all materials within each other, it can be assumed that the value of plastic waste is perceived similarly to the material itself. This may also mean that plastic is always perceived as waste in terms of value, regardless of whether the material itself or the waste is asked about. This is supported by Survey 2, in which

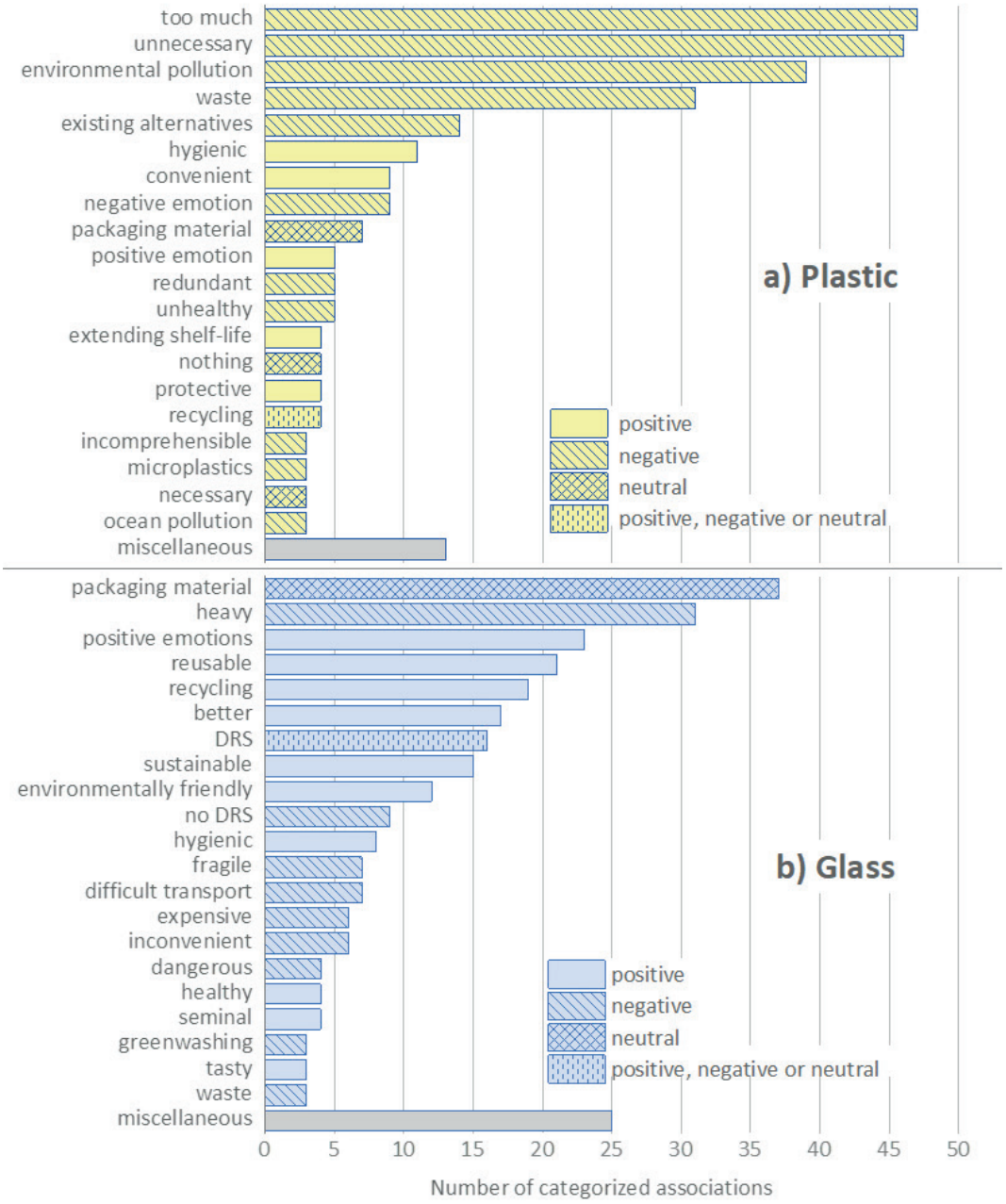

FIGURE 4: Free associations for (a) plastic and (b) glass and the corresponding categories on the left. The categories can be assigned positive (solid), negative (striped), or neutral (crossed). In two cases (deposit-return system (DRS) and recycling), the reasons matching the category were positive, negative, or neutral, so the category cannot be clearly assigned. (In between-subject design) (N=310).

associations with "waste" ultimately lead to the category with the fourth most frequent mentions and is consistent with a pilot study conducted by Koenig-Lewis et al. (2022) in which participants considered plastic food packaging as "waste". Additionally, a study by Bertling et al. (2018) came to similar conclusions, with plastics taking last place when asked about the value of materials, which was attributed to the fact that they are often used as replacements for more expensive goods such as ivory or, in the case of packaging, their primary function is to safeguard products, consequently making the plastic packaging itself appear comparatively low in value. Glass was ranked in second place after wood. This different perception, particularly between glass and plastic, could even be illustrated in a blindfold experiment with Italian students where products were judged to be better when believed to be coming from glass packaging (Balzarotti et al., 2015). This is unfortunate, as the perceived value influences perceived product quality (Magnier et al., 2016) purchasing and recycling intentions (Landaran Isfahani et al., 2023; Testa et al., 2022). While refillable and reusable functions, which are more common in glass packaging, add value, and result in increased recycling of this packaging (Langley et al., 2011; Nemat et al., 2022), distortions, such as crumpling, impair recyclability (Trudel et al., 2016). Additionally, plastic packaging often loses value as it is smaller in size,

rarely reusable and frequently contaminated by greasy or sticky residues (Nemat et al., 2020, 2022). At precisely this point, the Single-Use Plastics Regulation (European Commission, 2019b) intervenes, targeting small items like cotton bud sticks, balloons, or cigarette buds and items which have lower value when being made of plastic like plates, cups, or cutlery and are therefore carelessly disposed of in the environment.

Finally, while naturalness is closely interlinked with the perception of environmental friendliness (Steenis et al., 2017), it is understandable that a synthetically produced polymer (Selke et al., 2021) is not considered natural.

In general, in Survey 1, when asked about waste, the results show a slightly lower agreement than for the material itself. This reflects the fact that waste is automatically seen as something with less value or even without any value at all (Thompson & Reno, 2017). Nevertheless, paper, glass, and metal achieve relatively high approval ratings, as all means are above 3 on a 5-point Likert scale, so materials can be seen as valuable, even when already being "waste", and those also have higher SCR than plastic. This might be one of the reasons that 47% are not considered recyclable and end up in mixed waste streams in Austria (Lipp & Lederer, 2025) which leads to considerably lower recycling quotas of plastic. With a recycling rate of 26.9% in Austria compared to 42.1% in Europe and a target of 55% by 2030, Austria, like many other Member States, still has some catching up to do in this area (Eurostat, 2024a).

Additionally, Survey 2 suggests that plastic is not perceived as recyclable, while glass is considered in the free associations as "recyclable," "reusable," "sustainable," and, in general, "environmentally friendly." In contrast, for "plastic as food packaging" associations like "too much," "waste," and "unnecessary" dominated the results. The expression "unnecessary" was also found to be mentioned in two studies in Germany (Herrmann et al., 2022; Rhein & Schmid, 2020) and two studies in Sweden, one as a focus group and the other as a consumer survey, as well as a general negative opinion (Fernqvist et al., 2015; Lindh et al., 2016). This aligns with the findings of Otto et al. (2021), in which consumers reported that too much packaging is used, especially for fresh products. This leads to consumers who wish to avoid overpackaging they perceive as unnecessary e.g., toothpaste packaged in carton (Lindh et al., 2016), and even change the previously purchased brand (Pro Carton, 2025). However, this is not only consumer perception, until 2021 increasing numbers of all packaging materials confirm this view (Eurostat, 2024b). Beyond overpackaging, the limited recyclability especially of plastics constitutes a substantial concern and is not only perception. Lipp and Lederer (2025) show that plastics have a SCR of 53%, but only a 25% recycling rate, resulting in a loss of 28%, compared to just 1–3% for paper, glass, or metals. Improvements must be made at the design stage (FH Campus Wien, 2024) and extended producer responsibility (European Commission, 2018a) must be taken seriously. An example for a possible redesign of packaging are easier separable material combinations, where necessary due to stability and barrier properties (Richter et al., 2014), or recyclable multilayer packaging which is already possible with ideal combinations (Seier et al., 2023).

Of course, one of the highest priorities for all materials in the waste management hierarchy is prevention (Potting et al., 2017).

4.1.1 Implications arising from the results and their interpretation

Compared with the other dimensions plastic performs better in terms of convenience, there it ranges closer to the other materials and does not differ significantly from metal.

However, as waste it lacks approval of being convenient. This suggests that the disposal process for plastic waste might be perceived as unclear and that further measures are needed to remedy this. Consequently, packaging-waste collection systems must be designed to be as convenient as possible for consumers. Austria recently addressed this issue by introducing a uniform nationwide collection system for all lightweight packaging (including metals) (ARA - Altstoff Recycling Austria, 2024). However, in public spaces separate collection is still lacking and could lead to further improvements (Kladnik et al. 2025). In addition, sticky or greasy residues hinder convenient collection for recycling. Highlighting the value of plastic, irrespective of cleanliness, may enhance recycling intention, and support a more efficient plastic cycle. According to the vision of Dennis (2024) (p. 6): "The future use of plastics needs to be a time when the true value of the materials is considered." Similarly, strong positive perceptions of paper and glass seem to correspond to high SCR.

Companies need to gain the trust of consumers and provide credibility through clear communication and better design for recycling (e.g. better emptying (Wohner et al., 2019)) otherwise, participation will be low (Henriksson et al., 2010). To move toward circularity, manufacturers and packaging designers must rethink their products, prioritize recyclability, and expand the use of refillable and reusable formats that can enhance the perceived value of plastic.

Policy makers can increase the value of plastic by creating incentives for recycling through various economic measures, such as setting mandatory targets for recycling rates and recycled contents, introducing a DRS, and enforcing penalties but also by unifying pictograms for recycling (European Commission, 2025; Larrain et al., 2021).

Especially in comparison to paper and glass, the current negative view of plastic is evident and is, as our results show, already associated with the material itself. This is evident from Survey 1, in which all materials were surveyed, and was confirmed in Survey 2, in which only plastic and glass were compared. In addition, the free associations of Survey 2 confirmed the discontent with the vast amounts of plastic which are perceived as too much. Combined with the literature, this underlines the need to reduce packaging where possible and avoid unnecessary combinations of packaging.

In addition to technical solutions, we suggest formulating more carefully as Ertz et al. (2016) suggest that fostering positive attitudes can promote pro-environmental behavior.

At present, however, plastic as waste is seen as neither valuable, important, convenient, good, nor natural as other materials. This negative perception poses a major challenge for plastics recycling, as plastic is much more likely to be recycled when collected separately (Plastics Europe, 2022). While a well-functioning collection system is of high significance for waste management, also the consumer is crucial and the current clearly visible negative perception of plastic as a material or waste in comparison to the other materials investigated is most likely a disadvantage.

4.1.2 Limitations

This research focused entirely on consumers' self-reported perceptions of materials, packaging, and waste, with an emphasis on plastic and glass. Since our studies capture only perceptions, further research is needed to examine how these perceptions align with actual consumer behavior. While perceived convenience is a recognized and important influencing factor for recycling behavior, its specific relationship with plastic as a material remains unclear. To the best of our knowledge, no research has directly explored this link. Additionally, the free associations of Survey 2 did not clarify what respondents specifically meant by "convenience". Further studies could investigate this aspect to gain deeper insights.

A further limitation of the study is that the sample was recruited from an online panel of a market research agency rather than through random probabilistic sampling. Although the samples´ sociodemographic characteristics closely resembled those of the Austrian population and panel-based research is common in research on consumer perception (c.f. Geissmar et al., 2023; Hofstetter et al., 2024; Sokolova et al., 2023), panel-based samples might still differ in unobserved ways from the general population. Therefore, caution is important when generalizing the findings beyond the study sample.

Furthermore, regarding Austrian policy regulations over the past two decades, various measures have been evaluated and implemented to improve recycling plastic packaging, with a special focus on Vienna, where the positive effects of a combined collection system and technical improvements for plastics and metals have been confirmed (Gritsch & Lederer, 2023; Schuch et al., 2023). As a member of the European Union, Austria follows the EU Commission's regulations, including the recently updated Packaging Regulation (European Commission, 2025). This regulation sets a target of recycling 50% of plastic packaging by the end of 2025, a significant increase from the 22.5% target set in 2008 (European Commission, 2004) which was met without difficulty (Van Eygen et al., 2018). However, the very high new recycling target, as well as a revised calculation method introduced in 2019 (European Commission, 2019a) for better comparability among member states, led to lower reported recycling rates and set Austria under pressure. Therefore, the most recent step in Austria's waste management reforms is the implementation of a DRS in 2025, alongside the full unification of the collection system across the country with the aim to fulfill the targets (ARA - Altstoff Recycling Austria, 2024). The scheme ensures recycling of collected plastic bottles and metal cans while continuing to cover reusable plastic and glass bottles and containers (ARA - Altstoff Recycling Austria, 2024). Given the recent changes, it will be very interesting to observe if, with the DRS, the value of plastic packaging, in general, can improve or if only bottles will increase in perceived value, assuming that no further actions will be taken, although we would encourage additional measures. The study data displayed, however, pictures the perception before those changes.

5. CONCLUSIONS

Returning to the initial question, the study clearly demonstrated that materials such as paper and glass retain a high perceived value even when considered waste. This, however, does not apply to plastic, which is perceived far more negatively than other materials. This was confirmed through two different surveys with representative samples of Austria. Both an in-between-subject design and a within-subject design showed that plastic is rated significantly lower in the dimensions valuable, good, important, and natural. The only dimension in which plastic was not viewed as the worst material was convenience, but even with the free associations, it was not possible to undoubtedly explain what the perception of plastic as convenient was based on, which could be investigated in further detail.

The findings for plastics were largely anticipated. However, the evidence that other materials retain value, and that this might be reflected in higher SCR, reveals an untapped lever for improving recycling rates.

Consumers need to be made aware of the importance of collecting plastic waste as it is a valuable resource for new recycled plastics, especially given its prevalence in society. This complex challenge must be addressed with various measures like recycling targets, recycled contents, economic incentives in various forms, and improved product design to enhance recyclability. So that plastic will also be associated with positive aspects of sustainability in the future, as is currently only the case with glass, as seen by the participants' free associations in Survey 2.

While producers use the convenience factor to increase purchase intentions, they must be held responsible for the fact that this, in turn, requires a convenient collection system for a functioning recycling loop. This responsibility must not be shifted and should be tackled through consultation with recyclers to achieve the best possible solutions, and a clear communication strategy with the consumer, like proposed by the EU, with unified symbols (European Commission, 2025).

To sum up, improving the public perception of plastic (waste) requires clear communication, better design, and stronger circular systems.

First, products must be designed to be more durable, reusable, and easy to recycle, helping consumers see plastic as valuable materials rather than disposable items.

Second, the benefits of plastics, such as low weight, longevity and resource efficiency need to be communicated more effectively.

Third, well-functioning collection and recycling systems, along with visible use of high-quality recyclates, can strengthen the idea of plastics as a resource. Meanwhile, raising awareness about proper disposal and highlighting

innovations in recycling and circular design can further shift perceptions toward plastics as part of a sustainable material cycle.

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