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The price of sustainability: How consumers trade-off conventional packaging benefits against sustainability

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ABSTRACT

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Keywords: Sustainable packaging Trade-off Biodegradable and compostable packaging Paper packaging Path model Sustainable food packaging alternatives represent an ever-expanding trend on supermarkets' shelves. Despite the technological efforts, a higher sustainability level often comes at the expense of other (perceived) benefits which consumers might not want to sacrifice. While the balance between the benefits and drawbacks of "cleaner" packaging production is central to the designers' perspective, it is generally overlooked in consumer research. This paper investigates how European consumers cope with product-packaging decisions, when these involve a compromise. Through an online survey with 5035 consumers in five different European countries, our results show that the sustainability appreciation can spill-over to other conventional benefits, such convenience, aesthetic quality or the perceived ability of the packaging to preserve the content. By contributing to sustainability literature and, in particular, to the understanding of the halo and spill-over effect of sustainability, this study shows that positive associations triggered by eco-design elements (e.g., a biodegradable and compostable material) absorb and filter out negative experiences, preventing consumers from perceiving certain drawbacks. This research also provides valuable practical implications to marketers and product designers, by demonstrating how different product categories, packaging types and consumer characteristics, in terms of gender, age, nationality, values and lifestyle, influence product-packaging decisions and their inherent trade-offs.

1. Introduction

The entire food system, from production to consumption, including sourcing, processing, transport and packaging, contributes to one third of the total greenhouse gas emissions, responsible for global warming and to the general environmental crisis (Crippa et al., 2021). It is important to note that the environmental footprint of the food product is much larger than the environmental footprint of the packaging (Crippa et al., 2021; Silvenius et al., 2014). However, the global concerns about plastic pollution (with micro and nano-plastics) are of such a magnitude, that they rightly highlight the question of how the sustainability of packaging can be improved (Bruijnes et al., 2020). Packaging has become a key player in the green revolution of food industries which are increasingly committed to changing their products, processes or organizational structures towards a more sustainable development (Allied market research, 2016). Various companies, such as McDonald's, Unilever, Nestle, Kraft-Heinz, PepsiCo and Coca-Cola have started to target packaging sustainability in their action plans, through the launch of new materials (e.g., biodegradable, recycled) or new designs that allow a reduced amount of material (lighter packaging with less plastic) (Boz et al., 2020; Guillard et al., 2018; Olsen et al., 2014).

The Sustainable Packaging Coalition (a packaging industry collaboration) defines sustainable packaging as: "a packaging that is sourced responsibly, designed to be effective and safe throughout its life cycle, meets market criteria for performance and cost, is made entirely using renewable energy, and once used, is recycled efficiently to provide a valuable resource for subsequent generations" (SPC, 2011). This definition, that integrates both environmental and economic considerations, reminds that packaging is more than just a container. In long supply chains, packaging has a crucial contribution to product loss prevention and waste reduction, the environmental impact of which would be far greater without the packaging (Bruijnes et al., 2020). This implies a careful balance between packaging environmental efficiency and packaging functionality. For the successful introduction of more sustainable packaging, designers aim to increase the environmental efficiency without compromising functionality (e.g., in terms of preservation, protection or communication) (Boz et al., 2020; De Koeijer et al., 2017; Luchs et al., 2012).

Next to being important from a design perspective, this balance

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between the different packaging functions is also relevant from a consumer perspective, more specifically in the perception and evaluation process of sustainable alternatives. More sustainable packaging designs may lead to (un)intended changes in consumer perception, evaluation and purchase intention of packaged products, both in a positive and a negative direction (Steenis, 2019). For example, as the concept of sustainability is cognitively associated with other benefits (Luchs et al., 2010), a sustainable packaging appearance can lead consumers to perceive a higher product quality or naturalness (Magnier et al., 2016). At the same time, sustainable packaging can also be associated with potential sacrifices, such as in terms of perceived aesthetic quality. For example, biodegradable and compostable materials tend to be cloudier and opaquer than conventional plastics, whose transparency is associated with an attractive, fresh and reliable product (Billeter et al., 2012; Guillard et al., 2018; Simmonds and Spence, 2017; Sirviö et al., 2013; ten Klooster, 2008). This change in appearance, due to a change in material type for environmental reasons, may confront consumers with a trade-off, where aesthetic quality must be compromised for a (potentially) greater material sustainability.

Taken together, these examples imply that the "price of sustainability" can be either objective or perceived. It is important to note that sustainable packaging innovations, at the present stage, often present objective drawbacks, despite the technological efforts aimed at finding "the optimal" solution. A higher sustainability level often comes at the expense of other benefits that consumers might not want to sacrifice (e. g., aesthetic quality). Even when these drawbacks are not objective (namely, the alternative packaging material is not objectively worse than conventional ones), they may be still perceived as such. It is, therefore, important to investigate how consumers trade-off and compromise between the perceived benefits and sacrifices, as this ultimately affects consumers' intention to purchase sustainable alternatives.

While this balance between the benefits and drawbacks from a "cleaner" packaging production is central to the designers' perspective, it is generally overlooked in consumer research. Prior research has largely studied consumer acceptance of sustainable packaging with a focus on the enhanced sustainability level (Herbes et al., 2018; Ketelsen et al., 2020; Lindh et al., 2016; Steenis et al., 2018) but hardly from the perspective of a benefits-drawbacks trade-off. As a result, the research focus often lies on the sustainability benefit per se (Granato et al., 2022a; Magnier and Schoormans, 2015) and not in relation to other competing benefits in a choice set. As sustainability is only one of the many criteria in consumer decision making, a perspective that integrates both benefits and drawbacks contributes to a more realistic and fuller understanding of consumers' acceptability level of sustainable technologies.

This research investigates consumers' response to sustainably packaged products, by integrating such a trade-off perspective. It centres around the research question: "How, in their packaged product choices, do consumers trade-off and compromise between packaging sustainability and other relevant benefits in the choice set, as convenience, preservation or aesthetic quality?". In addition, acknowledging that contextual factors, such as consumers' characteristics or product categories, might influence the way in which consumers cope with productpackaging decisions and their inherent trade-offs, this research replies to a second research question: "How do packaging design cues, benefits' perceptions and consumers' characteristics relate and interact in affecting consumers' purchase intention for sustainable productpackaging alternatives?".

To answer these two research questions, the current research builds on the theoretical model of the *object-subject interaction*, which relies on consumers' subjective perception and evaluation processing of objective design elements (Brunswick, 1952; Olson, 1978; Steenkamp, 1990). Through a large-scale survey among European consumers in five different European countries, our study contributes to the literature and practice. At a theoretical level, this paper enriches the current understanding of the underlying processes that determine consumers' acceptance and purchase intention for sustainable product-packaging combinations. Rather than merely studying the direct effect of packaging design cues on consumers' purchase intentions, our research focuses on the mechanism underlying this relationship, namely benefit perceptions and the trade-offs. Moreover, this research contributes to study of how different consumers (in terms of age, gender, nationality, values, and lifestyle) differently perceive and evaluate sustainable alternatives, thus representing a highly relevant research aspect with the increasing societal concerns about environmental issues (Li et al., 2019, 2021a, 2021b). At a practical level, by investigating which benefits consumers are more willing to sacrifice for a higher sustainability and how this may differ across countries, values, lifestyle, age and gender, this research provides valuable practical implications to product-packaging designers.

2. Theoretical background and framework

The way in which consumers respond to sustainable productpackaging design, including how they trade-off and compromise between available alternatives, can be seen as the result of two sequential psychological processes: 1) a cue perception stage, in which consumers utilize the physical features (i.e., cues) of the packaging design to infer product-packaging benefits (cues-benefits relations) (Grunert, 2005; Grunert and van Trijp, 2014; Olsen et al., 2014; Steenkamp, 1990; Zeithaml, 1988) and 2) a cue evaluation stage, in which consumers evaluate and trade off the perceived benefits to ultimately respond in terms of attitudes (evaluative judgements), purchase intention and choices (benefits-intention relations) (Ajzen, 1991; Brunswik, 1955; Fazio, 2007). How consumers deal with the trade-off depends on the relative importance they assign to the perceived benefits that in turn depends on contextual factors and consumer characteristics (Basili and Chateauneuf, 2011; Edwards, 1954; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992; Von Neumann and Morgenstern, 1947).

2.1. Cue perception stage: cues-benefits relations

Packaging design cues are the result of a design and production process focused on three main goals and functions, namely to "protect and preserve", "communicate" and "facilitate handling and ease of use" (Lindh et al., 2016). With the growing concern about environmental issues, sustainability has become an additional decision criterion in packaging design, setting new challenges and initiating changes in the structural packaging cues. Such cues, like the material type, format, opening/closure mechanism and transparency refer directly to the physical features of the packaging and are the primary focus of packaging developers to convey specific consumer benefits, as a certain degree of sustainability, convenience, preservation or aesthetic quality (Magnier and Crié, 2015; Rettie and Brewer, 2000; Steenis et al., 2017). An important characteristic of structural cues is that they are "implicit" in nature, as they influence consumer response through an inferential belief formation process, and they require interpretation from consumer's side. Based on previously encountered associations and prior knowledge (Olson, 1978; Steenkamp, 1990), consumers might, for example, rely on an opaque (non-see through) biodegradable packaging to infer a greater sustainability or a lower aesthetic quality.

In "re-designing" structural cues for improved product-packaging sustainability (i.e. eco-design), packaging developers can work on two frontiers, 1) on the packaging through the use of more environmentally friendly materials (e.g., biodegradable, recycled, recyclable, paper materials to replace conventional plastics) (Granato et al., 2022b; Lindh et al., 2016; Magnier and Schoormans, 2015) or through material reduction (e.g., flexible and lightweight bags to replace rigid formats) (Ojha et al., 2015), and 2) on the packaged product, allowing a more efficient product use and reduction of waste. For example, a format that allows completely emptying packages of liquid products or a mono portion or re-closable packaging can reduce food spoilage and waste

(Verghese et al., 2015; Williams et al., 2012).

As sustainability is not the only criterion in consumer decision making, a key design challenge lies in balancing the structural design cues so that these, next to having a reduced environmental impact, also positively contribute to (or at least do not jeopardize) the primary packaging functions, recognized by consumers as the benefits of preservation and protection ("protect and preserve"), convenience ("facilitate handling and ease of use") and attraction or aesthetic quality ("communicate") (Granato et al., 2022b; Lindh et al., 2016).

The balance between sustainability and other functional benefits (as protection, preservation, communication) is particularly relevant from a consumer marketing perspective, as perceptions of these benefits are often interlinked. For example, changes in the packaging material for environmental reasons (e.g. biodegradable and compostable) may have unavoidable consequences for the perceived appearance of the packaging (bio materials tend to be more opaque than conventional plastics) (Steenis, 2019). This may affect consumers' perceptions and evaluations of the aesthetic quality (benefit of attraction) and even its perceived ability to properly preserve the content (benefit of preservation) (Billeter et al., 2012; Granato et al., 2022b; Lin and Chang, 2012; Pancer et al., 2017; Simmonds and Spence, 2017). Moreover, although they might be more sustainable, packages with a reduced amount of material, such as a lightweight flexible foil instead of a rigid lid, are perceived as less convenient, since they are non-re-closable and less practical for on-the-go consumption (Granato et al., 2022b). Therefore, the process of "re-designing" for an improved product-packaging sustainability may lead to perceived changes in other benefits besides sustainability (Lin and Chang, 2012; Luchs et al., 2010).

These considerations imply that it is important to consider and anticipate all the relations that structural packaging cues have with benefit perceptions (cues-benefits relations) and how these ultimately affect consumers' intention to purchase sustainable alternatives.

2.2. Cue evaluation stage: benefits-intention relations

When competing and mutually exclusive features co-exist in the choice set, consumers make a trade off and compromise (Da Silveira and Slack, 2001; Johnson, 1974). New sustainable technologies often imply a real and/or perceived trade-off between functionality and sustainability (Lin and Chang, 2012; Luchs et al., 2010). How this trade-off is resolved depends on the subjective importance that consumers attach to each of the competing benefits (Basili and Chateauneuf, 2011; Edwards, 1954; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992; Von Neumann and Morgenstern, 1947). This subjective importance is highly linked to individual differences (Bettman et al., 1998) which influences consumer decision making at a more proximal or distal level. At a more distal level, consumers' socio demographic and socio-economic characteristics, like country, gender, age, education or income, have been recognized to indirectly influence sustainable food behaviour (Dolnicar et al., 2018; Fischer and Frewer, 2008; Grebitus et al., 2015; Hansen et al., 2018; McFadden and Huffman, 2017; Paul and Rana, 2012). These characteristics exert their influence through more intermediary or proximal determinants (Ajzen, 1991; Carvajal et al., 2004). For example, people's age (distal factor) can affect their values (intermediary factor), goals and lifestyle (more proximal factors) that, in turn, influence which benefits consumers find important and desirable (Bettman et al., 1998).

Consumers' values, defined as the life guiding principles in people's lives (Schwartz, 1992) might explain and predict consumer trade-off involving sustainability (De Groot and Steg, 2009; Poortinga et al., 2004; Steg et al., 2014). Consumers who strongly endorse self-transcendent values, such as universalism and benevolence are more likely to act pro environmentally compared to individuals who endorse self-enhancement values (Nordlund and Garvill, 2003; Stern, 2000; Thøgersen and Ölander, 2002). While values are abstract principles, consumer goals are more proximal and context-specific determinants (Steg et al., 2014). In the food domain, for example, consumers' food

related lifestyle (Grunert et al., 1993), like consumer sensitivity to prices or convenience, their willingness to search for information or the degree to which they enjoy shopping, reflect consumer goals in a specific context, directly influencing food shopping behaviour.

Existing research has focused on several of these consumer characteristics to explain acceptability level in the context of sustainable packaging (Martinho et al., 2015; Prakash and Pathak, 2017; Van Birgelen et al., 2009). Nevertheless, these characteristics have not yet been integrated in a comprehensive model, and how these characteristics influence the relationships between packaging design cues, benefits' perceptions and consumers' intentions remains unclear. To fill this knowledge gap in how packaging design cues and benefits' perceptions relate and interact in affecting consumers' purchase intention for the sustainable product-packaging alternative, this research 1) integrates a benefits-drawbacks trade-off perspective, and 2) validates these relationships across different contextual factors, as consumers' characteristics of age, gender, nationality, lifestyle and values and product categories.

2.3. Theoretical framework: cue perception and cue evaluation in the consumer response to sustainable product-packaging alternatives

The theoretical framework combining the different theoretical concepts is displayed in Fig. 1. Based on the concept of "object-subject interaction" (Brunswick, 1952; Olson, 1978; Steenkamp, 1990), this framework integrates insights from the theoretical models related to cue perception (e.g., Olson, 1978; Steenkamp, 1990) and cue evaluation process (e.g., Ajzen, 1991; Brunswik, 1955; Fazio, 2007). The way in which consumers respond to sustainable product-packaging alternatives (and express a purchase intention) is modelled as the result of a two-step process, a cue perception and a cue evaluation process.

Applied to the context of sustainable product-packaging combinations, this framework is first used to explore which benefits the packaging is perceived to signal through its physical design cues (cuesbenefits relations) (Grunert, 2005; Grunert and van Trijp, 2014; Steenkamp, 1990; Zeithaml, 1988). As primary attention is on the process of re-designing towards an improved sustainability, this framework focuses on a series of structural cues, namely the material type, format, opening/closure mechanism and transparency/opacity level (Steenis et al., 2017). These cues indirectly affect consumers' intention to purchase the sustainable packaging alternative, through the four benefits' perceptions of sustainability, convenience, preservation & protection and attraction (Magnier and Crié, 2015; Rettie and Brewer, 2000; Steenis et al., 2017). Moreover, this framework is used to investigate how consumers' trade-off the perceived benefits and how they cope with (product-packaging) decisions when these involve inherent benefits-drawbacks trade-off (benefits-intention relations). Thus, the second part of the framework, the cue-evaluation stage, regards the subjective importance consumers assign to the perceived benefits (Brunswick, 1952; Lancaster, 1966). This research first tests the overall model, and specifically, the cues-benefits-intention relations. As the existence of these relations have been largely confirmed in prior research (Ajzen, 1991; Brunswick, 1952; 1955; Fazio, 2007; Olson, 1978; Steenkamp, 1990; Steenis, 20017), our focus will not be on reconfirming the existence of each individual relation, but on exploring differences in these relations in the context of sustainable product-packaging combinations. After having tested the overall model, this research validates it across different contextual factors, as product categories and consumers' characteristics.



Fig. 1. Theoretical framework of consumer response to sustainable product-packaging alternatives.

3. Methods

3.1. The MYPACK project as context for validation

The proposed framework (Fig. 1) was tested in the context of product-packaging innovations within the European consortium MYPACK,¹ that includes food and packaging companies and research institutes across Europe. The aim of the MYPACK consortium, created in 2017 with the support of the European Union, is to develop and commercialize a portfolio of sustainable food packaging innovations for three distinct food product categories: biscuits, baby food, and fresh salad. Within the portfolio of sustainable food packaging innovations, MYPACK has worked to develop and optimize, among others, biodegradable & compostable materials, recycled materials, paper packaging and blow device technologies (extending shelf life). The research in this paper tests two material-type design efforts towards an improved packaging sustainability, namely biodegradable & compostable packaging and paper packaging. These technologies were chosen in agreement with packaging experts of MYPACK, including companies performing Life Cycle Assessment analysis (LCA) as highly promising in the sustainable packaging design process.

The diversity, in terms of countries in which the MYPACK project operates (Germany, the Netherlands, Italy, France, Greece), product categories involved (biscuits, baby food, salad) and packaging innovations (biomaterials, paper alternatives etc.) informed the design of this research, contributing to the realistic and diversified setting for testing and validating the proposed framework.

3.2. Sample and procedure

A total of 5035 participants from the five MYPACK European countries (Germany, the Netherlands, Italy, France, Greece) participated in the study, based on quota sampling on gender, age and educational level and screened on the use of the three MYPACK product categories (baby food or fresh salad or biscuits) in each country. Data were collected in October/November 2019. Participants were sampled from the panels of a market research agency (GfK) and invited to participate in the survey by email for which the recruitment agency (GfK) ensured appropriate translations into local language after consultation with native speakers. Respondents were asked to provide socio-demographic/economic characteristics (e.g., gender, age) before they were confronted with the stimulus material and answered questions measuring their purchase intention, benefits' perceptions, their values, and food related lifestyle.

Six versions of the survey were created, varying in 1) the packaging material for the sustainability benefit (biodegradable/compostable and paper) and 2) the product category (biscuits, baby food, fresh salad). Participants were assigned to one of these six versions and engaged in a survey with a cyclic design.

3.3. Stimuli

Product-packaging combinations were designed as stimulus material, varying in the structural cues of material type, format, opening mechanism, transparency level (part of our framework, Fig. 1). No labels or brands were included to make sure respondents would focus only on the structural elements. For each of the three MYPACK product categories, visual representations of product-packaging prototypes were developed using 3D modelling by a graphic designer, in collaboration with MYPACK project. Stimuli were presented to respondents including a brief description and series of definitions, formulated with the MYPACK packaging experts (Fig. 2).

To mimic the shopping contexts in which consumers evaluate products in comparison to others (rather than in isolation), this study adopts a cyclic design to generate systematic pairs of product-packaging combinations. As characteristic to cyclic designs (David, 1988; Spence and Domoney, 1974), pairs were selected to ensure that in each pair one option scored high or low on the four benefits of sustainability, convenience, preservation & protection and attraction and was the opposite of the other one.² This would result in 8 pairs. To ensure all pairs reflected an informative benefits' trade-off, a fractional factorial cyclic design was adopted such that the (trivial) pair comparing a product scoring high on all four benefits with a product scoring low on all four was omitted (Table 1).

The resulting 7 pairs of product-packaging combinations were shown to each respondent, in a randomized order. The position of each option

² For example, if the option on the left was low in sustainability, convenience, and attraction but high in preservation/protection, the option on the right was the exact opposite, namely high in sustainability, convenience, and attraction and low in preservation/protection (pair 1, Table 1).

Sustainability level: plastic vs biodegradable/compostable

Definitions for the product of salad:

*Plastic: the packaging is made of conventional plastic

*Biodegradable and compostable material: it means that the material can decompose and turn into compost.

*Flexible bag: the packaging is a soft pillow bag

**Rigid box: the packaging is a rigid box*

*Re-closable packaging: it means that the packaging has a zip or a lid that permit to partially use the product and close it again afterwards.

*Non-re-closable packaging: once the packaging is open it cannot be reclosed.

*Transparent: the packaging is see-through, and the product can be seen completely

*Opaque: the packaging is not see-through, and the product cannot be clearly seen



Description:

Material: Plastic Format: Flexible bag Opening/closure mechanism: Non-re-closable packaging Colour: Transparent



Description:

Material: Biodegradable and compostable material Format: Rigid box Opening/closure mechanism: Re-closable packaging Colour: Opaque

Definitions for the product of baby food (only when differs from previous ones): **Re-closable packaging: it means that the packaging has a cup or a lid that permit to partially use the product and close it again afterwards.*

*Easy to empty: the shape of the packaging makes easy to completely empty the product from inside *Difficult to empty: the packaging has difficult to reach corners, or a shape that makes difficult to completely empty the product from inside



Description:

Material: Plastic

Format: Difficult to empty packaging

Opening/closure mechanism: Non-re-closable packaging

Colour: Transparent

Description:

Material: Biodegradable and compostable material Format: Easy to empty packaging Opening/closure mechanism: Re-closable packaging Colour: Opaque

Fig. 2. Examples of pairs of product-packaging combinations shown to respondents in the six survey versions. Pair 3 is depicted in this picture with the option 1 (on the left) with profile: 1 (sustainability low), 1 (convenience low), 1 (preservation low), 1 (attraction high) and the option 2 (on the right) with profile: 2 (sustainability high), 2 (convenience high), 2 (preservation high), 1 (attraction low).

All definitions and descriptions are a translation of the respective languages of the survey.

Definitions for the product of biscuits (only when differs from previous ones): **Re-closable packaging: it means that the packaging has a zip or a mechanism that permit to partially use the product and close it again afterwards.*

*Non-re-closable packaging: once the packaging is open it cannot be reclosed. *Single units packaging: the biscuits are individually packaged, mono portion packaging *Entire packaging: the biscuits are all together, large family size



Description:

Material: Plastic Format: Entire packaging Opening/closure mechanism: Non-re-closable packaging Colour: Transparent



Description:

Material: Biodegradable and compostable material Format: Single units packaging Opening/closure mechanism: Re-closable packaging Colour: Opaque

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Sustainability level: plastic vs paper

Definitions (only when differs from previous ones): *See-through: the packaging is transparent or has a window that is transparent and permits to see the product. *Non-see-through the packaging is opaque or does not have any window to see the product.



Description:

Material: Plastic Format: Flexible Bag Opening/closure mechanism: Non-re-closable packaging Colour: See-through



Description:

Material: Paper Format: Rigid box Opening/closure mechanism: Re-closable packaging Colour: Non-see-through

Fig. 2. (continued).



Description:

Material: Plastic Format: Difficult to empty packaging Opening/closure mechanism: Non-re-closable packaging Colour: See-through



Description:

Material: Paper Format: Easy to empty packaging Opening/closure mechanism: Re-closable packaging Colour: Not see-through



Description:

Material: Plastic Format: Entire packaging Opening/closure mechanism: Non-re-closable packaging Colour: See-through



Description:

Material: Paper Format: Single units packaging Opening/closure mechanism: Re-closable packaging Colour: Not see-through

Fig. 2. (continued).

Table 1

Fractional factorial cyclic design for the creation of pairs of product-packaging combinations.

Pairs (7)	Benefits' trade off: Which benefit/s sacrificed for higher sustainability	Options (14)	Design 2 levels:	1 = low, 2 = high		
			Sustainability	Preservation/protection	Convenience	Attraction
PAIR 1	Sacrifice preservation/protection	Option 1	1	2	1	1
		Option 2	2	1	2	2
PAIR 2	Sacrifice convenience	Option 1	1	1	2	1
		Option 2	2	2	1	2
PAIR 3	Sacrifice attraction	Option 1	1	1	1	2
		Option 2	2	2	2	1
PAIR 4	Sacrifice preservation and convenience	Option 1	1	2	2	1
		Option 2	2	1	1	2
PAIR 5	Sacrifice preservation and attraction	Option 1	1	2	1	2
		Option 2	2	1	2	1
PAIR 6	Sacrifice convenience and attraction	Option 1	1	1	2	2
		Option 2	2	2	1	1
PAIR 7	Sacrifice all other 3 benefits	Option 1	1	2	2	2
		Option 2	2	1	1	1

Manipulation of product-packaging benefits. High vs low level of each benefit.

Benefits	Manipulations of pac	kaging cues across proc	luct categories
	Biscuits	Baby food	Salad
Sustainability	Biodegradable and compostable material (high) with the official European logo vs plastic (low) Paper (high) vs plastic (low)	Biodegradable and compostable material (high) with the official European logo vs plastic (low) Paper (high) vs plastic (low)	Biodegradable and compostable material (high) with the official European logo vs plastic (low) Paper (high) vs plastic (low)
Convenience	Single serve format (high) vs bulk format (low)	Easy (high) vs difficult to empty packaging format (low)	Re-closable (high) vs non-re-closable packaging (low)
Preservation/ protection	Re-closable (high) vs non-re-closable packaging (low)	Re-closable (high) vs non-re-closable packaging (low)	Rigid box (high) vs flexible bag (low)
Attraction	Transparent/see through (high) vs opaque/non see through (low)	Transparent/see through (high) vs opaque/non see through (low)	Transparent/see through (high) vs opaque/non see through (low)

of the pair (left/right) was counterbalanced.

To induce systematic variations in benefit perceptions, the four structural cues were manipulated (Table 2). This manipulation was informed by the study Granato et al. (2022b) that investigated cues-benefits relations from designers and consumers' perspective for the same product categories as our study (Granato et al., 2022b).³

3.4. Measures

Intention to purchase one alternative over the other was measured through the question: "Please look at the packaging's below. If you must choose one of these packaging, how likely are you to buy one or the other?", on a 7-point scale labelled at -3 (I would definitely buy the packaging on the left); 0 (I would equally likely buy either of them); and +3 (I would definitely buy the packaging on the right).

Benefit perceptions were similarly measured through relative scales that measured which of the two options was perceived as superior in one benefit over the other (i.e., *"To what extent do you think that one of the packages is more sustainable/convenient in use/appealing and aesthetically beautiful/preserve and protect the product better/than the other?"*). Answering categories were: 3 (The packaging on the left is definitely more <sustainable>), 0 (they are equally <sustainable>), +3 (the packaging on the right is definitely more <sustainable>). For each of the presented pairs, consumers were first asked their purchase intention and then the four benefit perceptions, in a fixed order. Each scale was presented below the image of the pair.

Consumers' values were measured through the 10-item 9-point short Schwartz values survey (SSVS) (Lindeman and Verkasalo, 2005) developed from original Schwartz scale (Schwartz, 1994; Schwartz and Sagiv, 1995). Consumers' food lifestyle was measured through the 3-item 7-point Food Related Lifestyle Scale (Grunert et al., 1993). Only the subscales of "search for product information", "enjoyment of shopping", "price sensitivity" and "convenience orientation" were selected from the complete scale, as relevant for this survey (table B1 and B2, Appendix B for values and lifestyle scales). Country of residence was recorded as Netherlands, Germany, Italy, France or Greece, gender as female or male, age was indicated in years by respondents and recoded into the categories 18–30, 31–50, 51–70, 71+ years. Level of education (to quota sample participants) was measured as highest completed level of education and classified into low, medium, and high level in accordance with national education systems.

3.5. Data analysis

As preliminary data screening, within subject variance was calculated for the responses on purchase intention and the four benefit perceptions. The 445 (8.84%) respondents who showed no variance in their responses on all these measurements were deemed to have provided irrelevant data $(Dewitt et al., 2019)^4$ and excluded from the analysis. See table A1, Appendix A, for the descriptive statistics of the remaining 4590 respondents.

In data analysis and reporting, the position of each option in the pair was re-structured and recoded accordingly, with the option superior in sustainability (option 2) always recoded as the righthand side of the pair. As perceptions and purchase intention ratings are relative scores (positive scores indicate preference for the righthand side stimulus in the paired comparison), dummy variables were created for the packaging cues of material type, format, opening and transparency level by subtracting the value of the option superior in sustainability (option 1) (2-1 = 1 or 1-2 = -1).

The proposed model (Fig. 1) was tested using path analysis with maximum likelihood estimation in the R package Lavaan (Rosseel, 2012). Path analysis uses a regression method to estimate causal relationships between measured variables (Grapentine, 2000). Causal relations between the four packaging design cues and the benefits' perceptions and between the four benefits' perceptions and purchase intention (including intercept) were tested. The covariances between benefits' perceptions were also included in the model (table B.3, Appendix B, for the complete R script).

To test for model robustness across contexts (product categories, consumers' values, lifestyle, and socio-demographic/economic characteristics), and to identify differences and similarities, a multi-group path analysis was performed. The model was tested in different steps: 1) a completely constrained model was tested in which path coefficients, intercepts and covariances were constrained. The variances of intention and benefit perceptions could vary.⁵ 2) Benefits-intention relations were relaxed: path coefficients between the benefit perceptions and intention, covariances between the benefit and intercept for intention were relaxed across groups. Only cues-benefits relations were kept constrained. 3) Cues-benefits relations were relaxed, while benefit-intention relations were constrained (the opposite of step 2. These steps were conducted for different group comparisons: packaging type (2 groups: sustainability conveyed through biodegradable/compostable material and paper), product categories (3 groups: biscuits/baby food/salad), gender (2 groups: female/male), country (5 groups: Italian/French/German/ Dutch/Greek), age (4 groups: 18-30/31-50/51-70/71+), values of universalism and benevolence (2 groups: high/low), and for food lifestyle of "search for information", "convenience orientation", "price

³ Based on Granato et al. (2022b) the cue of "material type" should affect the perception of sustainability, the "format" and "opening/closure mechanism" should both affect the benefits of convenience and preservation and the cue of "transparency level" the benefit of attraction. Results of this research also suggest, for example, that a biodegradable & compostable packaging (plastic) as material type is associated with a high (low) perception in the sustainability benefit.

⁴ The reason behind this exclusion criterium is that those respondents who assign the same score to every scale shows a very low commitment and do not reflect any plausible response pattern or true preferences Dewitt, B., Fischhoff, B., Davis, A. L., Broomell, S. B., Roberts, M. S., & Hanmer, J. (2019). Exclusion criteria as measurements I: identifying invalid responses. *Medical Decision Making*, *39*(6), 693–703.

⁵ These 5 variances were allowed to vary in all the steps, for model 1, 2 and 3.





■ sustainability perception ■ convenience perception □ preservation perception ■ attraction perception

Fig. 3. Consumers' perceptions of sustainability, convenience, preservation, and attraction for option 2 (sustainable one) over option 1 (plastic version). All values are significantly different from zero.

sensitivity", "enjoyment of shopping" (2 groups each: high/low). Categorical variables were created for values and lifestyle using a median split.⁶ The values of Universalism and Benevolence were selected as part of the "self-transcendence" value dimension most relevant in the study of sustainable food behaviour (Schwartz and Sagiv, 1995). The constructs of the Food Related Lifestyle Scale were screened on reliability, using the value of Cronbach's alpha ($\alpha > 0.70$ was taken as acceptable).

Model fit was assessed based on three criteria. First, four goodness of fit indices were analysed: 1) Comparative Fit Index (CFI), good if \geq 0.95, 2), Tucker-Lewis index (TLI), good if \geq 0.95, 3), Root Mean Square of Approximation (RMSEA), good if < 0.07, and 4), Standardized Root Mean Square Residual (SRMR), good if < 0.08 (Hair Jnr et al., 2010). Second, Chi-squared difference test was used for nested model comparisons (model 1 vs 2 and 1 vs 3). Third, BIC and AIC values were used for non-nested model comparison (model 2 vs 3) (Werner and Schermelleh-Engel, 2010).

4. Results

4.1. Cues-benefits relations and manipulation check

The results of the benefit perceptions confirm the manipulations: consumers perceived the packaging that was designed to convey a higher sustainability benefit (biodegradable/compostable material or paper) as more sustainable than the other packaging (plastic version). The same was found for the other benefit perceptions. When consumers perceived the packaging as more sustainable, they also perceived it as superior on all the other benefits (the values of pairs 1, 2, 3, 5 and 6 are positive on all the benefits) (Fig. 3). The mere presence of a biodegradable/compostable material (with its logo) leads consumers to form positive perceptions on other packaging benefits as well (e.g., convenience or attraction). Results suggest that when consumers must sacrifice a single benefit (pair 1, 2 and 3), a higher sustainability level tends

to "absorb" the perceived drawbacks in terms of preservation, convenience, or attraction. However, when consumers must sacrifice two or three benefits, the drawbacks become more evident (e.g., pair 4 and 7).

4.2. Overall model: relations between packaging design cues, benefits' perceptions, and purchase intention

4.2.1. Model testing

A path analysis showed that the proposed integrated model has a good fit with the data (Table 3).

Path coefficients showed that the four packaging cues of material type, format, opening/closure mechanism, and transparency level significantly and positively influenced the perception of sustainability, convenience, preservation/protection, and attraction (all values are significant at p = .05); validating all relations in the model. The type of material primarily influenced the perception of the sustainability benefit: a change in material type from plastic to biodegradable/compostable or to paper increased the perception of sustainability by 1.49. Changing material type did not only affect the perception of sustainability but also the perception of preservation/protection and attraction. The packaging format and opening/closure mechanism primarily influenced the perception of convenience and preservation, while the transparency level primarily affected the perception of attraction. A design change from an opaque to a transparent packaging led consumers to perceive the packaging as more appealing and aesthetically more beautiful, by 0.27 (Fig. 4).

Shifting the focus to the benefits-intention relations, path coefficients showed that the importance consumers attribute to the benefits of sustainability, convenience, attraction, and preservation/protection significantly affected purchase intention for the sustainable alternative and together explain 20% of the variance in purchase intention ($R^2 = 0.20$). The results also revealed substantial correlations between the perceived benefits of convenience and preservation/protection (0.55), suggesting that consumers might perceive a packaging that preserves and protects the product as highly convenient (and the other way around as well) (Fig. 4). See table C.1, Appendix C for complete data.

While this model explains how packaging design cues relate to

 $^{^{6}\,}$ Median for Universalism = 5.00, Median for Benevolence = 6.00 from the 9-point scale.

Fit measures for the proposed model.

	χ^2	df ^a	N. parameters to estimate ^b	CFI (≥0.95)	TLI (≥0.95)	RMSEA (<0.07)	SRMR (<0.08)
General model	384.49	3	32	0.99	0.92	0.06	0.01

^a The saturated model with one group would have 35 estimated parameters. Direct effects of cues (format, opening type and transparency level) to intention are not modelled. Material type function as a constant in the equation. This results in 3 free degrees of freedom.

^b In addition to the 20 regressions and 6 covariances in Fig. 1, the variances of the 5 measured constructs of intention, sustainability perception, convenience perception, preservation perception and attraction perception and the value of the intercept for intention were estimated, resulting in 32 parameters to estimate.



Fig. 4. Path coefficients (unstandardized) for the general model. All values are significant at p < .05. Intercept for intention = 0.48.

benefit perceptions and how these, in turn, are translated into a purchase intention, it does not show how consumers trade off and compromise the perceived benefits. Therefore, the next section focusses on the benefits-intention relations from the benefits-costs trade-off perspective.

4.2.2. Benefits-intention: consumers' willingness to trade off and purchase

Consumers' intention to purchase the sustainable alternative significantly differed across pairs of product-packaging combinations. If consumers had to sacrifice a single benefit for a higher sustainability level, they preferred to sacrifice preservation/protection (pair 1). If consumers had to sacrifice two benefits, they were more willing to sacrifice preservation/protection and attraction (pair 5). Purchase intention for the sustainable alternative is lower when consumers must sacrifice all the other three benefits (pair 7). Overall, consumers intended to purchase the sustainable alternative (biodegradable/compostable or paper version) over the non-sustainable (plastic version, values are all above zero) (Table 4).

4.2.3. Model validation-packaging type and product categories

A multi-group path analysis showed that the developed general model is robust across differences in packaging type. The fully constrained model presents a good fit ($\chi^2 = 1575.96$, df = 33, CFI = 0.96, TLI = 0.94, RMSEA = 0.05, SRMR = 0.04) (Table 5).

The model validation against different product categories showed that the constrained model does not present a good fit, providing reasons to relax the model ($\chi^2 = 5128.53$, df = 63, CFI = 0.88, TLI = 0.86, RMSEA = 0.09, SRMR = 0.07). After relaxing the benefits-intention relations, the model did not show any significant improvement (fit indices still below the cut off values). Relaxing the cues-benefits

Table 4

Consumers' intention to purchase the sustainable alternative	(option 2) over the plastic version (option 1). Mean (SD).
--	--

	-		-	-				
	PAIR 1	PAIR 2	PAIR 3	PAIR 4	PAIR 5	PAIR 6	PAIR 7	Fp
Inherent trade off and pair profiles	Sacrifice preservation (1,1, -1,1)	Sacrifice convenience (1, -1,1,1)	Sacrifice attraction (1,1,1, -1)	Sacrifice preservation & convenience $(1, -1, -1, 1)$	Sacrifice preservation & attraction (1,1, -1, -1)	Sacrifice convenience & attraction (1, –1,1, –1)	Sacrifice all 3 benefits (1, -1, -1, -1)	value
Purchase intention for the sustainable alternative (scale -3, +3)	1.44 ^a (2.04)	0.95 ^b (2.27)	1.16 ^c (2.20)	0.74 ^d (2.32)	0.93 ^b (2.26)	0.43 ^e (2.39)	0.24 ^f (2.40)	149.59, .000

Columns sharing the same superscript letter are not significantly different at the .05 level (Crosstabs with pairwise z-test Bonferroni corrected). All values are significantly different from zero.

Fit indexes for the models with packaging type and product categories as a group. Number of observations = 32132.

Group	Model type	N. parameters to	Fit measur	Fit measures				
		estimate	χ^2	df	CFI (≥0.95)	TLI (≥0.95)	RMSEA (<0.07)	SRMR (<0.08)
Packaging type (2 groups) Product category (3 groups)	 Completely constrained Completely constrained Relax benefits-intention relations^a 	37 42 64	1575.96 5128.53 3969.37	33 63 41	0.96 0.88 0.91	0.94 0.86 0.83	0.05 0.09 0.09	0.04 0.07 0.06
	3. Relax cues-benefits relations ^b	74	2137.15	31	0.95	0.88	0.08	0.04

^a 11 parameters per model are relaxed (4 benefits-intention regressions, 1 intercept and 6 covariances).

^b 16 parameters per model are relaxed (16 cues-benefits regressions).

relations, instead, showed an improvement in model fit ($\chi^2 = 2137.15$, df = 31, CFI = 0.95, TLI = 0.88, RMSEA = 0.08, SRMR = 0.04) (Table 5). The chi squared difference test showed that the constrained model (model 1) and the model in which the cues-benefits relations have been relaxed (model 3) were significantly different from each other and that the latter is significantly better (lower values of AIC and BIC). In addition, BIC and AIC values showed that model 3 is better than model 2 (Table 6). Therefore, the results suggested that differences in product categories influence the relations between packaging cues and benefits' perceptions (Tables 5 and 6). Looking at the path coefficients for the model in which the cues-benefits relations have been allowed to vary across product categories, results showed how packaging cues relate to benefit perceptions depend on product categories.

A change in material type from plastic to biodegradable/compostable or paper increased the sustainability perception of the biscuit packaging by 1.57, of the baby food packaging by 1.39, and of the salad packaging by 1.51 (Table 7). Opening type was particularly important for baby food products where a re-closable packaging could increase the perception of convenience (0.92) and attraction (0.40). Opening type was also important for the product of salad in affecting the perception of convenience (0.70) and preservation (0.58). The transparency level of the packaging increased the perception of attraction for the product of biscuits (0.32) and salad (0.42) (Table 7).

4.2.4. Model validation-consumers' characteristics

The general model showed to be robust across several consumers' characteristics, as gender, age, self-transcendent values, and food related lifestyle. For these groups, the fully constrained model showed good fit, providing no reason to relax the model (Table 8).

The fully constrained model with country as a group showed insufficient fit with the data ($\chi^2 = 5358.71$, df = 123, CFI = 0.87, TLI = 0.87, RMSEA = 0.08, SRMR = 0.07). After relaxing the benefits-intention relations, the model did not show sufficient improvement (χ^2 = 3803.54, df = 79, CFI = 0.91, TLI = 0.85, RMSEA = 0.09, SRMR = 0.05). Relaxing the cues-benefits relations, instead, further improved the model fit (χ^2 = 2069.11, df = 59, CFI = 0.95, TLI = 0.89, RMSEA = 0.07, SRMR = 0.05). The chi-squared difference test also showed a significant improvement of the model in which the cues-benefits relations could vary across countries (model 3) compared to the fully constrained model (model 1). BIC and AIC values also showed that model 3 is better than model 2 (Table 9). Therefore, country related differences influenced how packaging design cues relate with benefit perceptions.

The path coefficients of model 3 (with country as a group) showed that a change in material type can affect sustainability perception to a

Table 7

Path coefficients (unstandardized) between design cues and benefit perceptions in the multi-group path analysis with product category as a group. Values with the superscript "ns" indicate non significance at p < .05.

Design cues	Benefits' perception	Product cate	egories	
		Baby food	Biscuits	Salad
Sustainability	Sustainability Material Type		1.57	1.51
	Format	0.12	0.25	0.03 ^{ns}
	Opening type	0.20	-0.08	0.23
	Transparency level	0.01 ^{ns}	0.01 ^{ns}	0.06
	R ²	0.01	0.02	0.01
Convenience	Material Type	0.31	0.39	0.30
	Format	0.26	0.84	0.11
	Opening type	0.92	0.19	0.70
	Transparency level	0.03 ^{ns}	0.08	0.16
	R ²	0.14	0.13	0.10
Preservation/protection	Material Type	0.33	0.38	0.38
	Format	0.55	0.71	0.20
	Opening type	0.17	0.31	0.58
	Transparency level	-0.03^{ns}	0.02 ^{ns}	0.11
	R ²	0.06	0.11	0.07
Attraction	Material Type	0.38	0.45	0.34
	Format	0.15	0.19 ^{ns}	0.21
	Opening type	0.40	0.01 ^{ns}	0.19
	Transparency level	0.07	0.32	0.42
	R ²	0.04	0.02	0.04

different extent. For Italian consumers, for example, a change in material type from plastic to biodegradable/compostable or paper increases sustainability perception by 2.05. (Table 10). For German consumers the increment is of 1.81, for Dutch consumers of 1.77, for Greek consumers of 1.09 and for French consumers of 0.76.

5. Discussion

5.1. Theoretical implications

Through an online survey approach in which pairs of stimuli reflect an inherent benefits' trade off, this research investigated how today's European consumers cope with sustainable product-packaging decisions when these involve a sacrifice and compromise. Thanks to the fractional cyclic design, the nature and intensity of the trade-off between different benefits becomes visible. This provides a more realistic understanding of the trade-off in the field of sustainable development and extends the existing literature on sustainable packaging acceptance. Such literature has mainly focused on the sustainability benefit per se, for example, on

Table 6

Chi squared difference test for nested model comparison for product category (model 1 vs 2 and model 1 vs 3).

1	I I I I I I I I I I I I I I I I I I I	0.1	X				
Product category	Model	df	AIC	BIC	χ^2 diff	df diff.	P value
Model 1 vs 2	Model 2	41	665581	666117			
	Model 1	63	666696	667048	1159.2	22	<.001
Model 1 vs 3	Model 3	31	663768	664388			
	Model 1	63	666696	667048	2991.4	32	<.001

Fit measures for the models for gender, age, values, lifestyle, and country.

Consumers' characteristics	Model type		Fit indices					
		N. Parameters to estimate	χ^2	df	CFI (≥0.95)	TLI (≥0.95)	RMSEA (<0.07)	SRMR (<0.08)
Gender (2 groups)	1. Completely constrained model	37	668.47	33	0.98	0.97	0.03	0.02
Age (4 groups)	1. Completely constrained model	47	874.63	93	0.98	0.98	0.03	0.03
Self-transcendent value of universalism	1. Completely constrained model	37	904.12	33	0.98	0.97	0.04	0.03
Self-transcendent value of benevolence	1. Completely constrained model	37	776.65	33	0.98	0.97	0.04	0.03
Lifestyle "search for information"	1. Completely constrained model	37	830.71	33	0.98	0.97	0.04	0.03
Lifestyle "convenience orientation"	1. Completely constrained model	37	1323.02	33	0.97	0.95	0.05	0.03
Lifestyle "price sensitivity"	1. Completely constrained model	37	545.37	33	0.99	0.98	0.03	0.03
Lifestyle "enjoyment of shopping"	1. Completely constrained model	37	742.10	33	0.98	0.97	0.04	0.03
Country (5 groups)	1. Completely constrained model	52	5358.71	123	0.87	0.87	0.08	0.07
	2. Relax benefits-intention (right part)	96	3803.54	79	0.91	0.85	0.09	0.05
	3. Relax cues-benefits (left part)	116	2069.11	59	0.95	0.89	0.07	0.05

Table 9

Chi squared difference test to compare nested models with country as a group (model 1 vs 2 and model 1 vs 3).

Country		Model	df	AIC	BIC	χ^2 diff	df diff.	P value
	Model 1 vs 2	Model 2	79	664793	665597			
		Model 1	123	666260	666695	1555.2	44	<.001
	Model 1 vs 3	Model 3	59	663098	664070			
		Model 1	123	666260	666695	3289.6	64	<.001

Table 10

Path coefficients (unstandardized) between design cues and benefit perceptions in the multi-group path analysis with country as a group. Values with the superscript "ns" indicate non significance at p < .05

Benefits' perception	tion Countries				
	France	Germany	Greece	Italy	Netherlands
Material Type	0.76	1.81	1.09	2.05	1.77
Format	0.32	0.09	0.16	0.03 ^{ns}	0.08
Opening type	0.24	0.06	0.18	0.08	0.01 ^{ns}
Transparency level	0.05 ^{ns}	0.04 ^{ns}	0.06	-0.00^{ns}	-0.01^{ns}
R ²	0.03	0.00	0.01	0.00	0.00
Material Type	0.34	0.44	0.36	0.44	0.11
Format	0.51	0.31	0.34	0.39	0.46
Opening type	0.75	0.34	0.49	0.65	0.77
Transparency level	0.08	0.09	0.10	0.08 ^{ns}	0.10
R ²	0.12	0.03	0.06	0.09	0.12
Material Type	0.43	0.38	0.57	0.45	0.00 ^{ns}
Format	0.48	0.37	0.44	0.57	0.57
Opening type	0.47	0.18	0.31	0.40	0.41
Transparency level	0.00 ^{ns}	0.05 ^{ns}	0.02 ^{ns}	0.04	0.05 ^{ns}
R ²	0.08	0.03	0.05	0.08	0.09
Material Type	0.40	0.49	0.53	0.45	0.10
Format	0.26	0.10	0.22	0.16	0.18
Opening type	0.29	0.08	0.22	0.19	0.21
Transparency level	0.26	0.22	0.27	0.25	0.35
R ²	0.03	0.01	0.02	0.02	0.03
	Benefits' perception Material Type Format Opening type Transparency level R ² Material Type Format Opening type Transparency level R ²	Benefits' perceptionCountries FranceMaterial Type 0.76 Format 0.32 Opening type 0.24 Transparency level 0.05^{ns} R^2 0.03 Material Type 0.34 Format 0.51 Opening type 0.75 Transparency level 0.08 R^2 0.12 Material Type 0.43 Format 0.48 Opening type 0.47 Transparency level 0.00^{ns} R^2 0.08 Material Type 0.47 Transparency level 0.00^{ns} R^2 0.26 Opening type 0.40 Format 0.266 Opening type 0.26 R^2 0.03	Benefits' perception Countries France Germany Material Type 0.76 1.81 Format 0.32 0.09 Opening type 0.24 0.06 Transparency level 0.05^{ns} 0.04^{ns} R ² 0.03 0.00 Material Type 0.34 0.44 Format 0.51 0.31 Opening type 0.75 0.34 Transparency level 0.08 0.09 R ² 0.12 0.03 Material Type 0.43 0.38 Format 0.48 0.37 Opening type 0.47 0.18 Transparency level 0.00^{ns} 0.05^{ns} R ² 0.08 0.03 Material Type 0.40 0.49 Format 0.26 0.12 Dopening type 0.26 0.22 R ² 0.03 0.01	Benefits' perception Countries France Germany Greece Material Type 0.76 1.81 1.09 Format 0.32 0.09 0.16 Opening type 0.24 0.06 0.18 Transparency level 0.05 ^{ns} 0.04 ^{ns} 0.06 R ² 0.03 0.00 0.01 Material Type 0.34 0.44 0.36 Format 0.51 0.31 0.34 Opening type 0.75 0.34 0.49 Transparency level 0.08 0.09 0.10 R ² 0.12 0.03 0.06 Material Type 0.43 0.38 0.57 Format 0.48 0.37 0.44 Opening type 0.47 0.18 0.31 Transparency level 0.00 ^{ns} 0.05 ^{ns} 0.02 ^{ns} R ² 0.08 0.03 0.05 Material Type 0.40 0.49 0.53 R ² 0.0	Benefits' perception Countries Material Type France Germany Greece Italy Material Type 0.76 1.81 1.09 2.05 Format 0.32 0.09 0.16 0.03 ^{ns} Opening type 0.24 0.06 0.18 0.08 Transparency level 0.05 ^{ns} 0.04 ^{ns} 0.06 -0.00 ^{ns} R ² 0.03 0.00 0.01 0.00 Material Type 0.34 0.44 0.36 0.44 Format 0.51 0.31 0.34 0.39 Opening type 0.75 0.34 0.49 0.65 Transparency level 0.08 0.09 0.10 0.08 ^{ns} R ² 0.12 0.03 0.06 0.09 Material Type 0.43 0.38 0.57 0.45 Format 0.48 0.37 0.44 0.57 Opening type 0.47 0.18 0.31 0.40 Transpare

how to improve the sustainability communication of the packaging (Granato et al., 2022a; Magnier and Crié, 2015), or on how consumers are responding to eco alternatives (Magnier and Schoormans, 2015; Steenis, 2019; Steenis et al., 2017). However, little attention has been drawn to the role of sustainability in relation to the other competing benefits, particularly convenience, preservation/protection, and attraction.

benefits relations and the benefits-intention relations, the present work integrates two research lines in the packaging design field, mainly focused either on the cue perception or cue evaluation stage. By combining the cues-benefits relations and the benefits-intention relations in a single path model, this research advances the understanding of the mediating mechanism and underlying processes behind consumers' acceptance of sustainable product-packaging innovations. Rather than focusing on the direct effect between eco-packaging design

By integrating a two-step process into an overall model, the cues-

and consumers' purchase intention, this research sheds the light on indirect effects, the benefits' perception, and trade-off processes. The study of indirect effects has been recognized as crucial to truly enrich the current understanding of the factors influencing sustainable consumption and choices (Li et al., 2021a, 2021b).

Moreover, adding beyond previous packaging design studies (Lindh et al., 2016; Steenis et al., 2017), our results showed how the perception and evaluation process of product-packaging combinations is not the result of a one-to one relation but of many-to-many relations. In this regard, our results show that packaging cues, as the material type, do not only have a strong effect on perceived sustainability, but can also substantially affect other benefit perceptions, like the aesthetic quality or the perceived ability to preserve and protect the content.

Furthermore, the present work offers important contributions on the topic of "the power of sustainability". Our results showed that the sustainability appreciation can be so strong that it absorbs some of the losses on other benefits (e.g., in terms of preservation). However, results also reveal that if sustainability comes at a too high price or loss, such absorption capacity fails, and consumers still perceive the drawbacks. This phenomenon might relate to a higher-level assimilation effect through which positive associations triggered by sustainability absorb negative experiences, preventing consumers from perceiving certain losses.

Similarly, our results showed that the presence of a biodegradable/ compostable material (with its logo) leads consumers to form favourable evaluations on other packaging benefits (e.g., convenience or attraction), besides sustainability. Consumers indeed tended to perceive the more sustainable option as superior on the other benefits as well. This might be caused by a sustainability halo affect or "spill-over" (Chandon and Wansink, 2007; Schuldt et al., 2012; Sundar and Kardes, 2015), through which consumers' positive impressions based on one (packaging) aspect, sustainability in this case, tend to "spill-over" to other unrelated packaging benefits, as convenience (Steenis et al., 2017).

Finally, this research adds to the understanding on how product/ packaging and consumer characteristics might influence purchase intention of sustainable packaging. The results show that while the benefits-intention relations (right part of the model) do not vary across product, packaging and consumers' differences, the cues-benefits relations (left side of the model) might do. Our research suggests that product and country related differences affect the extent to which design cues lead to benefit perceptions, rather than affecting the benefit trade off. Distinctive product categories, like baby food, biscuits, and salad, require distinctive packaging functions and specifications, in turn leading to different benefit perceptions.

5.2. Managerial implications

A key challenge in the eco (packaging) design process lies in balancing between the benefits derived from a higher environmentally efficiency and the possible drawbacks. In terms of consumers' perceptions, our results show that when consumers must sacrifice a single benefit for greater sustainability, they tend not to perceive the potential drawbacks, such as an objectively inferior performance in terms of convenience, preservation, or attraction. Thus, a higher sustainability level seems to "absorb" some of the drawbacks until a certain threshold, beyond which the losses are perceived. Therefore, while developing more sustainable packaging alternatives, it should be considered that a higher sustainability level tends to mitigate or even absorb the drawbacks (e.g., opacity level) when these are limited (e.g., when a single benefit is compromised), leading consumers to still hold positive attitudes toward the sustainable packaging. When, on the other hand, the sacrifice asked to consumers is greater, packaging designers should carefully consider which benefits consumers are most willing to compromise. Our results suggest that consumers might be more willing to accept a packaging perceived as inferior in preservation and attraction if perceived superior in sustainability. In this regard, though, it may

be important to consider how consumers balance between the direct (packaging disposal) and indirect environmental impact of packaging (food waste), as the latter is often mistakenly perceived as less severe by consumers (Brennan et al., 2021; INCPEN, 2019; Lindh et al., 2016).

Moreover, the results of the model validation suggest that product and country related differences are likely to affect how packaging design cues translate into benefit perceptions. Therefore, in the process of "redesigning" for an improved product-packaging sustainability, packaging developers might want to consider how cues-benefits relations change across different contexts and consumers' characteristics. For example, changing an opening/closure mechanism from a non-re-closable packaging to re-closable (with a zip, lid) is likely to increase the perceived sustainability for certain products, as baby food and fresh salad, but significantly decrease it for others (as biscuits). In this case, it might be worthy to consider whether the balance between food waste and packaging waste is equally or differently relevant across product categories. Similarly, packaging designers might consider that the benefits that packaging cues might signal to consumers differ across countries. Our results show that, for German consumers, convenience in mainly signalled by material type, for the French by packaging format and for the Dutch by the opening/closure mechanism.

5.3. Limitations and future research

The current study has some limitations that should be acknowledged. First, this study shares the same limitation of other self-report surveys that measured expressed purchase intentions, rather than actual behaviour. Although purchase intention has been considered as a key predictive component of purchase behaviour (Fishbein and Ajzen, 1977; Fishbein et al., 1980; Follows and Jobber, 2000), the comparison between expressed purchase intention and actual behaviour has been challenging (Barber et al., 2012; Follows and Jobber, 2000; Lange et al., 2002; Morwitz, 1997). In the context of sustainable purchase behaviour, self-reported measures have often produced a halo effect, leading respondents to over-report environmentally responsible behaviour, that is actually not fully adopted (Barber et al., 2009; Follows and Jobber, 2000; Roozen and Pelsmacker, 1998). However, the fractional cyclic design mitigates this limitation and increases the realism of the choice context, by including relative responses and options with competing and mutually exclusive features.

Second, instead of measuring the extent to which consumers perceive and prefer one packaged product over the other, as in our study design, future research could adopt a more classical choice model, where respondents are asked to choose one of the two options. In this regard, hybrid choice models may hold potential for future research avenues, as an alternative way to look at the effect of benefits' perceptions (the mediator) on purchase intention (Ben-Akiva et al., 1994, 2002; Kim et al., 2014).

Third, while using packaging prototypes with no labels or brands increased the internal validity of our study, avoiding cross-cultural differences in brands, language, and other communication issues, it can compromise on external validity. In real purchase scenarios, consumers may be less likely to compare an extensive set of packaging pairs, only varying on a limited set of cues, compared to an experimental setting. In this respect, it is important to consider that, although packaging highly influences choices, consumers purchase food products (that are packaged) and not packaging per se. Again, the fractional factorial design compensates on this limitation and increases the external validity, recreating a certain realism of the shopping environment.

Last, future research could investigate additional ways in which packaging design cues can contribute to sustainability perception, besides the structural cues of the present work. For example, more specific changes in the sensory packaging properties, as in the tactile, auditory, visual aspects of the packaging or verbal elements might be added for a more exhaustive representation of potential redesign strategies to signal sustainability to consumers or any other benefits. This, in turn, might

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also lead to more explained variance than in our study. Similarly, while the present study focuses on bioplastics and paper materials as more sustainable packaging design configurations, future research may investigate consumers' perceptions of other design efforts, such as recycled materials or innovative technologies able extend food shelf life and prevent food waste.

Despite these limitations, the present research advances the understanding of "the price of sustainability", and specifically, how consumers perceive and evaluate sustainable product-packaging alternatives, when these involve a trade-off between sustainability and other decision criteria. By combining packaging design cues, benefits' perceptions and contextual factors (as product/packaging and consumers' differences) in an overall model, this research contributes to a more realistic and fuller understanding of consumers' acceptance of sustainable technologies and its determinants. These insights reveal a robust, valid, and generalizable model across different product-packaging contexts and consumers' characteristics.

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Table A 1

Appendix A

Descriptive statistics of the respondents (N = 4590)

CRediT authorship contribution statement

Giulia Granato: Conceptualization, Methodology, Software, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration. Arnout R.H. Fischer: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision. Hans C.M. van Trijp: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Variable		Percentage
Product category	Baby food	33.4%
	Biscuits	33.4%
	Salad	33.2%
Packaging type-sustainability manipulation	Biodegradable/compostable	50%
	Paper	50%
Gender	Female	51.3%
	Male	48.7%
Age	18-30 years	19.8%
ũ là chí	31–50 years	39.2%
	51–70 years	35.9%
	71 +	5.2%
Educational level	Low	17.5%
	medium	42.6%
	High	39.9%
Country	France	20.1%
•	Germany	19.0%
	Greece	20.4%
	Italy	19.7%
	Netherlands	20.8%

Appendix **B**

Table B.1

Consumers' values asked to the respondents in randomized order.

"Please, rate the importance of the statements below as life guiding principles for you" with scale points labelled as: 1 (Opposed to my principles), 0 (not important), 3 (important), 7 (of supreme importance).

Security: national security, family security, social order, cleanliness, and reciprocation of favours

Power: social power, authority, and wealth Achievement: success, capability, ambition, and influence on people and events Hedonism: gratification of desires, enjoyment in life, and self-indulgence Stimulation: daring, a varied and challenging life, and an exciting life Self-Direction: creativity, freedom, curiosity, independence, and choosing one's own goals Universalism: broadmindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature, and environmental protection Benevolence: helpfulness, honesty, forgiveness, loyalty, and responsibility Tradition: respect for tradition, humbleness, accepting one's portion in life, devotion, and modesty

Conformity: obedience, honouring parents and elders, self-discipline, politeness

Table B.2

Food lifestyle scale

"Please state the extent to which you agree on the following statement", with scale labelled as 1 (definitely disagree) to 7 (definitely agree).

Importance of product information

- To me, product information is of high importance. I need to know what the product contains
- I compare labels to select the best product for me
- I compare labels to decide which brand to buy

Enjoyment of shopping

- Shopping for food bores me
- I just love shopping for food
- Shopping for food is like a game to me

Price criterion

- I always check prices, even on small items.
- I notice when products I buy regularly change in price
 I watch for advertisements for the store specials and plan to take advantage of them when I go shopping

Convenience

- I use frozen food for at least one meal a day
- To me, the microwave oven is essential for my cooking.
- I use lot of mixes, for instance baking mixes or powder soups

Table B.3

R script for testing the general model.

setwd() install.packages("readr") library(readr) installpackages("lavaan") library(lavaan)
PathData<-read_csv ("PathData.csv)
Model1<-" SustainabilityPerception ~ Format + Opening + Transparency ConveniencePerception ~ Format + Opening + Transparency PreservationPerception ~ Format + Opening + Transparency AttractivenessPerception ~ Format + Opening + Transparency
$Intention \sim c1*1 + SustainabilityPerception + ConveniencePerception + AttractivenessPerception + PreservationPerception$
ConveniencePerception ~ PreservationPerception ConveniencePerception ~ AttractivenessPerception ConveniencePerception ~ SustainabilityPerception SustainabilityPerception ~ AttractivenessPerception SustainabilityPerception ~ PreservationPerception AttractivenessPerception ~ PreservationPerception"
fitmod1<-sem(Model1, data=PathData, auto.var=TRUE)
summary(fitmod1, fit.measures=TRUE, standardized=TRUE, rsquare=TRUE, modindices=TRUE)
fitmeasures(fitmod1,c("cfi", "tli", "rmsea", "srmr", "chisq", "df"))

Appendix C

Table C.1

Complete data from the integrated model

Regressions:									
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all			
Sustainability Perception \sim									
Format	0.135	0.012	11.262	0.000	0.135	0.065			
Opening	0.116	0.012	9.678	0.000	0.116	0.056			
Transparency	0.028	0.012	2.342	0.019	0.028	0.013			
					(continu	ued on next page)			

Table C.1 (continued)

Regressions:								
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all		
Convenience Perception ~								
Format	0.403	0.013	31.590	0.000	0.403	0.175		
Opening	0.604	0.013	47.406	0.000	0.604	0.263		
Transparency	0.089	0.013	6.989	0.000	0.089	0.039		
Preservation Perception ~								
Format	0.489	0.012	40.375	0.000	0.489	0.226		
Opening	0.355	0.012	29.330	0.000	0.355	0.164		
Transparency	0.031	0.012	2.544	0.011	0.031	0.014		
Attractiveness Perception ~								
Format	0.186	0.012	15.436	0.000	0.186	0.088		
Opening	0.201	0.012	16.759	0.000	0.201	0.096		
Transparency	0.272	0.012	22.665	0.000	0.272	0.129		
Intention ~								
Sustainability perception	0.176	0.006	29.054	0.000	0.176	0.157		
Convenience perception	0.223	0.006	34.550	0.000	0.223	0.220		
Attraction perception	0.218	0.006	33.736	0.000	0.218	0.198		
Preservation perception	0.012	0.007	1.782	0.075	0.012	0.011		
r · · · ·								
Covariances:								
	Estimate	Std.Err	z-value	P(> z)	Std.lv	Std.all		
Convenience Perception ~~								
Preservation perception	2.377	0.029	83.264	0.000	2.377	0.525		
Attraction perception	2.113	0.028	76.174	0.000	2.113	0.469		
Sustainability Perception ~~								
Convenience perception	1.422	0.026	54.039	0.000	1.422	0.316		
Attraction perception	1.243	0.025	50.405	0.000	1.243	0.293		
Preservation perception	1.364	0.025	54.555	0.000	1.364	0.320		
Preservation Perception ~~								
Attraction perception	1.772	0.026	68.639	0.000	1.772	0.415		
Intercente (motorial turo):								
intercepts (inaterial type).	Ectimate	Std Err	z voluo	$\mathbf{p}(\mathbf{z})$	Std ly	Std all		
Sustainability paraoption	1 402	0.012	2-value	F(> 2)	1 402	0.722		
	0.225	0.012	124.212	0.000	0.225	0.723		
Dresorvation perception	0.333	0.013	20.204	0.000	0.333	0.147		
Attraction perception	0.303	0.012	30.027	0.000	0.303	0.170		
	0.390	0.012	52.445	0.000	0.390	0.187		
Intercept:								
Intention	0.479	0.014	33.763	0.000	0.479	0.208		
Variances								
Estimate	Std Frr	7-value	P(z)	Std ly	Std all			
Sustainability perception	4 238	0.033	126 752	0.000	4 238	0 994		
Convenience perception	4.238	0.033	126.752	0.000	4.238	0.994		
Preservation perception	4 303	0.034	126.752	0.000	4 303	0.926		
Attraction perception	4.305	0.033	126.752	0.000	4.305	0.930		
Intention	4 947	0.034	126.752	0.000	4 947	0.800		
P Square:	7.277	0.034	120.752	0.000	7.277	0.000		
n oquare.	Estimate							
Sustainability perception	0.006							
Convenience perception	0.000							
Dreservation perception	0.064							
Attraction perception	0.004							
Intention	0.023							
Intention	0.200							

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