Experimental evidence on sustainability perceptions of prospective customers

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ABS	Access-based services
ANOVA	Analyses of variance
CRM	Cause-related marketing
FSE	Factorial survey experiment
ISCED	International Standard Classification of Education
LCA	Life-cycle assessment
NGO	Non-governmental organization
PaaS	Packaging-as-a-Service

1. Introduction

The world is marked with rising consumption levels of natural resources (Wiedmann et al., 2020). This poses a threat to planetary health and, thus, human existence in that "consumption (...) is inherently linked to sustainability because every decision of what to buy, how much to buy, how much to consume, and how to dispose has a direct impact on the environment and future generations, and the cumulative effect of each individual consumer's consumption is devastating" (Trudel, 2019, p. 85). One way to reduce these environmental impacts is offered by more sustainable consumption, which is defined as "the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations" (Norwegian Ministry of the Environment, 1995). In this respect, it is an encouraging development that consumer interest in sustainable consumption continued to rise over the past. According to the Global Sustainability Study 2022, which surveyed more than 11,000 consumers in 19 countries worldwide, consumers' purchasing behavior and choices shifted towards buying more sustainable products (i.e., products with positive environmental and/or social attributes; Luchs et al., 2010) compared to five years earlier (Pope, 2022). Consequently, it can be expected that more and more companies will have an interest in introducing products to be marketed as sustainable.

A challenge inherent to sustainable products is that, in most cases, sustainability presents an unobservable product attribute that needs to be explicitly communicated to prospective customers (Meise et al., 2014; Steenis et al., 2022). Companies have responded to this challenge by using a broad range of sustainability claims and labels as well as imagery and colors associated with the environment to market their products (Carlson et al., 1993; Kwon et al., 2023; Segev et al., 2016). Prospective customers select, organize, and interpret

this product-related sustainability information to form a meaningful picture of the product to be evaluated (Kotler et al., 2020). Thus, whether they judge a product as sustainable or not largely depends on their perceptions of this product which, subsequently, influence consumer responses (Bangsa & Schlegelmilch, 2020; Pancer et al., 2017). Therefore, it is essential for a company's success to have a good understanding of prospective customers' perceptions of sustainable products and services (Gershoff & Frels, 2015).

The rising interest in sustainable consumption has sparked related academic research (Bangsa & Schlegelmilch, 2020; Marcon et al., 2022; White et al., 2019) which can broadly be divided into research on product-related (e.g., design, raw materials, production processes), individual-related (e.g., personal values, habits, income) and context-related (e.g., point of purchase, social influence, legal background) factors to explain sustainable consumption (Testa et al., 2021; Trudel, 2019). Notably, extant literature on product-related factors still needs more studies that explore what drives consumers' sustainability perceptions of products marketed as sustainable (Pancer et al., 2017). This is of scholarly interest because the extent to which consumers perceive a product to be sustainable influences their responses to such products (Bangsa & Schlegelmilch, 2020; Gershoff & Frels, 2015). Furthermore, examining consumers' product-related sustainability perceptions is relevant for practitioners for two reasons: First, companies that manufacture sustainable products can directly influence product-related factors much better than individual- and context-related factors. Second, these companies design sustainable products according to their understanding of sustainability, but often lack knowledge on which product attributes are also perceived as sustainable by prospective customers (Marcon et al., 2022). Against this background, this dissertation aims to gain further insights on consumers' sustainability perceptions and thereby offer companies guidance on communicating their sustainable products more effectively.

In doing so, this work focuses on three key challenges typically encountered by companies that wish to sell sustainable products, which correspond to research gaps identified in the academic literature (see Table 1):

Table 1. Key challenges to market sustainable products and related research gaps

Key challenges	Relevance	Research gaps
1. Which and how much product-related sustainability information is most effective to successfully market a sustainable product?	"How can firms offering truly green products effectively communicate these products (and avoid claims of greenwashing)? Are there particular tactics that make their claims more effective?" (Gershoff & Frels, 2015, p. 109)	"(…) some signals may be more effective than others, so scholars might examine the efficacy of various sustainability initiatives in communicating the desired effect." (Connelly, Ketchen, & Slater, 2011, p. 95) "(…) existing research on environmental cues (…) typically examine the effects of one particular cue. (…) This approach (…) obscures potentially important outcomes associated with the use of multiple environmental cues." (Pancer et al., 2017, p. 162)
2. How can companies best circumvent accusations of greenwashing?	"This can leave firms in a challenging position where they want to communicate the sustainability benefits of their products as a competitive advantage but, at the same time, also need to take care that consumers do not see this communication as deceptive." (Steenis et al., 2022, p. 2)	"Despite the frequent use of greenwashing claims in advertising (Baum, 2012), we lack research on individuals' perceptions of greenwashing and the consequences for attitudinal outcomes." (Matthes, 2019, p. 94) "(…) an experimental design to explore the effect of deceptive/ nondeceptive green advertising on consumers' perceptions and responses should be the next step in greenwashing research. (Segev et al., 2016, p. 92)
3. How can companies address two (or more) different customer groups? (Particularly relevant in the case of sharing services)	"(…) two separate comprehensive value propositions need to be developed. One value proposition needs to be offered to the buyer, and one to the supplier of services or products, because the engagement of both stakeholder categories is crucial to the sustainability of the model." (Andreassen et al., 2018, p. 894)	"(…) most research has investigated engagement in collaborative consumption from a customer perspective (…), leaving the peer service provider perspective underexplored." (Hazée et al., 2020, p. 398)

This dissertation responds to these challenges and research gaps by examining respective product perceptions of prospective customers. To this end, this research adopts a primarily quantitative approach and builds on experimental designs with different sustainable

products (food, personal and household care, electronics, textiles) and a recently emerged service innovation aimed at reducing packaging waste. In the remainder of the introduction, the relevance of researching product-related sustainability perceptions will be further elaborated. Next, the specific research questions addressed in this research will be derived from the key challenges and research gaps outlined in Table 1. This chapter closes with an outlook on the structure and key contributions of this cumulative dissertation.

1.1. Relevance of researching sustainability perceptions of prospective customers

When studying consumer behavior, marketing research traditionally has focused on the drivers and effects of perceived product quality (Kirmani & Rao, 2000; Olson & Jacoby, 1972; Steenkamp, 1990; Zeithaml, 1988). This was (and still is) of central interest because a higher perceived quality would result in favorable consumer responses such as positive product attitudes, increasing purchase intentions, higher willingness to pay, or product choice (e.g., Dodds et al., 1991; Kopalle et al., 2017). Nowadays, perceived product *sustainability* increasingly plays a similar role to the extent that sustainability perceptions can influence the same consumer responses (see Figure 1) (Bangsa & Schlegelmilch, 2020; Marcon et al., 2022). Following Steenkamp's (1990) definition of perceived product quality, this research understands perceived product sustainability as "an idiosyncratic value judgment with respect to the fitness for consumption which is based upon the conscious and/or unconscious processing" (p. 317) of sustainability cues in relation to relevant sustainability attributes within the context of significant individual and contextual factors. While one stream of research has already closely examined the relation between sustainability and quality perceptions (Chernev et al., 2021; Luchs et al., 2010; Pancer et al., 2017; Skard et al., 2021), this dissertation intends to dive deeper into the formation of sustainability perceptions (highlighted in dark gray in Figure 1). The following section outlines two central

characteristics of product quality and product sustainability, which emphasize the relevance of studying sustainability perceptions of prospective customers.

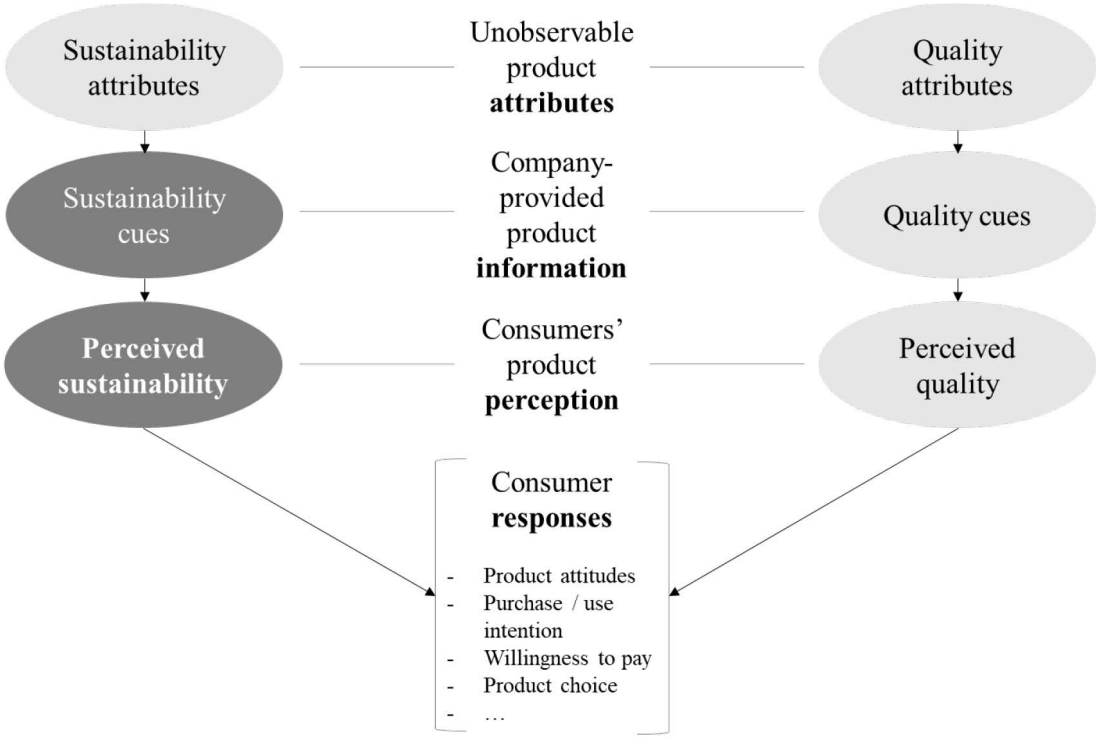

Figure 1. Research need and focus of this research on sustainability perception (own figure).

A first characteristic of a product's quality and sustainability attributes is that both tend to be unobservable (Kirmani & Rao, 2000; Meise et al., 2014; Steenkamp, 1990). This means that companies need to communicate sustainability attributes with the help of sustainability cues so they can be considered at all by prospective customers in their evaluation process (Steenis et al., 2022). Similar to quality cues, sustainability cues can be described as informational stimuli that are related to the product's sustainability and can be observed by prospective customers using their senses prior to consumption (Steenkamp, 1990). Notably, while some quality attributes can be ascertained during consumption (e.g., taste) and thus, represent experience attributes, sustainability attributes usually cannot be verified even after consumption (e.g., energy use during production, fair trade practices), representing credence attributes that need to be trusted (Atkinson & Rosenthal, 2014; Carlson

et al., 1993; Darby & Karni, 1973). Thus, prospective customers need to fully rely on the available sustainability cues and their subsequent sustainability perception, what makes them relevant to research.

A second characteristic that emerges from the unobservable product attributes is that manufacturing companies tend to know more about the actual quality and sustainability of their products than prospective customers, which describes a so-called information asymmetry between sellers and buyers (Atkinson & Rosenthal, 2014; Connelly, Ketchen, & Slater, 2011). Companies with a genuine interest in improving their products' sustainability usually apply science-based evaluation tools (such as life-cycle assessments (LCAs)) to calculate the sustainability impacts of their products (Boesen et al., 2019). Drawing on the idea that "objective quality refers to measurable and verifiable superiority on some predetermined ideal standard" (Zeithaml, 1988, p. 4), it can be argued that managers' product sustainability perceptions are probably quite close to objective sustainability as measured by LCAs. However, average consumers do not have this expert knowledge (Gleim et al., 2013) and tend to rely on lay theories to form sustainability perceptions, which have been shown to differ from the more objective, science-based LCAs (Boesen et al., 2019; Steenis et al., 2017). To make it possible for consumers to value companies' sustainability efforts accordingly, companies can provide specific sustainability information to reduce the gap between managers' and prospective customers' sustainability perceptions (Connelly, Ketchen, & Slater, 2011). This makes it all the more important to study product-related sustainability perceptions from the perspective of consumers (Marcon et al., 2022).

Notably, some companies will not make genuine efforts to invest in more sustainable products, but will use misleading sustainability cues (i.e., greenwashed cues) to give the impression of offering sustainable products, which in fact, are greenwashed (Carlson et al., 1993; Szabo & Webster, 2021). This means that these products do not provide the

sustainability attributes that are promised by greenwashed cues, such as empty sustainability claims and dubious labels (Lyon & Montgomery, 2015). The prevalence of greenwashing in practice has been documented in various content analyses of print and online media, accompanying the rise of green advertising (Baum, 2012; Carlson et al., 1993; Kwon et al., 2023; Segev et al., 2016). As a result, today's consumers not only need to distinguish between sustainable products and their traditional counterparts (i.e., regular products), but also between sustainable and greenwashed products (Matthes, 2019; Pancer et al., 2017). Studying the sustainability perceptions of prospective customers can help to understand when they differentiate between sustainable and regular products (i.e., stronger (weaker) sustainability perceptions for sustainable (regular) products). However, weak sustainability perceptions can refer to both a regular as well as a greenwashed product (if the greenwashed one is recognized as such). This introduces the need to account for *greenwashing* perceptions in addition to sustainability perceptions. The latter describes the extent to which consumers evaluate a product as sustainable (Gershoff & Frels, 2015) while the former describes the extent to which consumers perceive a product to be misleading with regard to its sustainability benefits (Chen & Chang, 2013; Schmuck et al., 2018). These two perceptions designate a positive and a negative side of the same coin, that is, sustainability perceptions tend to positively influence consumer responses, whereas greenwashing perceptions tend to negatively do so (Gleim et al., 2013; Meise et al., 2014; Newell et al., 1998; Steenis et al., 2022). Therefore, it is essential for scholars as well as practitioners not only to understand when prospective customers perceive products as sustainable or not sustainable, but also when they perceive products as sustainable or greenwashed (Carlson et al., 1993; Matthes, 2019).

In closing, this research takes into account that sustainability and greenwashing perceptions are not only influenced by product-related sustainability cues, but also by

individual-related factors (e.g., Schmuck et al., 2018). In particular, different people can form different perceptions of the same product (Kotler et al., 2020), which means that prospective customers can judge the same product to be sustainable (or greenwashed) to a very different degree (Guyader et al., 2017; Lyon & Montgomery, 2015). Research has shown that individual characteristics such as consumers' involvement, value orientations, and sustainability awareness influence sustainable (consumption) behaviors and, accordingly, also impact sustainability perceptions (Bangsa & Schlegelmilch, 2020; Testa et al., 2021). By extension, entire customer groups may perceive different sustainable product attributes to be of varying relevance. Particularly in the context of sharing services, companies have to cater to the needs of distinct customer groups (e.g., end consumers and service suppliers), which highlights the importance to consider their respective perceptions of the service (Andreassen et al., 2018; Hazée et al., 2020). Therefore, while the influence of product-related factors on prospective customers' sustainability perceptions reflects the focus of this dissertation, it also accounts for specific individual-related factors to craft effective sustainability communication.

1.2. Key challenges, research gaps, and research questions

Based on Table 1, this section briefly outlines each key challenge and related research gap to derive the specific research questions addressed in this research.

Typically, sustainability encompasses a breadth of issues ranging from social aspects (e.g., human rights) to environmental aspects (e.g., recycling), which vary in their impacts along the product life cycle from sourcing raw materials until the end of life (Bangsa & Schlegelmilch, 2020; Marcon et al., 2022). This shows that companies can communicate a plethora of different sustainable product attributes. To increase credibility, information about

such attributes can additionally be validated by third-parties (Atkinson & Rosenthal, 2014; Delmas & Grant, 2014). Furthermore, companies can also engage in cause-related marketing (e.g., donations to a sustainable cause), which is unrelated to a product's attributes (Nan & Heo, 2007). Against this background, companies face the challenge of choosing the most effective sustainability cues or signals to market their products (Connelly, Ketchen, & Slater, 2011; Gershoff & Frels, 2015). Yet, it remains unclear to what extent which, and also how much, product-related sustainability information actually influences sustainability perceptions among consumers (Bangsa & Schlegelmilch, 2020). While most of the extant research singled out one specific sustainability signal and examined its effects in an isolated manner (e.g., Atkinson & Rosenthal, 2014), in reality, consumers usually are confronted with multiple sustainability signals at the same time (Meise et al., 2014; Pancer et al., 2017). To better map this real-world complexity, the first paper examines the following question using an integrative experimental research approach:

Research question 1: *What is the relative impact of different contents and numbers of sustainability signals on consumers' perceived sustainability of products?*

Even with some more clarity on the content and number of sustainability cues that can enhance consumers' sustainability perceptions, a risk that some companies engage in misleading sustainability communication (i.e., greenwashing) exists (Lyon & Montgomery, 2015). This confronts genuinely sustainable companies with the challenge of marketing their products without falling into a greenwash attempt, while responsible consumers face the challenge of distinguishing between greenwashed and honest green products when making purchases (Newell et al., 1998; Steenis et al., 2022). Notably, research assessing how greenwashed cues of respective products are perceived by consumers has been scarce (Schmuck et al., 2018). More importantly, most of the reported consequences of greenwashing or green advertising are implicitly based on the assumption that consumers can

distinguish between greenwashed and honest green products (Pancer et al., 2017). But in fact, many theoretical and practical implications may be futile if consumers actually cannot do so (Newell et al., 1998). Responding to different calls to research consumers' greenwashing perceptions (Matthes, 2019; Segev et al., 2016; Seo & Scammon, 2017), the second paper asks:

Research question 2: *Are consumers able to identify greenwashing, namely, can they distinguish between greenwashed, honest green, and regular products?*

While the previous challenges and research questions revolve around common dyadic exchanges, in which a company sells sustainable products to prospective customers and thereby transfers product ownership, this dissertation also examines access-based triadic frameworks, in which three actors are involved and no ownership transfer takes place (Andreassen et al., 2018; Benoit et al., 2017; Hazée et al., 2020). Collaborative non-ownership consumption can be considered as one form of sustainable consumption because its focus on reusing assets or using underutilized assets through sharing can decrease overall resource use (Andreassen et al., 2018; Habibi et al., 2016). In this context, the third paper studies Packaging-as-a-Service (PaaS) systems for reusable food containers, in which PaaS providers (i.e., the focal company) supply reusable containers to partnering restaurants. These restaurants then serve takeaway food to their customers in reusable containers instead of single-use packaging. After finishing their meals, consumers can return reusable containers to participating restaurants. Therefore, PaaS providers face the challenge to satisfy potentially divergent demands of two distinct customer groups (Andreassen et al., 2018), namely, they need to address not only consumers' demands, but also those of restaurants. Going beyond the end consumers' perspective is essential here as restaurants need to offer access to the system's reusable food containers, that is, to deliver the core service for the PaaS system to work (Benoit et al., 2017). Thus, to complement the more commonly studied consumer view

with the supplier perspective (i.e., restaurants) and account for both sides of the market (Andreassen et al., 2018; Hazée et al., 2020), the third paper investigates the question:

Research question 3: *Which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers?*

1.3. Structure and key contributions of the dissertation

This dissertation consists of three empirical papers of which each addresses one of the research questions outlined before (see Figure 2). Taken together, the three papers develop a better understanding of prospective customers' perceptions of sustainable products and services. Figure 2 presents an overview of the outlined papers:

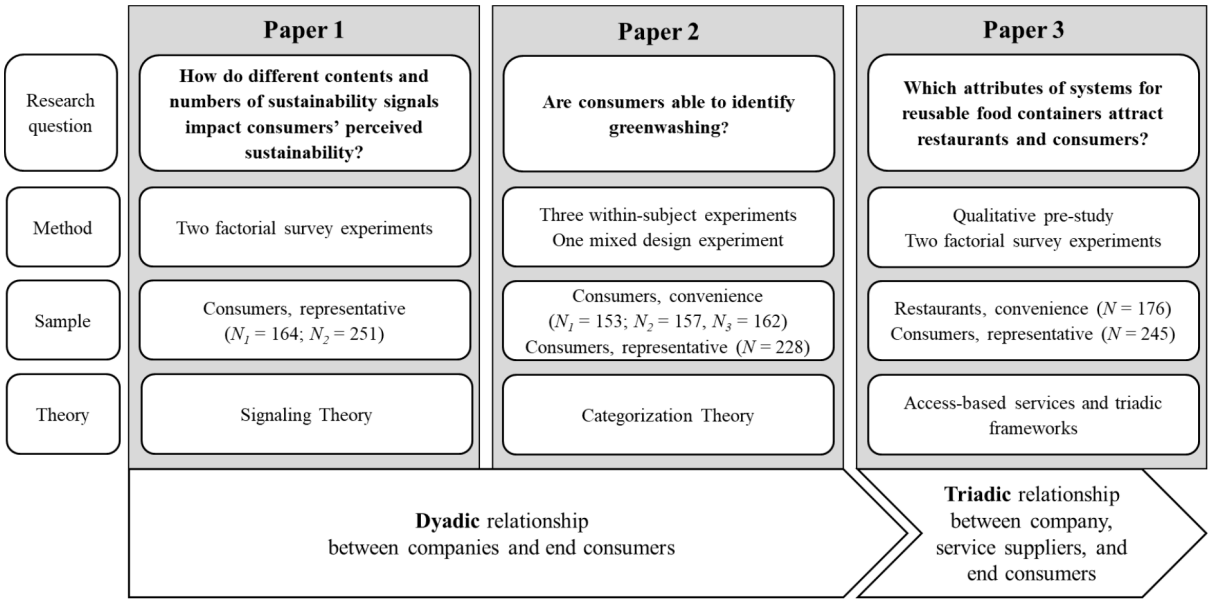

Figure 2. Overview of the three empirical papers of this dissertation (own figure).

The first paper titled *"The (relative) effectiveness of product-related sustainability signals for consumers' sustainability perception – Insights from two factorial surveys"*[1] (chapter 2) aims to improve our understanding of how combining different sustainability signals influences consumers' perceptions. To this end, factorial survey experiments (FSEs) were applied, a method that combines elements from traditional experiments and survey methodology to reap benefits of both (Atzmüller & Steiner, 2010). FSEs are well-suited to examine a number of independent variables called dimensions (here: product-related sustainability signals), which are systematically varied in their levels using vignette descriptions. These vignettes are rated by participants in terms of relevant dependent variables (here: perceived sustainability), after which a survey part elicits information on individual characteristics. Paper 1 applies two FSEs with consumer samples ($N_1 = 164$; $N_2 = 251$) that are representative of the German population. Relevant product-related sustainability signals were identified from extant literature as dimensions to be tested across three different product categories (electronics, fashion, and food). Participants rated between seven and nine vignettes by providing their perceived sustainability for each vignette (see Table 3 for an example). The paper makes three main contributions: From an empirical lens, the use of FSEs allowed for an integrative examination of different sustainability signals that have typically been studied in isolation. From a theoretical lens, the findings contribute to less investigated aspects of signaling theory, such as the importance of considering a signal's content in addition to its costs, and of investigating multiple simultaneous signals. From a practical lens, this paper provides companies with a foundation to integrate the consumer

[1] Under review at the Journal of Business Research as of 28.11.2023.
Earlier version (full paper) accepted at double-blind peer-reviewed 83rd Annual Meeting of the Academy of Management: https://journals.aom.org/doi/abs/10.5465/AMPROC.2023.13084abstract
Earlier version (full paper) accepted for a paper development workshop of the International Journal of Research in Marketing. Presented online in September 2022 by Stefanie Fella and Melina Burkert (co-author).
Ealier version (short paper) accepted at double-blind peer-reviewed 20th International Conference on Research in Advertising. Presented in June 2022 by Stefanie Fella and Melina Burkert in Prague, Czech Republic.

perspective into their corporate sustainability efforts, and highlights areas where consumer education may be necessary.

The second paper titled *"Green or greenwashed? Examining whether and when consumers are able to identify greenwashing"*[2] (chapter 3) aims to shed light on consumers' ability to distinguish between honest green and greenwashed products. First, to examine whether consumers can identify greenwashing, three within-subject experiments (N_1 = 153; N_2 = 157, N_3 = 162) were conducted using convenience samples, covering three different product categories (household care, personal care, electronics). In each experiment, every participant was shown three pictures of the respective product that was operationalized as honest green, greenwashed, and regular based on different green(washed) cues derived from the literature (see Tables B2-B4 for examples). Participants provided their purchase intention, perceived greenness, and perceived greenwashing for each product picture using established closed scales. Second, to study the underlying cognitive processes that enable or disable participants to identify the greenwashed product, a mixed experimental design (N = 228) was applied using a representative sample. The same product stimuli as in the first experiment denoted the within-factor while the former dependent variables were now introduced as independent variables, resulting in three treatments: Upon viewing the three product pictures, participants either responded to perceived greenness, greenwashing, or purchase intention questions. In addition, the closed scales were complemented by thought-listing and explicit categorization tasks to shed more light on the underlying cognitive processes. The paper makes three main contributions: From an empirical lens, the within-subject design provides a conservative approach to examine consumers' ability to recognize the greenwashed product because every participant could compare the three product stimuli. From a theoretical lens,

[2] Single authored. Under review at the Journal of Environmental Psychology as of 28.11.2023.
Earlier version (full paper) accepted at the first conference of Research Innovations in Sustainable Marketing: A Global Virtual Symposium. Received Best Paper Award and was presented online in March 2023 by the author.

this research shows that consumers are not always able to distinguish honest green from greenwashed products and suggests that consumers' mental category representations of such products affect their ability to identify greenwashing. From a practical lens, these insights can help practitioners apply the potential of activating a greenwashed category to support consumers in detecting greenwashing in purchase contexts.

Going beyond the typical company-consumer dyad, the third paper titled *"Blending access-based services and triadic frameworks: An empirical evaluation of Packaging-as-a-Service"*[3] (chapter 4) aims to investigate the challenges and opportunities around the adoption of access-based triadic systems that involve a triadic relationship between a company, service suppliers, and end consumers. Using the specific case of recently emerged Packaging-as-a-Service (PaaS) systems for takeaway food, Paper 3 applies two FSEs with a convenience restaurant sample ($N_{Rest} = 176$) and a representative consumer sample ($N_{Cons} = 245$). Because extant literature was not sufficient to derive relevant system attributes for the comparably new systems for reusable food containers, a qualitative pre-study consisting of interviews and focus groups was conducted with the two target groups. The qualitative results were used to identify relevant system attributes, which subsequently were quantitatively tested with regard to their influence on adoption intentions. To this end, participants provided their use intentions for eight vignettes that consisted of different combinations of system attributes (see Table C2 for an example). The paper makes three main contributions: From an empirical lens, the use of two FSEs allowed to systematically compare adoption intentions of different customer groups and thereby provides a valuable

[3] Revised and resubmitted to the Journal of Service Management as of 28.11.2023.
Earlier version (short paper) accepted at double-blind peer-reviewed 52nd Annual Conference of the European Marketing Academy. Presented in May 2023 by Stefanie Fella in Odense, Denmark.
Earlier version (extended abstract) accepted at double-blind peer-reviewed 12th European Conference of the Association of Consumer Research. Presented in July 2023 by Stefanie Fella in Amsterdam, The Netherlands.
Earlier version (full paper) accepted at double-blind peer-reviewed 23rd conference of the European Academy of Management.

method to account for the demands of two distinct target groups. From a theoretical lens, a yet unexplored hybrid of access-based services and triadic systems called “access-based triadic system” is conceptualized and empirically examined with regard to the challenges and opportunities it poses for PaaS providers. From a practical lens, these insights can support PaaS providers to scale more effective reusable packaging services and thereby increase their positive environmental impacts.

Finally, chapter 5 illustrates the overarching theoretical implications of this dissertation and presents avenues for future research.

2. Paper 1: The (relative) effectiveness of product-related sustainability signals for consumers' sustainability perception – Insights from two factorial surveys[4]

Co-authored with Melina Burkert, Rüdiger Hahn, Verena Hüttl-Maack.

Abstract

Consumers are increasingly challenged with evaluating the sustainability of products based on various sustainability signals present on the market. To better understand the influence of these signals on consumers' sustainability perceptions in an integrative way, we conducted two explorative factorial surveys. The aim was to identify, (1) the relative impact of different product-related sustainability signals and, (2) the impact of the number of signals on consumers' perceived product sustainability. Study 1 found variations in the effects of signals related to different sustainability domains, life-cycle phases, and validation levels. Study 2 showed that providing more signals positively affects consumers' perceptions of product sustainability. This research contributes a receiver perspective on signaling theory by highlighting the importance of signal content and the effects of multiple simultaneous signals. For practitioners, the results provide a foundation to integrate the consumer perspective into corporate sustainability efforts, and highlight areas where consumer education may be necessary.

Keywords: Consumer perception, sustainability information, factorial survey, vignette experiment, signaling theory

[4] Under review at the Journal of Business Research as of 28.11.2023.
Earlier version (full paper) accepted at double-blind peer-reviewed 83rd Annual Meeting of the Academy of Management: https://journals.aom.org/doi/abs/10.5465/AMPROC.2023.13084abstract
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2.1. Introduction

In recent years, not only has consumer interest in sustainable product alternatives increased, but so has the availability of sustainability-related product information and offerings (Sigurdsson et al., 2023). The true extent of a product's contribution to sustainability usually represents an unobservable quality for consumers and, thus, is communicated by companies in the form of a wide variety of signals (Connelly, Ketchen, & Slater, 2011; Sigurdsson et al., 2023). From the consumer's perspective, this creates a high-noise information environment characterized by a high degree of complexity and abstractness, as well as a multitude of diverse signals that are difficult to interpret and compare, which makes it hard for laypersons to navigate (Janssen et al., 2022; Steigenberger & Wilhelm, 2018; White et al., 2019). As a result, consumers often have difficulties in estimating the "true" sustainability of a product and consumer perceptions sometimes differ considerably from an objectively assessed level of sustainability (Peloza et al., 2012). Thus, effectively integrating corporate sustainability efforts into the marketplace, as well as promoting sustainable product choices, is susceptible to consumer perceptions and awareness (Janssen et al., 2022; Öberseder et al., 2013; 2014; Peloza et al., 2012).

Against this background, previous research has provided insights on the effects of various product-related sustainability signals. For example, consumers' sustainability perceptions are often shaped by environmental rather than social aspects (e.g., Catlin et al., 2017). Furthermore, product-inherent sustainability features lead to a stronger positive impact than supplementary aspects, such as donations to a sustainable cause (Buell & Kalkanci, 2021; Gershoff & Frels, 2015). Moreover, extant research shows how consumers recognize product sustainability using labels or certifications (Atkinson & Rosenthal, 2014). Although these are valuable insights, researchers as well as marketers remain uncertain when it comes to the combined influence of different contents and numbers of sustainability-related signals

on consumers' product sustainability perceptions (Cowan & Guzman, 2020; Öberseder et al., 2014; Sigurdsson et al., 2023). While extant research usually singled out one specific sustainability signal content and examined its effects in an isolated manner (Pancer et al., 2017; Sigurdsson et al., 2022), sustainability communication is characterized by a high-noise environment where consumers encounter multiple sustainability messages at the same time (Sigurdsson et al., 2023; Steigenberger & Wilhelm, 2018; Zerbini, 2017). Thus, it is unlikely that consumers form their perceptions of a product's sustainability based on the presence or absence of a single sustainability-related feature or information piece; rather, they consider multiple signals and weigh different signal contents against each other (Drover et al., 2018).

To address this real-world complexity and complement existing insights on the influence of individual signals, the present research follows a more integrated approach. The aim is to scrutinize the impact of combining different sustainability signals (Bangsa & Schlegelmilch, 2020), which we define as pieces of information provided by companies that inform about sustainability-related features of a product.[5] To improve our understanding of how consumers form sustainability perceptions of products, we ask the following research questions: What is the relative impact of different contents and numbers of sustainability signals on consumers' perceived sustainability of products? Do sustainability signals influence sustainability perceptions differently, depending on consumers' individual characteristics?

To answer these research questions, we conducted two subsequent studies using a quasi-experimental approach. Because a wide variety of sustainability signals have largely been studied in fragmented settings (Bangsa & Schlegelmilch, 2020), we synthesized the relevant aspects from prior research and examined their combined influence in an exploratory

[5] This includes direct components of the product, but also process-related and supplementary aspects, which are not necessarily visible in the final product.

manner. Factorial surveys, also referred to as experimental vignette studies (Aguinis & Bradley, 2014; Oll et al., 2018), allow the simultaneous examination of numerous factors. This method integrates elements from classical experiments and survey research and is thus well suited for investigating human perceptions (Oll et al., 2018). Specifically, we study the impact of different sustainability-related signals and the overall number of sustainability signals communicated, while considering their interplay with consumer characteristics relevant to sustainable consumer behavior.

This research contributes to the existing literature in several ways. Empirically, our integrated approach adds to the fragmented consideration of consumer perceptions of product sustainability by examining the relative impact of various pieces of sustainability-related product information and their combinations. Furthermore, our results connect to interesting and so far less investigated aspects of signaling theory: First, we examine how signal content affects consumer perceptions, emphasizing the importance of considering the receiver's perspective (Connelly, Certo, et al., 2011; Hahn et al., 2021). The refined perspective on valuable signals, which are not only characterized by their cost to the business side (costly signals) but also by their interpretation on the receiver side (signal content), contributes to a better understanding of the impact different signals have on consumers as a relevant stakeholder group (Baier et al., 2022; Hahn et al., 2021). Second, our paper accommodates the coexistence of multiple signals as a specific aspect of sustainability communication. In this context, consumers are confronted with a multitude of information, which is characteristic for today's high-noise information environments (Connelly, Ketchen, & Slater, 2011; Cowan & Guzman, 2020; Steigenberger & Wilhelm, 2018). Third, by advancing knowledge on which specific signal content about a sustainable product and how many different signals are conducive to consumers' sustainability perceptions, we provide

empirically validated feedback on the effectiveness of product-related sustainability signals from the consumer view.

From a practical perspective, our research implies that including consumer perceptions in sustainable management decisions, in addition to the financial costs of certain sustainability efforts, can be worthwhile because consumers often cannot estimate the actual cost of a sustainability signal (Hahn et al., 2021). Therefore, presenting product sustainability to consumers with valuable signals can help managers to spend costly sustainability efforts in areas that are especially recognized by consumers. Moreover, providing a consumer view can support managers to identify aspects where consumers' perceptions differ from the real cost for companies' sustainability measures and respective environmental benefits (Herbes et al., 2018). Here, targeted consumer education might be needed to help consumers process the impact of certain sustainable product features, and thus better evaluate the potentially costly signals sent by companies.

This paper is structured as follows. In the next section, we review extant literature on the most relevant sustainable product features. Based on this, the first study examines the relative impact of different contents of sustainability signals and consumer-related influences. The second study examines how the number of sustainability signals affects consumer perceptions. A general discussion aligns our findings with signaling theory. The paper closes with theoretical and practical implications as well as suggestions for future research.

2.2. The relative impact of different product-related sustainability signals

Sustainable product features can address a wide range of issues, ranging from compliance with human rights in the production process to the recyclability of materials contained in the product (Marcon et al., 2022). In addition, the communication of respective sustainability information (i.e., product-related sustainability signals) is influenced by numerous factors,

such as validation by external parties. Extant literature has examined a variety of factors which potentially influence consumers' sustainability perceptions, purchase decisions, or behaviors in an isolated manner (Pancer et al., 2017; Sigurdsson et al., 2022). In the following, we identify important influencing factors to be examined in conjunction. To this end, we deliberately do not formulate a complete set of hypotheses, because the many unexplored effects of combined sustainability information would make such an approach unfeasible. Instead, we highlight the exploratory nature of our study, especially regarding the relative effects of different product-related sustainability signals.

A common dimension in which sustainable product features can differ is the sustainability domain. Business practice often refers to the "Triple Bottom Line" consisting of a social, an environmental, and an economic sustainability pillar (Elkington, 1998). Whereas economic sustainability is primarily considered as a managerial concern (Bangsa & Schlegelmilch, 2020), consumers are increasingly interested in the environmental and social sustainability of products (e.g., Gershoff & Frels, 2015). These two domains of product sustainability differ in their focus: while environmentally sustainable products provide benefits to the natural environment (e.g., reduced resource use or less pollution), socially sustainable products offer a positive impact on society (e.g., fair working conditions or compliance with human rights) (e.g., Catlin et al., 2017). Despite the heterogeneity of sustainability aspects, prior research often treats multiple sustainability-related features as a single "sustainable" product (Luchs et al., 2010), thus disallowing a finer-grained analysis of the impacts of environmental versus social aspects on consumers' perception. In cases where a more detailed view on specific sustainability aspects is taken, the literature usually focuses on the environmental sustainability domain by covering features such as eco-labels, while neglecting the social one (Bangsa & Schlegelmilch, 2020). This is an important gap, as consumers perceive both domains as distinct and consider different domains when making

sustainable product choices (e.g., Catlin et al., 2017). Thus, we argue that an inquiry into the relative impacts of the environmental and social domains of sustainability will provide important insights.

Furthermore, sustainable product information typically refers to different stages of a product's life cycle. For example, some products may have a sustainability hotspot (UNEP, 2020) in the sourcing of raw materials (e.g., the mining of conflict minerals). Others may have a significant impact during the production phase (e.g., the use of toxic chemicals in production processes), whereas some may be potentially harmful to the environment when disposed (Marcon et al., 2022). Companies constantly differentiate between life-cycle phases when designing sustainable products. However, consumers' perceptions of this aspect have only been sparsely researched (Marcon et al., 2022; Petersen & Brockhaus, 2017), despite initial qualitative evidence suggesting that they are well aware of the different phases (Herbes et al., 2018; Luchs & Miller, 2015). Thus, the relative influence of sustainability-related information on product life-cycle phases remains unclear.

Next, the sustainability of a product is usually a credence feature that cannot be verified through personal experience but has to be accepted as true (Delmas & Grant, 2014). In such cases, the validation of sustainability information through an external third party provides a credibility cue (Zerbini, 2017). Validation as a signaling mechanism ensures that certain practices or product characteristics meet codified standards that have been established and validated by an external source (Terlaak, 2007). In this context, the certifying source may also matter with regard to the strength of such credibility signals (Atkinson & Rosenthal, 2014). Information validated or certified by an independent third party appears to be more credible than that provided by a commercial entity, and this perceived credibility has a positive influence on consumer decisions (Delmas & Grant, 2014). However, such validation

efforts have mostly been studied without accounting for their relative impact compared to other pieces of information.

In summary, we investigate information on the overall sustainability domain (i.e., environmental and social sustainability), different product life-cycle phases (i.e., sourcing, production, and End-of-Life), and external validation of sustainable product features (i.e., validation by non-governmental organizations and governmental institutions) as relevant sustainability signals. To date, the effects of these sustainability signals have not been investigated in terms of their relative effectiveness, which leads to our first research question:

RQ1a: What is the relative impact of sustainability signals addressing different product features?

Notably, extant research shows that not only product-related aspects influence perceptions and behaviors with regard to sustainable consumption, but also consumer-related aspects in terms of relatively stable characteristics of the individual (Chrysochou & Grunert, 2014; Öberseder et al., 2013; Sproles & Kendall, 1986). Different forms of value orientation, especially biospheric (i.e., valuation of the environment) and altruistic values (i.e., valuation of the well-being of others), have been shown to be relevant for sustainable behaviors (Bouman et al., 2018). Values can influence the processing of sustainability information because they determine the frame of thinking, such that information corresponding to one's mindset is perceived more strongly (Gleim et al., 2013; Verplanken & Holland, 2002). Therefore, we include value orientations in the research design.

Another relevant consumer characteristic is the ability to deal with varying amounts of information, which plays an important role in consumer decision-making processes (Sproles & Kendall, 1986). This trait characteristic is relevant to our study, because we consider the effects of different combinations and varying numbers of sustainability-relevant signals. While some consumers are comfortable forming an integrated viewpoint from

different pieces of available information, others experience chronic overload in such situations (Misuraca et al., 2021). Therefore, we include information-processing capacity in our study to account for the different cognitive abilities of handling information.

Additionally, consumers differ in their general skepticism toward corporate sustainability information (e.g., Leonidou & Skarmeas, 2017). We refer to the general attitude toward greenwashing as consumers' general greenwashing skepticism. As greenwashing skepticism leads consumers to question the truthfulness of sustainability information, it is likely that it affects consumers' sustainability perceptions (Chen & Chang, 2013).

Therefore, we also examine individual characteristics that are assumed to influence the interpretation and impact of the outlined sustainability signals:

RQ1b: How do individual characteristics affect perceptions of product sustainability?

2.3. Study 1

2.3.1. Stimuli and experimental design

We applied an experimental vignette study in the form of a factorial survey, a method that has explicitly been found suitable to tackle complexity in business and society research (Oll et al., 2018) and is thus adequate for our setting. A vignette describes a hypothetical object, person, or situation along so-called dimensions with different levels, that are systematically varied (Auspurg & Hinz, 2015). In our case, each vignette was composed of information on a product's sustainability in terms of sustainability domain, life-cycle phases, and third-party validation as manipulated dimensions.

In a first step, we specified these three vignette dimensions with three levels respectively, which later define the vignette universe (Atzmüller & Steiner, 2010). For the

first dimension, the sustainability domain, we distinguished between environmentally and socially sustainable product information[6]. Furthermore, we included non-sustainability-related information to establish a baseline against which to compare sustainability-related information. To ensure that the manipulation of environmental and social sustainability information would work as intended, we conducted a pretest (N = 179, 56.4% female, mean age = 31.84). To this end, we presented participants with different statements that either referred to environmental or social sustainability in different life-cycle phases. Participants separately rated each statement once regarding the extent to which it reflects environmental sustainability and once in terms of social sustainability. In all cases, environmental (social) statements were rated significantly ($p < .001$) more environmentally (socially) than socially (environmentally) sustainable, confirming that environmentally and socially sustainable product information was not associated with the respective other sustainability domain. For the second dimension, the life-cycle phases, we followed prior research and identified three levels based on key phases that are relevant for consumers, and can be actively shaped by companies: the sourcing of raw materials, production processes, and the end-of-life span, including recycling or disposal (e.g., Luchs et al., 2010; Petersen & Brockhaus, 2017). For the third dimension, third-party validation of information, extant research examined effects of validation by governmental institutions as well as non-governmental organizations (NGOs) mostly separately (Atkinson & Rosenthal, 2014). Therefore, we included NGO- and government-validated signals as separate levels in our design to compare their relative impact against corporate (not externally validated) information as baseline.

All vignette dimensions and levels combined yielded a 3 (sustainability domain: non-sustainability-related, environmentally sustainable, socially sustainable) × 3 (life-cycle phase:

[6] We did not cover the dimension of economic sustainability, as this is considered primarily a managerial, rather than consumer concern (Bangsa & Schlegelmilch, 2020).

sourcing, production, end-of-life) × 3 (validation: not externally validated, validated by NGO, validated by governmental institution) design. The resulting vignette universe consisted of 27 (3^3) combinations which were each represented by one vignette. For example, the combination of environmental sustainability (sustainability domain) and the sourcing of the product (life-cycle phase) and external validation by an NGO (third-party validation) yielded the following vignette: “Fully recycled materials are used as raw materials for the production of the product. This information has been validated by a non-governmental environmental or social organization.” Table A1 illustrates all verbal expressions for the three levels of each of the three dimensions.

In a second step, we determined the number of vignettes rated by each respondent. To prevent information overload and fatigue, we divided the 27 vignettes into three sets (Aguinis & Bradley, 2014). Thus, each participant was randomly allocated to separately rate nine vignettes, which is well below the recommended maximum of 20 (Auspurg & Hinz, 2015). Within a vignette set, the order in which vignettes were presented was randomized to prevent order effects. To avoid confounding effects due to the specific composition of the vignette sets, we opted for a d-efficient blocking procedure[7] instead of a random allocation of vignettes to sets (Atzmüller & Steiner, 2010; Auspurg & Hinz, 2015). Third, we selected our dependent variable as well as post-vignette measures. Perceived sustainability ("How sustainable do you perceive this product?", Gershoff & Frels, 2015) as dependent variable was measured on an 11-point Likert scale which is recommended to allow for linear modeling (Oll et al., 2018). Post-vignette measures included questions on respondent-specific data, such as demographics. We also measured biospheric and altruistic values, information-processing capacity, and greenwashing skepticism at the level of the individual participants.

[7] Search algorithms for d-efficient designs try to find an optimal efficient solution between perfect balance and orthogonality.

Table A2 presents the various measurement scales and their reliability. Finally, to determine the necessary sample size we opted for a rather conservative approach with each vignette being rated at least 15 times, requiring a minimum sample of 135 participants (Aguinis & Bradley, 2014).

We recruited the sample from a consumer access panel provider. Within the survey, we included two attention checks and screened out participants who failed these. Additionally, we removed three participants because of non-differentiation in their ratings. The final sample (N = 164) was representative for the German population in terms of gender, age, and education (M_{age} = 46.45, SD = 16.78; 51.2% female, education: 36.0% low (International Standard Classification of Education (ISCED) 0-2), 43.4% middle (ISCED 3-4), 20.6% high (ISCED 5-8)). We applied the experimental design to three products from different categories (cell phones, jeans, and cereals) to gain insight into the generalizability of the effects across different product categories. The categories were selected to represent different levels of purchase frequency and the resources involved (electronics, fashion, and food). Participants were randomly assigned to one of the three products ($N_{cell\ phone}$ = 52, N_{jeans} = 56, $N_{cereals}$ = 56), and then to one of the created sets of vignettes within the product category. This resulted in 1,476 vignette ratings in total.

2.3.2. Results and preliminary discussion

For the data analysis, we used a multilevel regression approach, which is recommended when the outcomes (i.e., multiple ratings by one participant) are not independent (Heck et al., 2014). We followed general recommendations for mixed models and applied grand mean centering for the dependent and metric control variables (Heck et al., 2014). First, we checked for differences between the three product categories. Multilevel models containing only product effects did not show significant differences in sustainability perceptions across the three products, which allowed us to conduct subsequent analyses across all the products

combined (see Table A3). Next, specifying an unconstrained model (baseline model) including only the dependent variable and random intercepts for each participant showed an intraclass correlation coefficient of 22.5% for sustainability perception, justifying a multilevel analysis (Heck et al., 2014). Following a stepwise modeling approach, we extended the baseline model in three steps: First, we estimated Model 1 including only the vignette dimensions depicting different product information (level 1). Second, we added respondent-specific characteristics (level 2) and individual-level controls, yielding Model 2. Third, we included relevant cross-level interaction effects between vignette dimensions and respondent characteristics to compile Model 3.

The results in Table 2 indicate significant main effects for all three dimensions (Model 1). Notably, information on the sustainability domain showed the largest effect compared to information on the life-cycle phases or validation. Sustainable product information influenced sustainability perceptions more positively than non-sustainability-related product information. This effect was stronger for environmentally compared to socially sustainable product information ($\beta_{env} = 2.57$, $p < .001$; $\beta_{soc} = 1.63$, $p < .001$). The product life-cycle phase information seemed to be about as important as the signals for third-party validation. Regarding life-cycle phases, only signals referring to the end-of-life phase (not the production phase) were perceived as more sustainable compared to signals on the sourcing phase ($\beta_{prod} = 0.03$, $p > .1$, $\beta_{eol} = 0.71$, $p < .001$). Third-party validated product information influenced sustainability perception more positively than non-validated information. The effect was stronger for information validated by a governmental institution than by an NGO ($\beta_{ngo} = 0.42$, $p < .01$; $\beta_{gov} = 0.81$, $p < .001$).

Table 2. Results (Study 1).

	Model 1			Model 2			Model 3		
	β	***SE***	***t***	**β**	***SE***	***t***	**β**	***SE***	***t***
Intercept	-2.06***	0.18	-11.16	-1.32**	0.49	-2.72	-1.31**	0.48	-2.71
Vignette dimensions (L1)									
Sustainability domain									
Non-sustainability-related (ref.)									
Environmental	2.57***	0.14	18.72	2.54***	0.19	13.38	2.54***	0.18	13.81
Social	1.63***	0.14	11.87	1.56***	0.17	9.01	1.56***	0.17	9.22
Life-cycle phase									
Sourcing (ref.)									
Production	0.03	0.14	0.18	-0.03	0.13	-0.26	-0.05	0.13	-0.36
End-of-life	0.71***	0.14	5.20	0.64***	0.15	4.35	0.64***	0.15	4.36
Validation									
Manufacturer (ref.)									
NGO	0.42**	0.14	3.04	0.37*	0.15	2.55	0.38*	0.15	2.56
Governmental institution	0.81***	0.14	5.94	0.69***	0.13	5.36	0.69***	0.13	5.36
Respondent-specific characteristics (L2)									
Biospheric values				-0.17	0.13	-1.37	-0.37**	0.14	-2.74
Altruistic values				0.36*	0.14	2.53	0.27†	0.14	1.90
Information-processing capacity				0.16*	0.08	2.13	0.16*	0.08	2.13
Greenwashing skepticism				-0.30**	0.11	-2.73	-0.30**	0.11	-2.72
Cross-level interactions									
Environmental sust. × biospheric values							0.50***	0.13	4.00
Social sust. × altruistic values							0.33*	0.13	2.58
Controls									
Sex (Male, ref.)				-0.40	0.25	-1.61	-0.40	0.25	-1.61
Age				0.00	0.01	0.46	0.00	0.01	0.47
Product (Cell phone, ref.)									
Cereal				0.19	0.30	0.65	0.19	0.30	0.65
Jeans				-0.33	0.30	-1.13	-0.34	0.30	-1.14
-2LL	6699.62			6556.92			6540.03		
Covariance Structure	VC			UN			UN		
***N* (participants)**	164			164			164		
***N* (vignette ratings)**	1476			1476			1476		

Note. Unstandardized coefficents; method: restricted maximum likelihood; controlled for vignette set effects
† $p < 0.1$; * $p < .05$; ** $p < .01$; *** $p < .001$.

To determine if respondent-specific characteristics influence sustainability perception, we ran random intercept-and-slope models showing significant direct effects of both value

orientations ($\beta_{bio} = -0.37$, $p < .01$; $\beta_{alt} = 0.27$, $p < .1$), information-processing capacity ($\beta_{ipc} = 0.16$, $p < .05$), and greenwashing skepticism ($\beta_{gs} = -0.30$, $p < .01$) (Model 3). In addition, sustainability perception of more altruistic consumers was even more positive for social sustainability signals ($\beta_{soc \times alt} = 0.33$, $p < .05$). Similarly, the sustainability perception among consumers with high biospheric values increased more strongly for environmental sustainability signals ($\beta_{env \times bio} = 0.50$, $p < .001$).

In sum, we find that various sustainability signals differ in their effect on consumers' sustainability perceptions. Differentiating the signal content, information on the sustainability domain is most influential, whereby environmental sustainability has a stronger positive influence on sustainability perceptions than social sustainability. This can potentially be due to the fact that the environmental domain of sustainability is more deeply embedded in consumers' minds (Simpson & Radford, 2014). Current challenges, such as climate change and its consequences, have been very salient in public debate, and have probably contributed to the dominance of environmental sustainability in the eyes of consumers (Bangsa & Schlegelmilch, 2020). Nevertheless, the positive effect of information on social product features should not be neglected because the impact of the respective sustainability domain also depends on individual value orientations. Specifically, we find that people with altruistic values react more favorably to social sustainability information, whereas those with biospheric values respond more positively to environmental information.

Turning to life-cycle phases as another element of signal content, the results show that sustainability information on the end-of-life phase has a significantly more positive impact than information on the phases of sourcing or production. Our study is one of the few which experimentally compare the impact of different life-cycle phases and support initial evidence that the end-of-life phase is particularly strongly represented in consumers' minds (Herbes et al., 2018; Luchs et al., 2010). One possible explanation might be that, from the consumer's

perspective, the impact of sourcing and production on people and the environment seems more distant from their own reality than the impact of the end-of-life phase, in which they are usually involved themselves and can take some form of responsibility (Luchs & Miller, 2015). In addition, current media attention to the circular economy, with public topics such as ocean plastics, may have directed consumer attention to this specific phase (e.g., Bucci et al., 2020).

Finally, a sustainability signal seems most effective when it is validated by a governmental institution compared to an NGO. The results demonstrate a variation in the signal effectiveness dependent on the certifying institution. This is reasonable given that the impact of certifications relies on the perceived credibility of a specific independent third party (Atkinson & Rosenthal, 2014). Our results imply that within independent certifications, a governmental third party certification best supports the sender's trustworthiness (Zerbini, 2017).

2.4. The impact of the number of sustainability signals

While Study 1 provided valuable insights into the relative importance of different sustainability signals, it investigated the impacts of signal content by holding the number of signals constant (e.g., information on environmental sustainability in the end-of-life phase validated by an NGO, or not validated information on social sustainability in the sourcing phase). However, in reality, sustainability-related product information does not only exist for single life-cycle phases and sustainability domains, but typically appears simultaneously for a combination of these dimensions. Thus, the question arises as to whether increasing the absolute number of sustainability signals positively impacts consumer perception.

With regard to the wide range of sustainability features of different products, it is challenging to avoid overwhelming and confusing consumers with the sheer volume of

sustainability information (White et al., 2019). To date, research has mainly dealt with the confusion caused by different information about different products from different sources (Chen & Chang, 2013). Cognitive dissonance and confusion often arise because of conflicting information from various sources (Chen & Chang, 2013). If all these sustainability signals relate to different features of the same product, they could enhance cognitive consistency and subsequently create higher levels of processing fluency (Drover et al., 2018; Schwarz et al., 2020). Thus, the respective signals could strengthen the perception of a holistic, comprehensively sustainable product instead of causing confusion (Gleim et al., 2013; Pancer et al., 2017; Steigenberger & Wilhelm, 2018). Such consistency across several sustainability-related signals can facilitate the classification of a product as sustainable and different pieces of sustainability information can be more effective in enhancing sustainability perceptions when presented in combination (Gleim et al., 2013; Pancer et al., 2017). However, adding ever more signals may have contradictory effects if consumers are overwhelmed with excessive information (White et al., 2019).

In contrast to the product-inherent sustainable product features in Study 1, symbolic sustainability signals refer to non-product-related features (K. L. Keller, 1993). To increase the variety and quantity of sustainability signals, we supplemented our second design with cause-related marketing (CRM) activities (Buell & Kalkanci, 2021). These represent a company's promise to donate a monetary amount to a good cause for each purchase of its products or services (Nan & Heo, 2007). Previous research has identified positive effects of CRM information on consumer attitudes and choices, even in the presence of tradeoffs in product performance or prices (Nan & Heo, 2007). However, these results are unclear regarding the extent to which CRM has an impact in direct comparison to product-inherent sustainability features (Buell & Kalkanci, 2021).

Against this background, we conducted a second study to investigate how the amount of sustainable product information shapes the sustainability perceptions of consumers. We also included a symbolic sustainability signal to further increase the amount of information presented to consumers. Hence, Study 2 seeks to answer the following research question while still considering individual characteristics and the content of sustainability signals.

RQ2: How are consumer perceptions of product sustainability affected by the number of sustainability signals presented?

2.5. Study 2

2.5.1. Stimuli and experimental design

Study 2 followed a similar approach to Study 1, but focused on differentiating the absolute amount of information presented to respondents. As no differences between product categories emerged in Study 1, the new design was applied to only one product (i.e., jeans). We varied the number of life-cycle phases described, the number of sustainability domains addressed, and whether information on CRM was present or not. All dimensions and levels combined yielded a 4 (number of life-cycle phases addressed: none, one, two, three) × 2 (environmental sustainability addressed: yes, no) × 2 (social sustainability addressed: yes, no) × 2 (CRM: yes, no) design. After eliminating illogical combinations from the vignette universe[8]a total of 21 vignettes remained.

Since participants judged varying numbers of signals per vignette, some vignettes described only one or two life-cycle phases, requiring a decision on whether to include the life-cycle

[8] Illogical combinations occurred, for example, in cases where the number of life-cycle phases addressed was "none" and no CRM existed. In such a case, it would not have been possible to report on environmental or social sustainability issues at all. For example, a combination of "number of life-cycle phases addressed: none" with "environmental sustainability addressed: yes" was not possible and thus excluded from the vignette universe.

phase of sourcing, production, or end-of-life. To avoid the confounding influence of a particular life-cycle phase described in the vignette, we tripled the design. This allowed us to cover all possible combinations of sourcing, production, and end-of-life in the vignettes with only one or two life-cycle phases. This yielded 63 vignettes that were blocked in a d-efficient procedure for nine sets of seven vignettes. To compensate for any confounding effects of text length, we opted for a tabular format to present the product information, including a statement that no information was available where the combination of dimensions and levels made it necessary. Table 3 displays two exemplary vignettes.

Table 3. Two exemplary vignettes (Study 2).

	Environmental aspects	**Social aspects**	**Environmental aspects**	**Social aspects**
Raw materials	The organic cultivation of cotton complies with the highest environmental standards.	*No information available.*	The organic cultivation of cotton complies with the highest environmental standards.	The small farmers receive a fair wage for growing the cotton.
Production	*No information available.*	*No information available.*	The production is with 100% renewable energy.	Production creates well-paid jobs in emerging and developing countries.
End-of-life	*No information available.*	*No information available.*	The materials are fully degradable at the end of their life and can be composted.	When returned via the retailer, the refurbishment of the used jeans creates jobs in social institutions.
Donation	For every purchase of these jeans a donation is made to an environmental project.	*No information available.*	For every purchase of these jeans a donation is made to an environmental project.	For every purchase of these jeans a donation is made to a social project.

To ensure comparability, we conducted the study again with a German sample (N = 251) representative of gender, age, and education (M_{age}= 47.70, SD = 16.53; 50.6%

female, education: 21.1% low, 51.8% middle, 27.1% high). We followed the same procedure as in Study 1 and applied the same measurement scales (reliability is displayed in Table A2). This resulted in 1,757 vignette ratings in total.

2.5.2. Results and preliminary discussion

We followed the same analytical approach as in Study 1. The results showed significant main effects on all four dimensions (see Table 4, Model 1). Sustainability information, which refers to multiple phases (e.g., sustainable sourcing, production, and end-of-life versus only sustainable production), had a positive influence on sustainability perception. The more signals on life-cycle phases were available, the more positive this effect was ($\beta_{1phase} = 1.74$, $p < .001$; $\beta_{2phases} = 3.28$, $p < .001$; $\beta_{3phases} = 4.50$, $p < .001$).

Table 4. Results (Study 2).

	Model 1			**Model 2**			**Model 3**		
	β	***SE***	***t***	**β**	***SE***	***t***	**β**	***SE***	***t***
Intercept	-5.42***	0.22	-24.94	-5.98***	0.46	-13.02	-4.82***	0.54	-8.88
Vignette dimensions (L1)									
Sustainability domain									
No phase (ref.)									
One phase	1.74***	0.15	11.27	1.74***	0.14	12.25	1.68***	0.21	7.85
Two phases	3.28***	0.15	21.34	3.37***	0.14	23.97	3.12***	0.26	12.00
Three phases	4.50***	0.15	29.41	4.58***	0.15	30.20	4.21***	0.32	13.20
Environmental sustainability									
No (ref.)									
Yes	2.23***	0.11	20.18	2.26***	0.13	17.20	1.19***	0.20	5.95
Social sustainability									
No (ref.)									
Yes	1.20***	0.11	10.81	1.18***	0.10	11.39	0.15	0.18	0.80
Cause-related marketing									
No (ref.)									
Yes	0.70***	0.10	7.18	0.67***	0.10	6.63	0.90***	0.25	3.64
Respondent-specific characteristics (L2)									
Biospheric values				0.02	0.11	0.15	-0.16	0.12	-1.26
Altruistic values				0.12	0.12	0.94	-0.01	0.14	-0.08
Information-processing capacity				-0.01	0.07	-0.16	0.16†	0.08	1.85
Greenwashing skepticism				-0.12	0.09	-1.41	-0.33**	0.11	-2.97

(to be continued on the next page)

Table 4 (continued). Results (Study 2).

	Model 1			Model 2			Model 3		
	β	***SE***	***t***	**β**	***SE***	***t***	**β**	***SE***	***t***
Intercept	-5.42***	0.22	-24.94	-5.98***	0.46	-13.02	-4.82***	0.54	-8.88
Cross-level interactions									
Life-cycle phases x Environmental sust. x Social sust.							0.62***	0.09	6.87
Life-cycle phases x CRM							-0.12	0.11	-1.02
Environmental sust. x biospheric values							0.26*	0.10	2.61
Social sust. x altruistic values							0.19*	0.09	2.01
Life-cycle phases x information processing capacity							-0.09**	0.03	-3.15
Life-cycle phases x greenwashing skepticism							0.12**	0.04	3.00
Controls									
Sex (Male, ref.)				-0.40	0.25	-1.61	-0.40	0.25	-1.61
Age				0.00	0.01	0.46	0.00	0.01	0.47
Product (Cell phone, ref.)									
Cereal				0.19	0.30	0.65	0.19	0.30	0.65
Jeans				-0.33	0.30	-1.13	-0.34	0.30	-1.14
-2LL	6699.62			6556.92			6540.03		
Covariance Structure	VC			UN			UN		
***N* (participants)**	251			251			251		
***N* (vignette ratings)**	1757			1757			1757		

Note. Unstandardized coefficents; method: restricted maximum likelihood; controlled for vignette set effects
† $p < 0.1$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Controlling for the content of the described phases using a mixed ANOVA showed that the mean perceived sustainability ratings differed significantly for the sourcing, production, and end-of-life phases ($F = 355.03$, $p < .001$). Consistent with the results of Study 1, vignettes containing information on end-of-life yielded stronger perceptions of sustainability (see Table A4). This applied both to vignettes describing only the end-of-life phase and to vignettes that additionally addressed other life-cycle phases. Similarly, the presence of environmental sustainability signals again had a positive and stronger effect on perceived sustainability than social sustainability signals ($\beta_{env} = 2.23$, $p < .001$; $\beta_{soc} = 1.20$,

$p < .001$). Finally, the presence of information on CRM also showed a positive but comparably weaker effect on perceived sustainability ($\beta_{CRM} = 0.70$, $p < .001$).

Next, random intercept-and-slope models were used. When including respondent characteristics and their interactions in the model (Model 3), the social sustainability signals did not significantly impact sustainability perceptions ($\beta_{soc} = 0.15$, $p > .1$). Moreover, we found significant direct effects of information-processing capacity and greenwashing skepticism ($\beta_{ipc} = 0.16$, $p < .1$; $\beta_{gs} = -0.33$, $p < .01$). Other than Study 1, neither biospheric nor altruistic value orientation had a significant direct effect on perceived sustainability ($\beta_{bio} = -0.16$, $p > .1$; $\beta_{alt} = -0.01$, $p > .1$). However, we found the same significant cross-level interactions between value orientation and the respective sustainability domains ($\beta_{env \times bio} = 0.26$, $p < .05$; $\beta_{soc \times alt} = 0.19$, $p < .05$).

In addition to scrutinizing the effect of a varying number of life-cycle phases in product sustainability descriptions, we also investigated the influence of the number of signals using two interactions on the product-feature level. We found a significant three-way interaction between life-cycle phases, environmental, and social sustainability signals ($\beta_{LCP \times env \times soc} = 0.62$, $p < .001$). Thus, presenting more sustainability signals covering not only more life-cycle phases but also both sustainability domains has a positive effect on sustainability perception. However, the two-way interaction between life-cycle phases and CRM was not significant ($\beta_{LCP \times CRM} = -0.12$, $p > .1$). This indicates that if a product is perceived as inherently sustainable, information on CRM does not make an additional positive contribution to the perception of sustainability. Relating the number of life-cycle phases to information-processing capacity and greenwashing skepticism, we found significant interaction effects for both ($\beta_{LCP \times ipc} = -0.09$, $p < .01$; $\beta_{LCP \times gs} = 0.12$, $p < .01$). Providing a larger amount of information had a slightly negative effect on people with limited information-processing capacity; however, this limitation only minimally weakened the

strong positive direct effect of the increased amount of information. For people with stronger greenwashing skepticism, the provision of more sustainability signals has a particularly positive effect.

In sum, Study 2 altered the absolute number of signals and showed that providing more sustainability signals increases consumers' perceived sustainability. Describing more different life-cycle phases has a positive impact on sustainability perceptions. This might be due to the fact that an increased number of signals allowed consumers to get a holistic impression of sustainability along the entire product life-cycle (Steigenberger & Wilhelm, 2018; Zerbini, 2017). Similarly, adding both environmentally and socially sustainable information to the life-cycle phases had a significant positive effect. Notably, the non-significant effect of adding CRM supports the idea that, compared to several product-inherent sustainability signals, the addition of merely a symbolic signal is ineffective, as has been shown in the context of investors and sustainability reporting (Hahn et al., 2021).

Differences in individual consumer characteristics emerged in both studies and shaped the interplay between sustainability information and perceived product sustainability. Most importantly, identified interaction effects point to the value-congruent formation of sustainability perceptions. Additionally, we found a negative effect of general greenwashing skepticism on perceived sustainability in both studies. Consumers tend to be skeptical about sustainability-related product information, which usually leads them to seek more information (Leonidou & Skarmeas, 2017). Thus, as depicted in Study 2, providing more sustainability signals can counter general greenwashing skepticism because transparency may increase consumers' trust in the information supplied (Chen & Chang, 2013). Finally, both studies found that consumers with limited information-processing capacities reported higher perceived sustainability, potentially because they did not question the provided information

and, in the case of Study 2, used the amount of provided information as heuristic cue to infer sustainability.

2.6. General discussion

2.6.1. Empirical findings and contributions to signaling theory

Our studies provide new insights into how the content and number of product-related sustainability signals influence consumer perceptions. While extant research has mainly focused on sustainability signals in an isolated manner, this research adopted an integrated quasi-experimental approach to explore the effects of various sustainability signals in combination. Our findings relate closely to traditional signaling theory (Connelly, Certo, et al., 2011; Spence, 1973) and allow for some refinements. Information asymmetries on markets denote the starting point of signaling theory, where some actors (here: consumers) have an information disadvantage compared to other actors (here: manufacturers). This also applies to corporate sustainability activities, where it is difficult for consumers and other stakeholders to ascertain how sustainable a company's product actually is (Connelly, Ketchen, & Slater, 2011; Sigurdsson et al., 2023). Under conditions of incomplete, misleading, or imperfect information, consumers rely on signals sent by the manufacturers to evaluate product sustainability (Atkinson & Rosenthal, 2014; Connelly, Certo, et al., 2011). Against this background, we contribute empirical insights on signaling theory in the context of sustainability communication toward consumers (Atkinson & Rosenthal, 2014; Petersen & Brockhaus, 2017; Sigurdsson et al., 2022) and address related calls to further expand signaling theory (Hahn & Reimsbach, 2020; Zerbini, 2017).

To better understand the effectiveness of sustainability signals sent to consumers, we argue that the concept of "receiver interpretation" (Connelly, Certo, et al., 2011, p. 52) is

decisive. It describes a process in which receivers translate signals and thereby assign meaning to them (Baier et al., 2022; Connelly, Certo, et al., 2011). While traditional signaling theory states that the value of a signal is derived from its costliness to the sender, our results from Study 1 suggest that the value of a signal is also determined by the content and meaning that consumers ascribe to it (Connelly, Certo, et al., 2011; Hahn et al., 2021). This may be due to the limited ability of consumers to assess the real costs of different signals, especially in the complex area of sustainability (Connelly, Ketchen, & Slater, 2011; Peloza et al., 2012). Consumers usually do not possess comprehensive expert knowledge of sustainability (Gleim et al., 2013). Thus, they cannot adequately judge, for example, whether decent working conditions in the production process or using recycled raw materials during sourcing is a costlier measure for the company. Consequently, consumers' perceived sustainability of a product is predominantly influenced by the actual content of the signal, instead of only its cost for the manufacturer (Hahn et al., 2021). Moreover, in addition to the costliness of sustainability-related signals, consumers are often unable to accurately assess their credibility (Atkinson & Rosenthal, 2014). As suggested by our results, they may rely on external validation as a cue for content credibility (Connelly, Certo, et al., 2011; Delmas & Grant, 2014). Overall, we argue that, in situations where the signal content is complex and potentially ambiguous, focusing on the receiver's perception might be more meaningful than taking the traditional sender's perspective on costly signals (Baier et al., 2022; Steigenberger & Wilhelm, 2018).

Furthermore, it seems worthwhile accounting for individual differences within a group of signal receivers. According to signaling theory, receivers' attention depends on their individual characteristics, for example, the attention paid by particular receivers to specific information (Connelly, Certo, et al., 2011). Our results show that value-aligned information has a greater impact on the sustainability perception than signals that do not resonate with the

values of individual receivers. This implies that consumers are likely to pay the most attention to signals that match their values (Sigurdsson et al., 2023; Verplanken & Holland, 2002). Also, their interpretation of signals can be influenced by individual distortions or weights the receiver (group) assigns to signals (Baier et al., 2022; Connelly, Certo, et al., 2011). Our findings on greenwashing skepticism and information processing capacity reflect how such individual characteristics impact consumer perceptions.

Additionally, traditional signaling theory has focused on isolated signals, which are untypical in high-noise environments where multiple signals are sent simultaneously (Connelly, Certo, et al., 2011; Sigurdsson et al., 2023; Steigenberger & Wilhelm, 2018), as is the case in sustainability communications. Our findings from Study 2 imply that the use of multiple sustainability signals as a bundle (i.e., increasing signal frequency) can enhance signal effectiveness (Connelly, Certo, et al., 2011). In particular, higher effectiveness is obtained when different signals from the same sender complement each other to communicate the same underlying message (Connelly, Certo, et al., 2011; Drover et al., 2018). This signal consistency prevents confusion and reinforces the core messages. Our results of Study 2 suggest that building an entire portfolio of complementary sustainability signals covering several life-cycle phases and sustainability domains leads to a larger joint effect than single sustainability signals (Steigenberger & Wilhelm, 2018; Zerbini, 2017).

Finally, one theoretical element of the signaling process involves a feedback loop about the effectiveness of a signal from receivers back to senders (Connelly, Certo, et al., 2011; Connelly, Ketchen, & Slater, 2011). This implies that an information exchange is not only relevant along the initially described information asymmetry from businesses to consumers. To improve signaling effectiveness, companies could also benefit from learning how consumers actually interpret their signals (Connelly, Certo, et al., 2011). Such a feedback loop between signal receiver and sender has been examined for non-professional

investors (Baier et al., 2022; Hahn et al., 2021) and our research provides empirically validated feedback on the effectiveness of product-related sustainability signals from a consumer perspective.

In sum, this research makes four academic contributions: First, while extant research on consumers' product perceptions and traditional signaling theory tend to focus on isolated signals (Steigenberger & Wilhelm, 2018), we respond to the need to examine the effectiveness of different contents of sustainability signals communicated to increase sustainability perception (Connelly, Ketchen, & Slater, 2011). Second, we investigate the perspective of consumers in the role of signal receivers within signaling theory (Baier et al., 2022; Connelly, Certo, et al., 2011) and connect to a refinement of the traditional perspective by focusing on the concept of valuable signals (Hahn et al., 2021). Third, we address the simultaneous occurrence of several signals (Connelly, Certo, et al., 2011; Steigenberger & Wilhelm, 2018), which reflects the high-noise environment of sustainability communication (Connelly, Ketchen, & Slater, 2011; Zerbini, 2017). Fourth, this research offers empirical insights into the feedback loop between consumers and companies as theoretical element within signaling theory (Connelly, Certo, et al., 2011).

2.6.2. Practical implications

Businesses are confronted with multiple decisions on corporate sustainability on a regular basis (Hahn et al., 2021; Zerbini, 2017). During decision-making, managers naturally take the cost of different sustainability actions into account (Baier et al., 2022; Peloza et al., 2012). Genuine sustainability improvement usually incurs some cost irrespective of whether it is focused on environmental or social sustainability or on a specific life-cycle phase (Connelly, Ketchen, & Slater, 2011). At the same time, our findings highlight that it is worthwhile to extend this cost-based view with how consumers actually perceive corporate sustainability efforts (Öberseder et al., 2013). Notably, consumers usually are non-experts in

the field of sustainability and often cannot estimate the actual cost of a sustainability signal (Gleim et al., 2013; Peloza et al., 2012). Instead, our results from Study 1 suggest that consumers may consider the content of a signal and thereby derive value from it. By pointing to which sustainability domain, life-cycle phase, and validation type are best received by consumers, these insights can help managers in two ways: First, managers can ensure that costly sustainability efforts are spent in areas that are especially recognized by consumers (e.g., signals on environmental sustainability in the end-of-life phase that are validated by the government), which may motivate further corporate efforts. For example, a cell phone manufacturer might be inclined to focus on communicating the recyclability of its product at the end of its life to match consumers' perceptions of what makes a cell phone sustainable. Second, where consumers' perceptions differ from the real cost for companies' sustainability measures and respective environmental benefits (Gleim et al., 2013; Herbes et al., 2018; Peloza et al., 2012), targeted consumer education may be necessary to resolve these discrepancies. Returning to our example, a life-cycle analysis conducted by the same cell phone manufacturer might reveal that reducing ecological hazards in the extraction of raw materials and improving social issues from the mining of conflict minerals provide more important levers to improve overall product sustainability (Cordella et al., 2021). Consequently, companies could help raise consumer awareness of such more pressing sustainability hotspots. Notably, this endeavor typically transcends business boundaries and may require governmental and non-governmental action, particularly to protect consumers from corporate greenwashing (which is the case when companies signal sustainability without respective substantiation) (Chen & Chang, 2013; Connelly, Certo, et al., 2011).

In this context, our findings can support companies that truly value sustainability to differentiate themselves from less genuine companies in two ways: First, the results of Study 1 imply that companies can substantiate sustainability information with external validation,

preferably by governmental institutions, and thereby increase credibility. Second, the results of Study 2 encourage companies to invest in various product-inherent sustainability signals that address several life-cycle phases and sustainability domains to communicate a holistic sustainable product and value chain. On the one hand, this comprehensive approach is difficult to imitate and, thus, poses a challenge for companies that may be less serious about improving corporate sustainability. On the other hand, it seems to positively influence even those consumers who are highly aware of greenwashing.

In sum, this research shows that product sustainability can be presented to consumers with valuable signals that help align the expert with the consumer perspective.

2.6.3. Limitations and avenues for future research

Several limitations that future research can address should be noted. While we addressed various contents related to sustainability signals, we did not examine how this information is communicated. For example, some studies have shown that information specificity can have different effects when communicating sustainability to consumers (e.g., Janssen et al., 2022). However, the specific wording of such information should be carefully chosen because individual preferences may vary with different specifications for the same information content. Similarly, the use of an easily receptible tabular format may have affected the positive influence of providing more information (Misuraca et al., 2021), potentially not challenging information-processing capacity. Furthermore, the sole use of textual information may have reduced realism in our studies, as visual cues such as eco-labels, are often present in communications for sustainable products (Pancer et al., 2017; Zerbini, 2017). Thus, although using only text has the advantage of avoiding confounding effects associated with the use of selected visuals, future research could benefit from examining their effectiveness compared to verbal cues.

With respect to the amount of information, our results point toward a complementarity effect of information on different life-cycle phases and sustainability domains. However, extant research has warned that providing more signals can yield a negative effect in the case of signal redundancy (Steigenberger & Wilhelm, 2018). Therefore, future research on when sustainability signals are perceived as complementary as opposed to redundant may be warranted. Furthermore, this research studied the joint effect of sending multiple sustainability signals at one point in time (i.e., on one product). It could be worth examining how these effects may differ when multiple signals on one product are sent at different times, using different channels (i.e., information on the product itself, in different advertisements of the product) (Zerbini, 2017).

In our study, we focused on consumers' sustainability perceptions as dependent variable. This is especially valuable because there has been little research on the initial formation of consumers' sustainability perceptions based on sustainability information (Pancer et al., 2017). In addition, prior work identified manifold and context-dependent effects that follow if a product is perceived as sustainable. For example, research on the conditions under which sustainability poses an asset or a liability is extensive (Chernev & Blair, 2021; Luchs et al., 2010). While it was beyond the scope of our paper to examine the effects of increased sustainability perceptions in different settings, future research may benefit from linking our findings to the attitudinal and behavioral consequences of increased sustainability perceptions in consumers' decision-making processes (Gershoff & Frels, 2015). Finally, as both studies were conducted in Germany, we suggest that future research validate the results in other cultural contexts, as these may affect consumers' perceptions (Chrysochou & Grunert, 2014; Herbes et al., 2018).

2.7. Conclusion

Empirically, this work contributes to the sustainability literature by synthesizing fragmented research on how sustainable product features affect consumers' sustainability perception. Most studies in this research stream have made significant contributions by explaining the mechanisms behind the impacts of specific predefined product features (Pancer et al., 2017; Sigurdsson et al., 2022). Our research confirmed these fragmented results and complemented the knowledge by comparing the relative impacts of different information on sustainable product features, and thus acknowledge the real-life complexity of sustainable products (Zerbini, 2017). Additionally, we contribute to the literature on signaling theory. By looking beyond isolated signals, we account for the simultaneous occurrence of multiple signals in a sustainability context (Connelly, Ketchen, & Slater, 2011; Steigenberger & Wilhelm, 2018; Zerbini, 2017). Thereby, our studies enhance the understanding of the relation between the content and number of sustainability signals and the perception of consumers as signal receivers.

3. Paper 2: Green or greenwashed? Examining whether and when consumers are able to identify greenwashing[9]

Abstract

Nowadays, companies and consumers face the challenge of navigating around the pitfalls of greenwashing in markets presenting uncountable new and existing green products. This research examines consumer perceptions of such products and questions whether they are actually able to identify greenwashing. Drawing on categorization theory, consumers may classify a new product based on different green cues as honest green, greenwashed, or regular. We test this ability across three different products with four experiments ($N = 700$) conducted in Germany and find that consumers fall for greenwashing when they are asked solely for their purchase intentions. Only upon activation of a greenwashed product category by asking participants for their perceived greenwashing, they can spot the differences between the green products. The academic contribution of this research is twofold: First, we provide empirical evidence against the implicit assumption inherent to the greenwashing and green advertising literature that consumers can distinguish between greenwashed and honest green products. Second, we show that the activation of a greenwashed product category affects their ability to identify greenwashing. Practically speaking, this research may point public policy toward category activation as a simple measure to help consumers unmask greenwashing in purchase contexts.

Keywords: Greenwashing, green advertising, sustainability communication, consumer perception, green product cue, categorization

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3.1. Introduction

More than ever, there has been a marked increase in the general public's concern for environmental issues, evident in global movements such as Fridays for Future (Wallis & Loy, 2021) and public policy efforts as part of the European Green Deal (European Commission, 2023). A corresponding interest in more sustainable consumption has led companies to increasingly market products as environmentally friendly or green (Kwon et al., 2023; Leonidou & Skarmeas, 2017; Segev et al., 2016). At the same time, the occurrence of greenwashing, which describes "communication that misleads people into adopting overly positive beliefs about an organization's environmental performance, practices or products" has grown rapidly (Lyon & Montgomery, 2015, p. 226). In this context, genuinely sustainable companies face the challenge of communicating sustainable product improvements without falling into a greenwash attempt, while responsible consumers face the challenge of distinguishing between greenwashed and honest green products when making purchases (Newell et al., 1998; Schmuck et al., 2018; Steenis et al., 2022). Notably, if consumers are actually unable to identify greenwashing, companies will have an incentive to greenwash which can undermine genuine attempts to improve corporate and product sustainability (European Commission, 2023; Fernandes et al., 2020).

Related academic research has surged with the occurrence of greenwashing and can be divided into two literature streams: One looks at corporate greenwashing with a focus on drivers, types, and consequences of greenwashing on a company level, primarily anchored in organization and management studies (e.g., Leonidou & Skarmeas, 2017; for a review see Lyon & Montgomery, 2015). The other looks at (misleading) green advertising with a focus on the product level and consumer responses such as ad and brand attitudes as well as purchase intentions, emerging from marketing and advertising research (e.g., Schmuck et al., 2018; Schuhwerk & Lefkoff-Hagius, 1995; Steenis et al., 2022). Yet, in this second stream,

research assessing how green(washed) cues of respective products are perceived by consumers has been scarce (Kwon et al., 2023; Newell et al., 1998; Pancer et al., 2017; Schmuck et al., 2018; Szabo & Webster, 2021). More importantly, in both literature streams most of the reported consequences of greenwashing or green advertising are implicitly based on the assumption that consumers *can* distinguish between greenwashed and honest green companies and their products (Pancer et al., 2017). But in fact, many theoretical and practical implications may be futile if consumers actually cannot do so (Newell et al., 1998).

Against this practical and theoretical background, we challenge this implicit assumption and ask: Are consumers able to identify greenwashing, namely, can they distinguish between greenwashed, honest green, and regular products? To answer this research question, we draw on categorization theory according to which consumers navigate through the myriad of new and existing green products with the help of categorical representations of such products to classify and understand respective product information (Loken et al., 2008). Thereby, consumers use relevant environmental cues representing the green product category and evaluate to which degree the new product is similar to it. For example, the category of green cleaning detergents may be represented through plant-based and biodegradable ingredients, an eco-label, and green package color (Fernandes et al., 2020; Pancer et al., 2017; Schuhwerk & Lefkoff-Hagius, 1995). By combining different green, greenwashed, and non-green product cues prototypical categories of an honest green, greenwashed, and regular product are operationalized as stimuli for three different products (Simula & Lehtimäki, 2009; Szabo & Webster, 2021). In a first step, these stimuli were shown to German convenience samples in three within-subject experiments to evaluate whether participants could recognize the green(washed) product based on its cues. In a second step, a mixed experimental design was applied to support the prior findings with a

representative German sample and to gain further insights into the underlying cognitive processes.

This research offers important contributions on theoretical and practical accounts. On a theoretical level, we challenge consumers' ability to actually distinguish honest green from greenwashed products and provide empirical evidence that consumers are not always able to do so. We further show that what is on consumers' minds (i.e., two or three category representations) affects their ability to identify greenwashing. For practitioners, our insights point to the potential of activating a greenwashed category to help consumers detect greenwashing in purchase contexts.

3.2. Theoretical background and hypotheses

3.2.1. Categorization theory in the context of green(washed) products

According to categorization theory (for a review, see Loken et al., 2008), consumers use categories, that is, mental collections of objects that appear to be related in some way (Rosch, 1978), from which they make inferences to evaluate products. Hereby, a distinction is made between *categorical representations*, which describe the information stored in consumers' memories that identifies a consumer category (such as a set of products) and *category inference*, which denotes the process in which consumers use these categories to make judgments about new category members. Essential to this categorization process is the degree to which the representation of the product category matches the new product, also known as "similarity as heuristic" (Loken et al., 2008, p. 145). If similarity is low, it is unlikely that inferences will be drawn from the product category to the new member compared to when similarity is high. Notably, people prefer to categorize objects within a single category as

opposed to multiple categories, also known as single category inference process (Macrae et al., 1995).

Applied to the realm of green products, category inference influences how consumers respond to products with environmental cues (Gershoff & Frels, 2015; Lee et al., 2020; Pancer et al., 2017). Thereby, consumers can use four distinct categorical representations depending on how an organization's green advertising level (i.e., the extent to which environmentally friendly product features are communicated as a persuasive selling point; Atkinson & Rosenthal, 2014) matches the actual sustainability of their products (Simula & Lehtimäki, 2009; Szabo & Webster, 2021): *Honest green* products require that both the green advertising level and the product sustainability are high, while *honest non-green* or *regular* products result when both are low. If only the green advertising level is high, but actual product sustainability is low, a *greenwashed* product is described. The fourth and final combination occurs when the green advertising level is low, but product sustainability is high. This category will not be further investigated because it seems rather unlikely that today's organizations would not want to share the sustainability benefits of an actually sustainable product, as sustainability seems to have become an overall desirable product feature to communicate (Kwon et al., 2023; Leonidou & Skarmeas, 2017; Segev et al., 2016; Szabo & Webster, 2021).

Based on this conceptualization, the present research questions whether consumers are actually able to distinguish between the three outlined product categories – an implicit assumption in which various practical implications derived from the conceptualized categories are anchored (Pancer et al., 2017; Simula & Lehtimäki, 2009; Szabo & Webster, 2021). This research follows a prototype view of category representation, in which categories are represented by general, abstracted composites or prototypes (Loken et al., 2008). Next, we will identify such prototypes for green(washed) products, which are based on the most

likely features from a product that is member of the respective category (Rosch, 1978). Therefore, the following section provides a review of different green(washing) cues upon which each introduced product category may be represented in consumers' minds and used for category inference.

3.2.2. Category representation based on verbal and visual green(washing) cues

While some studies have focused on verbal (e.g., Schuhwerk & Lefkoff-Hagius, 1995) or visual cues only (e.g., Hartmann & Apaolaza-Ibáñez, 2010), the majority of research on green advertising examined both types of green product cues (Fernandes et al., 2020; Granato et al., 2022; Magnier & Schoormans, 2015; Schmuck et al., 2018; Steenis et al., 2022). This matches how products are marketed in practice (Kwon et al., 2023; Segev et al., 2016).

Starting with claims as verbal cues, a green product claim consists of one or more sentences that inform consumers about the environmental contribution of the advertised product (Segev et al., 2016). When such verbal cues are misleading, this is termed "claim greenwashing" (Parguel et al., 2015, p. 108). Drawing on specific misleading claims reflected in the seven "Sins of Greenwashing" (TerraChoice, 2010, p. 10), extant research has examined hidden trade-offs (Steenis et al., 2022), vague (Fernandes et al., 2020) as well as false claims (Newell et al., 1998; Schmuck et al., 2018). Because vague claims have been very prevalent in marketing green products and false claims posit another major type of misleading cue (Carlson et al., 1993; European Commission, 2023; Kangun et al., 1991; Segev et al., 2016), this research will use both claim types as verbal greenwashing cues. Specifically, *vague* claims are poorly defined or overly broad and can therefore be misunderstood by consumers, whereas *false* claims are simply false against objective evidence, representing outright lies (Kangun et al., 1991; Schmuck et al., 2018; TerraChoice, 2010). Interestingly, cross-cultural research found that the more prevalent vague claims were unrelated to perceived greenwashing (i.e., are particularly misleading), while the less

prevalent false claims significantly increased greenwashing perceptions (Schmuck et al., 2018), further warranting the use of both claim types in this research. Adding *irrelevant* claims, which present requirements that are imposed by law as distinctive product features (European Commission, 2023; TerraChoice, 2010), will complete our selection of verbal greenwashing cues.

Visual cues depict an ad's physical layout and include logos, nature imagery, colors, and backgrounds (Segev et al., 2016). Notably, when visuals are applied without any explicit reference to the actual environmental benefits of the advertised products, this is termed "executional greenwashing" (Parguel et al., 2015, p. 108; Schmuck et al., 2018). The simplest visual cue is the use of *green color*, which consumers tend to associate with environmental friendliness, regardless of the product's actual sustainability (Pancer et al., 2017; Seo & Scammon, 2017). In addition, research has shown that *nature imagery* (e.g., forests, wild creeks, or butterflies) positively influences brand attitudes (Hartmann et al., 2016; Hartmann & Apaolaza-Ibáñez, 2010) and specifically, enhances perceptions of a brand's ecological image even when objective information states inferior environmental performance (Parguel et al., 2015). Finally, eco-labels have been frequently used to market green products (European Commission, 2023; Segev et al., 2016). Notably, a distinction is made between third-party certified labels (e.g., by governmental institutions or non-governmental organizations) and labels without such external validation (e.g., self-declared company labels or mere graphic logos; Atkinson & Rosenthal, 2014; Pancer et al., 2017). Importantly, such *false* or *fake labels* can give consumers a wrong impression of third-party endorsement (Lyon & Montgomery, 2015; Segev et al., 2016; TerraChoice, 2010). When official or false eco-labels, nature imagery, and green color are combined, they typically yield an overall green look-and-feel (Segev et al., 2016), which will be applied to visually cue both the greenwashed and honest green product category in this research.

3.2.3. Examining consumers' ability to identify greenwashing

To test whether consumers are able to identify greenwashing, the formerly introduced product categories of an honest green, greenwashed, and regular product need to be operationalized using prototypical verbal and visual green(washed) cues representing these categories. Notably, extant research showed that the isolated use of an environmental cue introduces category ambiguity, while providing two cues (such as an eco-label and green color) helps consumers to clearly categorize a product as environmental (Lee et al., 2020; Pancer et al., 2017). Hereby, it is relevant that different environmental cues (e.g., verbal and visual) are congruent in communicating a product's greenness (Magnier & Schoormans, 2015). In this context, prior studies have shown that verbal and visual cues affect product perceptions and evaluations in different ways: Schmuck et al. (2018) found that verbal cues are processed through a more rational mechanism, while visual cues are processed through a more affective mechanism. Likewise, Parguel et al. (2015) suggested that verbal cues follow a more central route to persuasion, while visual cues follow a more peripheral route. Therefore, we combine the outlined multiple verbal and visual green(washing) cues to operationalize the greenwashed, honest green, and regular product as evident and unambiguous as possible and account for these different processing mechanisms.

To determine whether consumers recognize the honest green and greenwashed products as such, this research focuses on consumers' perceptions of greenness and greenwashing. Following extant research, perceived greenness measures the extent to which consumers evaluate a product as environmentally friendly (Gershoff & Frels, 2015) while perceived greenwashing describes the extent to which consumers believe a product to be misleading with regard to its environmental benefits (Chen & Chang, 2013; Schmuck et al., 2018). Assuming that consumers can identify greenwashing, it follows that a greenwashed product cued by a vague, false, and irrelevant claim as well as by green color, nature imagery,

and fake eco-labels will elicit higher greenwashing perceptions and lower perceptions of greenness. At the same time, an honest green product cued by a specific, true, and relevant claim as well as by green color, nature imagery, and official eco-labels will lead to lower greenwashing perceptions and higher perceptions of greenness. Therefore, consumers' ability to identify greenwashing can be derived from the differences in these product perceptions (Schmuck et al., 2018; Steenis et al., 2022). Going beyond product perceptions, consumer responses to green(washed) products, such as purchase intentions, have been of large interest in the green advertising literature. If consumers were indeed able to detect greenwashing this would likely reflect in their purchase intentions so that a product categorized as greenwashed will be least preferred (Newell et al., 1998; Steenis et al., 2022; Szabo & Webster, 2021). This leads to the following set of hypotheses:

H1. Consumers' purchase intention is higher for an honest green and a regular product than for a greenwashed product.

H2. Consumers' perceived greenness is higher for an honest green product than for a greenwashed and a regular product.

H3. Consumers' perceived greenwashing is higher for a greenwashed product than for an honest green and a regular product.

This general phenomenon of whether consumers are able to distinguish between honest green and greenwashed products will be tested in Studies 1a-c.

3.2.4. The role of category activation in consumers' ability to identify greenwashing

Next to the question of *whether* consumers can identify greenwashing, it is at least as important to examine *when* consumers can do so – and when not. In this research, consumers are tested regarding their ability to distinguish between two green-looking products, of which one is honestly green and the other is greenwashed. In terms of categorization theory,

consumers need to access a categorical representation of greenwashed products to be able to categorize the greenwashed product as such. Therefore, the question arises under what conditions this greenwashed product category is activated. While prior research suggests that the mere exposure to green(washed) cues on a product can be sufficient to activate an environmental schema (Pancer et al., 2017), the objective with which consumers evaluate a product can also influence category activation (Macrae et al., 1995). In particular, consumers do not usually evaluate each and every product regarding perceptions of greenness or greenwashing, but regarding their purchase intentions. In doing so, it is conceivable that consumers do not necessarily have a greenwashed category on their minds. Therefore, when evaluating their purchase intentions for an honest green, greenwashed, and regular product, consumers may only access a green and a regular category (arising from their distinct visual appearance), rendering consumers less capable of recognizing the greenwashed product.

To examine the role of category activation dependent on the objective of a product evaluation, the following rationales provide the basis for specific hypotheses to be tested: If consumers indeed only access a green and a regular category when evaluating their purchase intentions, then they will less likely think of greenwashing and, thus, cannot have a (third) greenwashed product category in mind. Second, when consumers think in only these two basic categories, it is conceivable that they will perceive both green-looking products to be similar and in contrast to the regular product (Rosch, 1978). In this research, this is more likely if they attend more to the shared visual cues (i.e., green color and nature imagery) than to the distinct verbal cues. Third, thinking in green and regular categories will lead consumers to need longer to categorize the greenwashed product because they need to access a third category which they have not thought of before (Loken et al., 2008). For the same reason, consumers are expected to more often wrongly categorize the greenwashed product. From this, we hypothesize the following:

H4. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will report fewer greenwashing thoughts.

H5. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will mention (a) shared visual cues more often and (b) distinct verbal cues less often.

H6. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will (a) need more time to categorize the greenwashed product and (b) more often wrongly categorize it.

Study 2 will examine whether consumers' ability to identify greenwashing depends on the number of categories that come to mind depending on what they are asked to evaluate.

3.3. Studies 1a-c

To investigate whether consumers are actually able to identify greenwashing, we conducted three online experiments across three different products in Germany. Each experiment contained three conditions: an honest green, a greenwashed, and a regular (control) product stimulus. Because the purpose of the studies was to examine whether one and the same consumer is able to distinguish between these product stimuli, a within-subject design was applied in which each participant evaluated all three of them. Compared to a between-subject design, this also enabled a more realistic decision context as consumers are usually confronted with competing products that may be greenwashed, honest green, or regular (Vargas et al., 2017). Moreover, this design provided a rather conservative approach to test consumers' ability to identify greenwashing as each participant could compare the three different product stimuli. The experimental design was applied to three different product types frequently studied in consumer research: two low-involvement products of which one is

associated with strength-related (toilet cleaner) and one with gentleness-related attributes (hand cream) as well as one high-involvement product (smartphones) (Atkinson & Rosenthal, 2014; Skard et al., 2021).

3.3.1. Methods

3.3.1.1. Pilot study

A pilot study was conducted to ensure that the selected products would indeed serve as low-involvement (toilet cleaner, hand cream) and high-involvement (smartphone) products as well as strength-related (toilet cleaner) and gentleness-related (hand cream). Therefore, 96 participants (M_{age} = 40 years; female: 40%, diverse: 1%; full-time employees: 68%) recruited from a panel provider were randomly assigned to rate one of the three products (N_{tc} = 32, N_{hc} = 33, N_{sp} = 31) with regard to involvement and strength/gentleness. Please note that the smartphone was rated only with regard to involvement because strength and gentleness were no relevant attributes for this product. Two established scales were used to measure participants' involvement (Mittal, 1995): Four items from the Personal Involvement Inventory (PII; Zaichkowsky, 1985) and six items from the Consumer Involvement Profiles (CIP; Laurent & Kapferer, 1985). The association of a product with strength- or gentleness-related attributes was measured following Study 2 by Luchs et al. (2010). The full items and reliabilities can be found in Table B1.

There was a statistically significant difference for involvement (PII) between the three products as determined by a one-way ANOVA ($F(2, 93) = 16.191$, $p < .001$). A Tukey post hoc test revealed that involvement was significantly higher for smartphones ($M = 6.07$) compared to toilet cleaners ($M = 4.38$, $p < .001$) and hand cream ($M = 4.61$, $p < .001$). Similarly, a one-way ANOVA using the CIP to measure involvement supports these results ($F(2, 93) = 17.693$, $p < .001$). Again, a Tukey post hoc test showed that involvement was

significantly higher for smartphones ($M = 5.58$) compared to toilet cleaners ($M = 3.52$, $p < .001$) and hand cream ($M = 4.23$, $p < .001$). Both involvement measures showed no significant differences between the low-involvement products. Therefore, it seems warranted to use smartphones as high-involvement product and the other two as low-involvement products.

The importance of strength- and gentleness-related attributes was analyzed for toilet cleaners and hand creams. Following prior research (Luchs et al., 2010; Skard et al., 2021), we calculated average measures of the five strength items (Cronbach's $\alpha = .76$) and five gentleness items (Cronbach's $\alpha = .79$). A one-way ANOVA of the relative attribute importance ratings for the two products ($F(1, 63) = 25.141$, $p < .001$) confirmed that strength was significantly more important for toilet cleaners ($M_{\text{tc Gentleness – Strength}} = -1.10$) and that gentleness was more important for hand cream ($M_{\text{hc Gentleness – Strength}} = 0.20$, $p < .001$).

3.3.1.2. Participants

Three German convenience samples were recruited between September 2021 and June 2023. A power analysis conducted in G*Power using an alpha of .05, a power of .95, and a conservative estimation of a small effect size ($f = 0.15$) suggested a sample size of 117. To account for exclusions due to non-existing product experience, we aimed for a sample size of 150 participants. For each experiment, participation was incentivized with the option to enter a sweepstake for four 15 Euro shopping vouchers upon survey completion. Participants were told that the studies were about the perception of an everyday product to avoid any early associations with greenwashing and related demand effects (Geuens & Pelsmacker, 2017). 153 usable responses were collected for toilet cleaners (20-29 years: 69%; female: 67%; full-time employees: 32%) in Study 1a, 157 responses for hand cream ($M_{\text{age}} = 30$ years; female: 73%, diverse: 2%; full-time employees: 37%) in Study 1b, and 162 responses for

smartphones (M_{age} = 29 years; female: 59%; full-time employees: 32%) in Study 1c. All participants reported that they have previously used or bought the respective product.

3.3.1.3. Product stimuli

For each experiment, we used three pictures of fictitious toilet cleaners (Study 1a), hand creams (Study 1b), or smartphones (Study 1c), which were created by professional media and graphic designers based on existing products (see Tables B2-B4). To reduce bias, the order in which the three stimuli were shown was counterbalanced and randomly assigned to each participant. Furthermore, participants were informed that the products had the same price to rule out any unforeseen effects thereof. The stimuli differed in the following verbal and visual cues:

The regular products carried a neutral brand name (e.g., 'clean right') whereas the greenwashed and honest green products carried a brand name indicating sustainability (e.g., 'clean green'). Fictitious brand names were chosen to avoid consumers inferring categories solely based on brand names and, thus, prevent bias due to personal experiences or expectations of known brands (Geuens & Pelsmacker, 2017; Lee et al., 2020; Loken et al., 2008). Furthermore, each product showed three different claims which referred to the actual product and not its packaging:[10] In line with our conceptualization, the greenwashed products contained a vague, a false, and an irrelevant claim. In contrast, the honest green products stated a specific, a true, and a relevant claim. The three claims on the regular products referred to its functionality rather than environmental benefits (see Tables B2-B4).

Turning to the visual cues, the honest green and greenwashed products shared the same green color and nature imagery to avoid any design-related preferences consumers

[10] The logic was to only manipulate core attributes (i.e., product ingredients) as opposed to peripheral attributes (i.e., packaging) to rule out any effects due to differences in attribute centrality (Gershoff & Frels, 2015; Skard et al., 2021; Steenis et al., 2022).

could have between these products. However, honest green products carried two official eco-labels (e.g., European eco-label and V-Label), while greenwashed products carried two fake labels to make them look like officially certified green products (see Tables B2-B4). The regular products displayed neither green color and nature imagery nor labels.

3.3.1.4. Measures

All items of the following measurement scales and their reliabilities can be found in Table B5. To minimize demand effects, the three main outcome variables were asked in the following order (Geuens & Pelsmacker, 2017): After viewing each product stimulus, we first queried purchase intention using the scale by Bian and Forsythe (2012) based on Dodds et al. (1991). Next, each stimulus was presented again in the same order as before. This time, we assessed perceived greenness with four items following Gershoff and Frels (2015). When each product was shown for the last time, we measured perceived greenwashing using five items from Chen and Chang (2013) and a sixth item by Schmuck et al. (2018) to also explicitly cover false claims. Participants responded to all items on 7-point rating scales and the order in which the items for each scale were shown was randomized. To screen out participants without product experience, they were asked if they had ever used or bought the respective product. Because the studies were carried out in Germany, all items were translated into German.

3.3.1.5. Manipulation check

After the three main outcome variables were queried, each experiment included a manipulation check for the greenwashed product cues. Following extant research (Schmuck et al., 2018), we first asked “Which symbol(s) stand(s) for a certified label for environmentally friendly products?”. The answer options contained the four labels which had already been shown on the respective greenwashed and honest green product. Thereby, we

could test whether the official and fake labels indeed were recognized as such. To control whether the false and vague claims on the greenwashed product were perceived as such, participants were asked to agree or disagree to the statements “This claim is vague” and “This claim is factually wrong” for each of the two presented claims. The irrelevant claims were not covered in the manipulation check because they provided information required by law, and thus, were based on objective facts.

3.3.2. Results

3.3.2.1. Manipulation check

Across the three experiments, the official labels were correctly identified by the majority of participants, while only few falsely selected the fake labels (see Table B6). Therefore, most participants recognized official labels as such and the fake labels were adequate to cue the greenwashed products. Turning to the claims, participants rated the false claim as “false” to a significantly higher degree than as “vague” (with one exception in Study 1b). Likewise, the vague claim was rated as “vague” to a significantly higher degree than as “false” (see Table B7). Please note that no participants were excluded based on a failed manipulation check because they may simply not have identified a claim or label as respective greenwashed cue (which was allowed as part of the study’s purpose).

3.3.2.2. Effects on purchase intention

Three repeated measures ANOVAs with a Huynh-Feldt correction and post hoc analyses with a Bonferroni adjustment were applied to compare the mean purchase intentions for each product (see Figure 3 and Table B8).

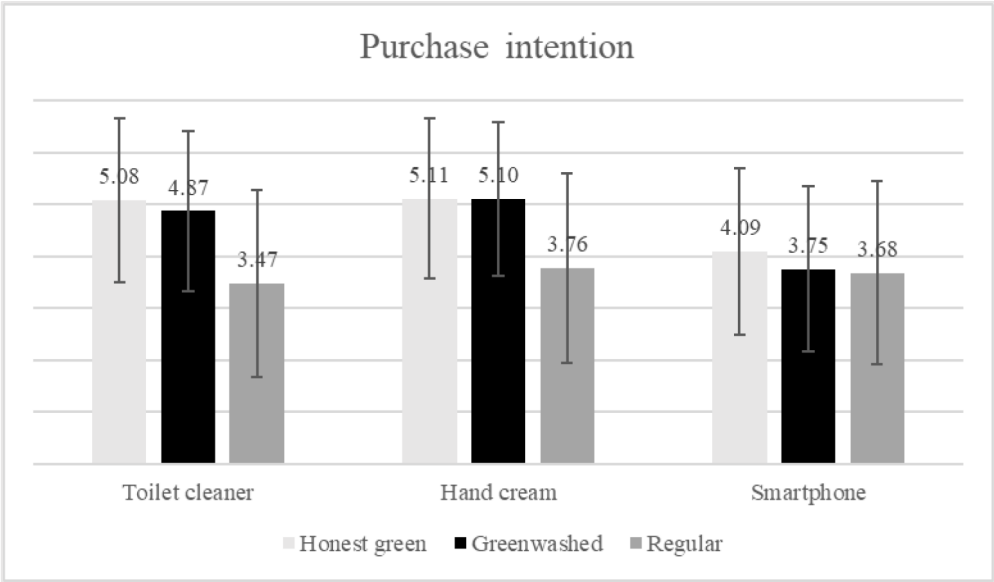

Figure 3. Purchase intention for the three stimuli per product (Studies 1a-c). Error bars represent the standard deviation of means.

S*tudy 1a: Toilet cleaner.* Mean purchase intention differed significantly between the three toilet cleaners ($F(1.609, 244.626) = 84.243$, $p < .001$, partial $\eta^2 = .357$). Post hoc analysis revealed that purchase intention differed only marginally significantly between the honest green ($M = 5.08$) and the greenwashed product ($M = 4.87$, $p = .078$). Notably, purchase intention for the regular product ($M = 3.47$) was significantly *lower* than for the greenwashed ($M = 4.87$, $p < .001$). Thus, H1 was not supported for toilet cleaners.

Study 1b: Hand cream. Mean purchase intention varied significantly between the three hand creams ($F(1.717, 267.810) = 56.295$, $p < .001$, partial $\eta^2 = .265$). Post hoc analysis showed that purchase intention did not significantly differ between the honest green ($M = 5.11$) and the greenwashed product ($M = 5.10$, $p = 1.000$). Again, purchase intention for the regular product ($M = 3.76$) was significantly *lower* than for the greenwashed ($M = 5.10$, $p < .001$). Therefore, H1 was not supported for hand creams.

Study 1c: Smartphone. Mean purchase intention differed significantly between the three smartphones ($F(1.892, 304.535) = 5.752$, $p = .004$, partial $\eta^2 = .034$). Post hoc analysis revealed that purchase intention was significantly higher for the honest green ($M = 4.09$) than

for the greenwashed product (M = 3.75, p = .008). However, there was no significant difference between purchase intention for the regular (M = 3.68) and the greenwashed product (M = 3.75, p = 1.000). Thus, H1 was only partially supported for smartphones.

3.3.2.3. Effects on perceived greenness

Three repeated measures ANOVAs with a Huynh-Feldt correction and post hoc analyses with a Bonferroni adjustment were applied to compare the mean perceived greenness of each product (see Figure 4 and Table B9).

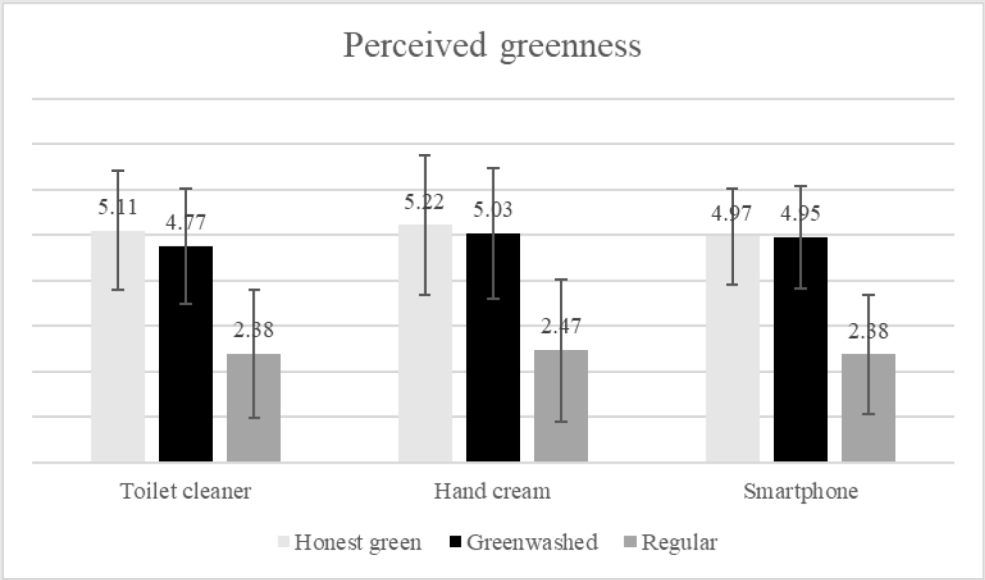

Figure 4. Perceived greenness of the three stimuli (Studies 1a-c). Error bars represent the standard deviation of means.

Study 1a: Toilet cleaner. Mean perceived greenness differed significantly between the three toilet cleaners (F(1.780, 270.554) = 265.199, p < .001, partial η^2 = .636). Post hoc analysis revealed that perceived greenness was significantly higher for the honest green product (M = 5.11) than for the greenwashed (M = 4.77, p = .005) and regular product (M = 2.38, p < .001), supporting H2.

Study 1b: Hand cream. Mean perceived greenness varied significantly between the three hand creams (F(1.850, 288.559) = 251.032, p < .001, partial η^2 = .617). Post hoc analysis

revealed that perceived greenness was significantly higher for the honest green (M = 5.22) than for the regular product (M = 2.47, p < .001). However, there was no significant difference between perceived greenness for the honest green (M = 5.22) and the greenwashed product (M = 5.03, p = .284). Thus, H2 was only partially supported for hand creams.

Study 1c: Smartphone. Mean perceived greenness differed significantly between the three smartphones (F(1.704, 274.376) = 234.124, p < .001, partial η^2 = .593). Post hoc analysis revealed that perceived greenness was significantly higher for the honest green (M = 4.97) than for the regular product (M = 2.38, p < .001). Again, there was no significant difference between perceived greenness for the honest green (M = 4.97) and the greenwashed product (M = 4.95, p = 1.000). Thus, H2 was only partially supported for smartphones.

3.3.2.4. Effects on perceived greenwashing

Two repeated measures ANOVAs which needed no correction for sphericity (toilet cleaner, hand cream) and one with a Huynh-Feldt correction (smartphone) followed by post hoc analyses with a Bonferroni adjustment were applied to compare the mean perceived greenwashing of each product (see Figure 5 and Table B10).

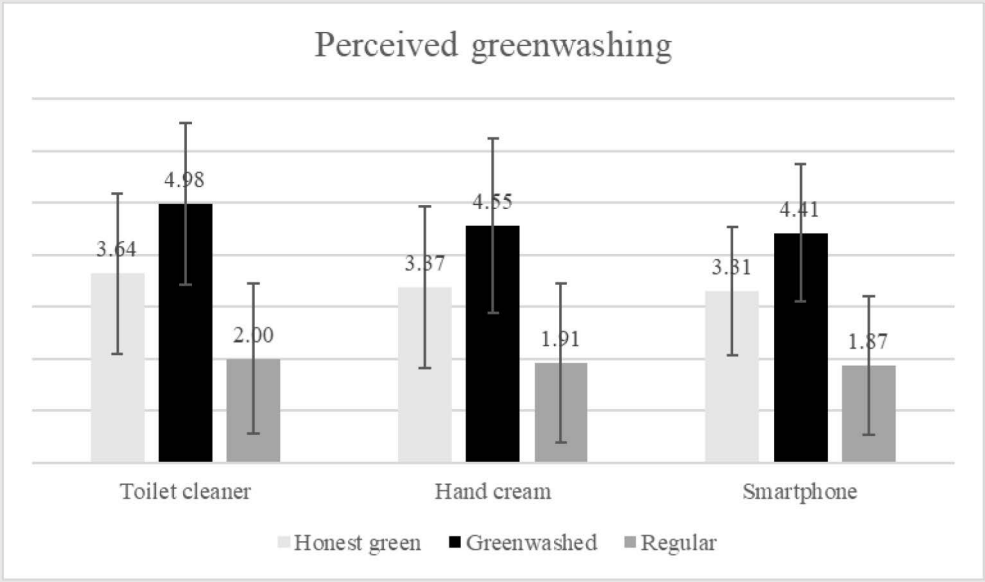

Figure 5. Perceived greenwashing of the three stimuli (Studies 1a-c). Error bars represent the standard deviation of means.

Study 1a: Toilet cleaner. Mean perceived greenwashing differed significantly between the three toilet cleaners ($F(2, 304) = 176.302$, $p < .001$, partial $\eta^2 = .537$). Post hoc analysis revealed that perceived greenwashing was significantly higher for the greenwashed product ($M = 4.98$) than for the honest green ($M = 3.64$, $p < .001$) and regular product ($M = 2.00$, $p < .001$), finding support for H3.

Study 1b: Hand cream. Mean perceived greenwashing differed significantly between the three hand creams ($F(2, 312) = 137.862$, $p < .001$, partial $\eta^2 = .469$). Again, post hoc analysis revealed that perceived greenwashing was significantly higher for the greenwashed product ($M = 4.55$) than for the honest green ($M = 3.37$, $p < .001$) and regular product ($M = 1.91$, $p < .001$), supporting H3.

Study 1c: Smartphone. Mean perceived greenwashing differed significantly between the three smartphones ($F(1.903, 306.428) = 145.572$, $p < .001$, partial $\eta^2 = .475$). Once more, post hoc analysis revealed that perceived greenwashing was significantly higher for the greenwashed product ($M = 4.41$) than for the honest green ($M = 3.31$, $p < .001$) and regular product ($M = 1.87$, $p < .001$, in support of H3.

3.3.3. Discussion of Studies 1a-c

Across three different products, Studies 1a-c empirically tested whether consumers are actually able to distinguish between honest green, greenwashed, and regular products (Simula & Lehtimäki, 2009; Szabo & Webster, 2021). Notably, when participants were first asked to report their *purchase intentions*, they seemed to fall for greenwashing: For toilet cleaners, purchase intentions were only marginally significantly different between the honest green and greenwashed products while for hand cream, no significant differences were found. Only the honest green smartphone was significantly preferred over the greenwashed one, as expected by H1. Moreover, the greenwashed product was actually preferred over the regular one in the case of toilet cleaners and hand creams, while there was no significant difference in the case

of smartphones. Therefore, we can summarize that H1 is not supported for the low-involvement products, and only partially supported for the high-involvement product. The finding that participants seem to be more susceptible to greenwashing in low- compared to high involvement products is reasonable because consumers tend to invest less time in evaluating low-involvement products, and thus, pay less attention to their product cues (Atkinson & Rosenthal, 2014; Zaichkowsky, 1985). Overall, this evidence against the common assumption that consumers are able to identify greenwashing is particularly astonishing in light of a rather conservative manipulation of the product categories, which aimed to be very obvious by combining multiple verbal and visual green(washing) cues to make correct categorization as unambiguous as possible.

Turning to the effects on *perceived greenness*, we find that perceived greenness is higher for an honest green toilet cleaner than for a regular and greenwashed one, in support of H2. However, for hand creams and smartphones there was no significant difference between the honest green and greenwashed products, providing only partial support for H2. This implies that (even) when consumers are asked to evaluate a product regarding its greenness, they may mistake the greenwashed for an honest green product. It appears that products in which consumers value environmental friendliness are prone to this mistake: Hand creams offer gentleness-related product attributes, which consumers tend to associate with environmental friendliness, resulting in a sustainability asset effect (Luchs et al., 2010; Skard et al., 2021). For smartphones, research anchored in impression management concerns shows that environmental friendliness may also be desirable in high-involvement products (Griskevicius et al., 2010), leading to a similar asset effect.

Finally, across all three products *perceived greenwashing* was significantly higher for a greenwashed than for an honest green and regular product, confirming H3. This provides some support for the implicit assumption that consumers can identify greenwashing at this

point, regardless of the specific product. Such an enhanced differentiation process depending on what participants were asked to evaluate was also evident in an increasing absolute difference score of mean purchase intentions, perceived greenness, and perceived greenwashing of the honest green and greenwashed products (see Figure 6). Notably, early research shows a similar pattern, where consumers could differentiate a deceptive from a neutral ad when asked for their perceived deception of either, but this differentiation was not evident when asked for their respective purchase intentions (Newell et al., 1998). Likewise, recent research also finds that consumers could detect greenwashed products when they were asked for their perceived deception but not when they were asked for their perceived sustainability (Steenis et al., 2022).

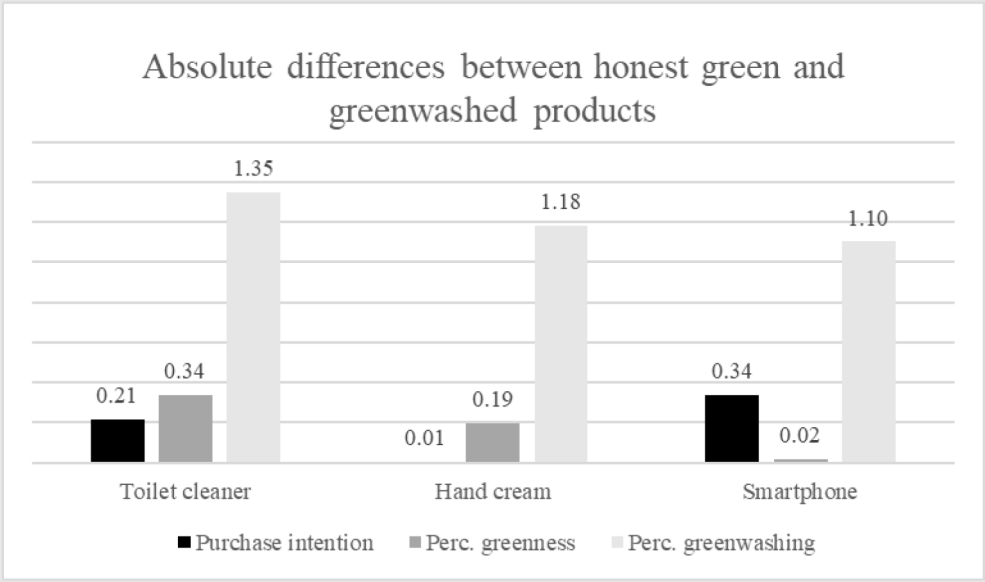

Figure 6. Absolute differences between honest green and greenwashed products dependent on questions asked (Studies 1a-c).

Overall, the results indicate that the ability to identify greenwashing requires category activation beyond the product type and the presented green(washed) product cues, as most participants did *not* seem to distinguish between the honest green and greenwashed products when being asked solely for purchase intentions. This suggests that consumers may initially only access two basic category representations which first come to their minds: a green and a

regular product category. It appears that only when participants' attention was directed more toward the green(washed) cues by asking them about their perceived greenness and, subsequently, perceived greenwashing, then they started to retrieve a third category, namely, that of greenwashed products. This idea, that consumers can be supported in detecting greenwashing by activating a greenwashed category through the objective with which a product is to be evaluated, was tested next.

3.4. Study 2

The aim of Study 2 was to replicate the prior results using a representative sample and to examine the underlying cognitive mechanism to explain when consumers detect greenwashing. Therefore, Study 2 was based on Study 1a with product as within-subject factor, but included the objective with which the products should be evaluated (i.e., type of questions asked) as between-subject factor. Thus, participants were randomly assigned to either respond to questions on purchase intention, perceived greenness, or perceived greenwashing after viewing each of three product stimuli. This mixed design had the advantage of eliminating potential confounding effects between the three closed question scales which now constitute three different between-conditions. Furthermore, it reduced the overall number of questions which enabled us to add a thought listing task (Cacioppo & Petty, 1981) and a categorization task to query participants' thoughts and explicit categorization of the product stimuli, respectively. The latter provides a direct measure of participants' ability to identify greenwashing in addition to the indirect measures based on their product perceptions and purchase intentions.

3.4.1. Methods

3.4.1.1. Participants

A representative German sample was recruited from a panel provider in February 2023. To have sufficient power (≥.95) to detect a small effect size ($f = 0.15$) at an alpha of .05, a minimum sample size of 141 was calculated using G*Power. Some more participants were recruited to compensate for potentially insufficient response quality in the thought listing task, which was particularly relevant for H4 and H5. We first removed speeders (i.e., participants faster than 300 seconds)[11] and then controlled the response quality of the remaining participants. Those who failed to respond to all three thought listing tasks in a meaningful manner (i.e., single letters, punctuation marks, "none", etc.) were also excluded. This resulted in 228 usable responses of participants who were representative of the German population in age (M_{age} = 47 years) and gender (female: 50%). There was structural equality regarding age and gender between the three conditions (N_{PI} = 71, N_{PG} = 78, N_{GW} = 79) and all participants reported that they have previously used or bought a toilet cleaner.

3.4.1.2. Product stimuli and measures

Study 2 used the same product stimuli (toilet cleaners) and measures as Study 1a (see Tables B2, B5). Following prior research (Granato et al., 2022; Schuhwerk & Lefkoff-Hagius, 1995), a thought listing task was added right after each closed question scale that related to one of three product stimuli: "Please write down any thoughts, reactions, or ideas that influenced your answers to the previous questions. Please describe them as completely and in as much detail as possible (as if you were thinking out loud)." Participants could respond using up to 15 text entry fields and take as much time as they needed. To identify the frequencies of participants' thoughts related to greenwashing, visual, and verbal cues, two

[11] The cut-off at 300 seconds was determined based on the first 10 responses that passed a quality check regarding the content of the open answers.

graduate students blind to the experimental conditions and hypotheses served as independent observers (Cacioppo & Petty, 1981). Using a predefined code book, open responses were coded with regard to the occurrence of greenwashing thoughts, visual, and verbal cues, respectively (0 = no, 1 = yes, see Table B11). The author checked the coding and solved differences between coders.

After the last thought listing task, participants were asked to categorize each of the prior product stimuli as either regular, green, or greenwashed product. The task was set-up so that each participant would view one product picture at a time (randomized in order) and could categorize it by clicking on one of three buttons stating the three abovementioned product categories. A hidden timing function of the survey measured how long it took participants to categorize each product. The survey proceeded with the same manipulation check questions as in Study 1a.

3.4.2. Results

3.4.2.1. Replication of Study 1a

The manipulation checks for claims and labels showed the same pattern as in Studies 1a-c (see Tables B6, B7). Three repeated measures ANOVAs with a Huynh-Feldt correction and post hoc analysis with a Bonferroni adjustment replicate the prior results with a representative sample (see Tables B8-B10).

Purchase intention. Mean purchase intention differed significantly between the three toilet cleaners ($F(1.843, 128.988) = 5.268$, $p = .008$, partial $\eta^2 = .070$). Compared to the marginal significance found in Study 1a, post hoc analysis revealed no significant differences between the honest green ($M = 4.51$) and greenwashed product ($M = 4.25$, $p = .535$). While Study 1a found a significant preference for the greenwashed over the regular product, Study 2 showed

no significant difference between the regular (M = 3.77) and greenwashed product (M = 4.25, p = .208). Overall, H1 was again not supported for toilet cleaners.

Perceived greenness. Mean perceived greenness varied significantly between the three toilet cleaners (F(1.715, 132.066) = 75.413, p < .001, partial η^2 = .495). Post hoc analysis showed that perceived greenness was significantly higher for the honest green product (M = 5.15) than for the greenwashed (M = 4.68, p = .005) and regular product (M = 2.92, p < .001), again supporting H2.

Perceived greenwashing. Mean perceived greenwashing differed significantly between the three toilet cleaners (F(1.889, 147.354) = 48.338, p < .001, partial η^2 = .383). Post hoc analysis revealed that perceived greenwashing was significantly higher for the greenwashed product (M = 4.66) than for the honest green (M = 3.52, p < .001) and regular product (M = 2.38, p < .001), replicating support for H3.

3.4.2.2. Thought listing task

The thought listing task resulted in 1,503 text entries in total and, on average, in six to seven entries per participant. Three chi-square tests of independence were conducted between condition (purchase intention, perceived greenness, perceived greenwashing) and greenwashing thoughts, visual, and verbal cues occurring in the thought listing task (0 = no, 1 = yes), respectively (see Figure 7).

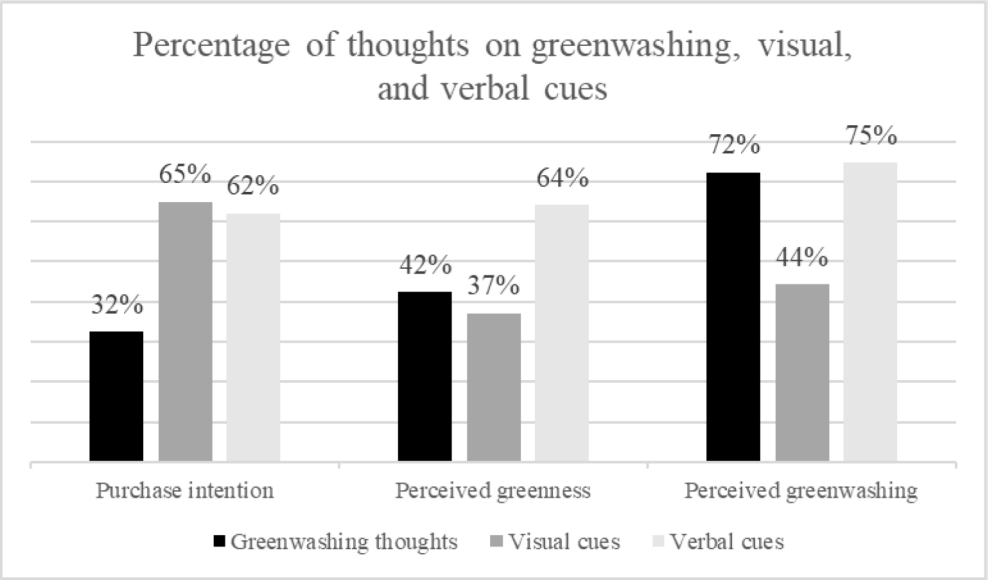

Figure 7. Percentage of thoughts on greenwashing, visual, and verbal cues across conditions (Study 2).

Greenwashing thoughts. There was a statistically significant association between condition and greenwashing thoughts, $\chi^2(2) = 26.14$, $p < .001$, Cramer's V = .339. The number of participants with greenwashing thoughts was about equal in the purchase intention and perceived greenness conditions, but up to twice as large in the greenwashing condition (see Table B12). This provides partial support for H4 because participants in the purchase intention condition indeed had fewer greenwashing thoughts than in the greenwashing condition, but a comparable number of greenwashing thoughts as in the greenness condition.

Visual and verbal cues. There was a statistically significant association between condition and visual cues, $\chi^2(2) = 12.10$, $p = .002$, Cramer's V = .230. Results show that participants mentioned shared visual cues more often when asked for purchase intention than when asked for perceived greenness or greenwashing, in support of H5a (see Table B13). In contrast, there was no statistically significant association between condition and verbal cues, $\chi^2(2) = 3.22$, $p = .200$, Cramer's V = .119. Thus, H5b stating that participants will mention distinct verbal cues less often when asked for purchase intention than when asked for perceived greenness or greenwashing was not supported (see Table B14).

3.4.2.3. Explicit categorization task

Response time. In categorizing the greenwashed product, a Kruskal-Wallis H test showed a statistically significant difference for median response time between conditions, $\chi^2(2) = 7.167$, $p = .028$. Based on adjusted p-values, post hoc analysis with a Bonferroni correction revealed a statistically significant difference in median response time between purchase intention (8.21) and perceived greenness (6.67, $p = .048$) and a marginally significant difference between purchase intention (8.21) and perceived greenwashing (6.36, $p = .072$). Therefore, H6a stating that participants will need more time to categorize the greenwashed product when asked for purchase intention than when asked for perceived greenness or greenwashing was partially supported (see Table B15).

Categorization. The greenwashed and honest green products were correctly categorized by 138 participants (60.5%), respectively, while the regular product was correctly categorized by 186 participants (81.6%). A chi-square test of independence between condition and the correct categorization of the greenwashed product (0 = incorrect, 1 = correct) finds no statistically significant association, $\chi^2(2) = 1.55$, $p = .461$, Cramer's V = .082. Thus, H6b stating that participants will more often wrongly categorize the greenwashed product when asked for purchase intention than when asked for perceived greenness or greenwashing was not supported see Table B16).

3.4.3. Discussion of Study 2

Study 2 replicates the overall results of Study 1a with a representative sample and sheds light on the cognitive process that influences when consumers can identify greenwashing. Three out of five different outcome variables support the idea that consumers' inability to identify greenwashing when solely asked for purchase intention may lie in their use of only two category representations (green and regular) and not accessing a third greenwashed category.

First, participants reported fewer greenwashing thoughts in the purchase intention condition compared to the greenwashing condition (but not the greenness condition). Second, participants mentioned visual cues more often in the purchase intention condition, while no significant difference between conditions was found for verbal cues. This aligns with extant research demonstrating the power of visual green(washing) cues (Parguel et al., 2015), for example, when positive nature evoking images could override any rational greenwashing perceptions based on claims through an affective persuasion mechanism (Schmuck et al., 2018), thus misleading consumers. Notably, the reliance on visual over verbal cues in the purchase intention condition occurred in an experimental context with rather limited cognitive load and will most likely be exacerbated in real shopping contexts in which consumers are confronted with a higher product variety and temporal pressure (Granato et al., 2022; Magnier & Schoormans, 2015). Third, participants indeed needed more time to categorize the greenwashed product in the purchase intention condition. This further supports the idea that participants may not have thought of greenwashing before and, thus, needed more time to access this additional category representation (Loken et al., 2008). Interestingly, there was no significant difference in participants' correct categorization of the greenwashed product across conditions. This may be explained by the longer response time in the purchase intention condition, which may have helped participants to arrive at a correct categorization about equally often as in the other conditions once the third greenwashed category was accessed.

3.5. General discussion

The aim of this research was to empirically test whether and when consumers are able to identify greenwashing in different products. Three studies using convenience samples and one using a representative sample show that this ability largely depends on what consumers

pay attention to during product evaluation. An overview of all tested hypotheses and the respective results across all studies is provided in Table 5.

Table 5. Summary of hypotheses-testing.

Hypotheses	Study 1a	Study 1b	Study 1c	Study 2
H1. Consumers' purchase intention is higher for an honest green and a regular product than for a greenwashed product.	Not supported	Not supported	Partially supported	Not supported
H2. Consumers' perceived greenness is higher for an honest green product than for a greenwashed and a regular product.	Supported	Partially supported	Partially supported	Supported
H3. Consumers' perceived greenwashing is higher for a greenwashed product than for an honest green and a regular product.	Supported	Supported	Supported	Supported
H4. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will report fewer greenwashing thoughts.	n.a.	n.a.	n.a.	Partially supported
H5. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will mention (a) shared visual cues more often and (b) distinct verbal cues less often.	n.a.	n.a.	n.a.	H5a supported, H5b not supported
H6. When consumers evaluate purchase intentions (vs. perceived greenness and greenwashing), they will (a) need more time to categorize the greenwashed product and (b) more often wrongly categorize it.	n.a.	n.a.	n.a.	H6a partially supported, H6b not supported

When participants were asked for their *purchase intentions*, they about equally preferred the honest green and greenwashed low-involvement products and even preferred the greenwashed over the regular low-involvement products. This provides evidence that participants have not recognized the greenwashed product as such when evaluating their purchase intentions. Three out of five outcome variables in Study 2 support the idea that this phenomenon appears when consumers only draw on two categories (green and regular) instead of three (green, regular, and greenwashed): When asked for their purchase intentions, consumers seem to barely think of greenwashing as measured by their reported greenwashing

thoughts. Instead, they seem to be trapped by overly considering the shared green look-and-feel of the green products which is driven by a focus on visual as opposed to verbal green(washing) cues. In addition, participants needed longer to categorize the greenwashed product which further indicates that a third greenwashed product category still needed to be accessed.

When participants were asked for their *perceived greenness*, this seemed to help them identify greenwashing in the strength-related low-involvement product (toilet cleaner), but not in the products for which environmental friendliness seems to be desirable (hand cream, smartphone). For the latter two, participants mistakenly perceived the greenwashed products to be similarly green as their honest green counterparts. Thus, simply moving consumers' focus to consider a product's greenness is not yet sufficient to successfully detect greenwashing. Only when participants were asked for their *perceived greenwashing*, there seemed to be no doubts about the greenwashed product: Across all studies, the greenwashed product was identified as such. This is backed by Study 2 which shows by far the largest number of greenwashing thoughts in the greenwashing condition compared to the other two conditions.

Embedding these findings into categorization theory, categories indeed may be activated through priming, which increases the likelihood of their later use (Herr, 1989; Loken et al., 2008; Macrae et al., 1995). In the context of green products, extant research suggests that environmental schemas can already be activated by viewing an isolated environmental product cue, such as eco-labels or green color, triggering environment-related thoughts (Pancer et al., 2017). The present research supports the idea that such an *implicit* category activation based on green(washed) product cues may be sufficient for consumers to dichotomously categorize a product as either green or regular on a very basic level of categorization (Rosch, 1978). However, the present findings further imply that even multiple

green(washed) product cues may be insufficient in protecting consumers from being deceived. The results suggests that only upon *explicit* category activation by asking consumers to evaluate products with regard to perceptions of greenness and greenwashing, they then focus their attention on the cues distinguishing the honest green and greenwashed product. In the words of Eleanor Rosch (1978, p. 9-10): "…in fact, objects may be first seen or recognized as members of their basic category, and (that) only with the aid of additional processing can they be identified as members of their superordinate or subordinate category." In our case, participants may have progressed from accessing the two basic categories of regular and green products to additionally consider a greenwashed category, which can be considered as subordinated to the green category. Notably, simply asking for consumers' perceived greenness was not always sufficient to meaningfully distinguish between the two green-looking products just yet. Following the logic proposed by Pancer et al. (2017), responding to questions on perceived greenness (environmental category prime) activated an environmental friendly schema that could have led consumers to search for green cues in support of a categorization as honest green product, potentially exacerbating the distinction in only the two basic categories. It is conceivable that only when participants answered questions on perceived greenwashing (greenwashing category prime), this activated a greenwashing schema which made them pay attention to the distinct greenwashing cues and enabled them to identify the greenwashed product as such.

3.5.1. Implications for theory and research

This research contributes to the literature on consumers' perceptions of products with green(washed) cues in several ways. First, we questioned the assumption implicit in the greenwashing and green advertising literature that consumers can identify greenwashing. Across four experimental studies, we provide empirical evidence that consumers actually cannot always do so. Second, while prior research has found similar evidence (Fernandes et

al., 2020; Schmuck et al., 2018), some studies tend to lack a holistic approach to manipulate greenwashing and compared only specific verbal (e.g., Iovino et al., 2023; Newell et al., 1998) or visual cues (e.g., Ende et al., 2023; Parguel et al., 2015), respectively. By combining multiple different visual and verbal cues reflected in executional and claim greenwashing, and by operationalizing the specific cues differently across three products varying in involvement and strength/gentleness, the present research offers comparably more generalizability of the phenomenon. Third, this research is among the little that measured consumers' perceived greenness in addition to perceived greenwashing (Steenis et al., 2022), which enabled a more detailed understanding of when consumers do detect greenwashing.

Finally, while extant research has drawn on attribution theory (Iovino et al., 2023), persuasion knowledge (Fernandes et al., 2020), the affect–reason–involvement model (Schmuck et al., 2018), and the elaboration likelihood model (Parguel et al., 2015), this research applied categorization theory to offer a different theoretical account to explain greenwashing perceptions (Ende et al., 2023). Specifically, we provide initial evidence for the idea that consumers' ability to identify greenwashing may be inhibited if they merely think of two basic category representations (green and regular) when evaluating products. This cognitive process can be altered by drawing consumers' attention from purchase intentions to consider how green(washed) they perceive a product. Therefore, drawing on categorization theory to explain when consumers are able to identify greenwashing contributes to a better understanding of consumers' perceptions and responses to green(washed) products.

3.5.2. Implications for practice

By empirically testing whether consumers are actually able to identify greenwashing or not, this research challenges the validity of various practical recommendations derived from an implicit assumption that consumers can do so (Newell et al., 1998; Pancer et al., 2017). The present finding that consumers do *not* necessarily identify greenwashing if they are not

primed to do so implies two possible consequences from a corporate view: First, companies pretending to be green may benefit when consumers mistake a greenwashed product as honest green. Second, when consumers think of an honest green product to be greenwashed, they may unintentionally penalize genuine companies that try to improve their sustainability performance. Since both errors are neither in the interest of genuine companies nor of public policy makers as they can undermine markets for honest green products, both stakeholder groups have an interest in enabling consumers to identify greenwashing.

For genuine companies, it is advisable to use specific, true, and relevant green claims combined with official eco-labels to make categorization of their products into the honest green category as easy and unambiguous as possible. This approach receives support from public policy that only recently proposed the Green Claims Directive, which intends to penalize the use of unsubstantiated voluntary environmental claims and labels in the European Union (European Commission, 2023). If the directive is to be implemented successfully, greenwashed products ideally would be crowded out in the long run. In the meantime, while green products still come in honest green and greenwashed forms, extant research has emphasized the importance of educating consumers to develop a thorough understanding about what makes green cues valid or misleading (Fernandes et al., 2020; Newell et al., 1998). While this is an important endeavor to combat greenwashing, an interim route may be more time-efficient and easy to apply compared to large-scale regulatory and educational measures: The present findings highlight the important role of category activation in directing consumers' attention to the possibility of greenwashing. By asking consumers to evaluate products with regard to their perceived greenwashing, the greenwashed product category could be activated through priming, which was sufficient for consumers to detect greenwashing. How exactly the greenwashed category can be meaningfully activated in purchase contexts still needs to be explored, ideally in conjunction with practitioners.

Overall, developing alternative measures to nudge consumers to critically reflect on green(washed) cues can provide a promising avenue to counter the undesired effects of greenwashing.

3.5.3. Limitations and future research

Several limitations that future research could address should be noted. First, although participants were able to distinguish the two green-looking products when asked for perceived greenwashing, the honest green product was also perceived to be greenwashed to a certain extent. This indicates that reminding consumers of the possibility of greenwashing can backfire and future research could help delineate what is needed to prevent this rebound effect.

Second, future research could also account for the fact that what is perceived as green(washing) may be very subjective (Lyon & Montgomery, 2015), meaning that the categories for honest green and greenwashed products may be represented differently among individuals. It is conceivable that not all consumers may follow the prototype view of category representation adopted in this research, where categories were composed of abstract prototypical cues. Instead, consumers may use specific stored product examples of a category, depicting the exemplar view of category representation (Loken et al., 2008). Thus, while this research defined prototypical green(washed) cues upfront based on prior studies, future research could use qualitative methods to learn more about the categories and cues with which green(washed) products are represented in individual's minds.

Third, the findings of this research are limited to environmental cues which were studied in a German context. Hence, future research could extend this design to include social cues (which currently are also not regulated in the Green Claims Directive) as well as to different cultural contexts to test whether the extant findings hold. Finally, if a useful way to

involve a real greenwashed product was found, it would also be desirable to replicate the results in an even more realistic setting where consumers' responses also entail behavioral consequences (such as an actual purchase).

3.6. Conclusion

Responding to different calls to better understand consumers' perceptions of (misleading) green advertising (Kwon et al., 2023; Newell et al., 1998; Pancer et al., 2017; Schmuck et al., 2018; Szabo & Webster, 2021), this paper set out to determine whether consumers are actually able to identify greenwashing. To this aim, four experiments examined consumer perceptions of honest green, greenwashed, and regular products. We find that consumers can successfully draw on their ability to distinguish the three product categories, however, they identified greenwashing only after they were primed to look for it. When not suspecting any potential for greenwashing, consumers do fall for it. Given that consumers can unmask greenwashed products once they pay attention to potential greenwashing, companies and public policymakers are advised to think of simple actions that can help direct consumers' attention. From an academic point of view, more research on when and how consumers can identify greenwashing would be helpful to further support practitioners in combating its negative effects on green markets.

4. Paper 3: Blending access-based services and triadic frameworks: An empirical evaluation of Packaging-as-a-Service[12]

Co-authored with Christoph Ratay.

Structured abstract

Purpose – Recently emerged Packaging-as-a-Service (PaaS) systems adopt aspects of access-based services and triadic frameworks, which have typically been treated as conceptually separate. To investigate implications of blending the two in what we call "access-based triadic systems", this paper empirically evaluates intentions to adopt PaaS systems for takeaway food among restaurants and consumers.

Design/methodology/approach – We derived relevant attributes of PaaS systems from a qualitative pre-study with restaurants and consumers. Next, we conducted two factorial survey experiments with restaurants ($N = 176$) and consumers ($N = 245$) in Germany to quantitatively test the effects of those system attributes on their adoption intentions.

Findings – This paper highlights that the role of access-based triadic system providers as both the owners of shared assets and the operators of a triadic system is associated with a novel set of challenges and opportunities: System providers need to attract a critical mass of business and end customers while balancing asset protection and system complexity. At the same time, asset ownership introduces opportunities for improved quality control and differentiation from competition.

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Earlier version (extended abstract) accepted at double-blind peer-reviewed 12th European Conference of the Association of Consumer Research. Presented in July 2023 by Stefanie Fella in Amsterdam, The Netherlands.
Earlier version (full paper) accepted at double-blind peer-reviewed 23rd conference of the European Academy of Management.

Originality – Conceptually, this paper extends research on access-based services and triadic frameworks by describing an unexplored hybrid form of non-ownership consumption we call "access-based triadic systems". Empirically, this paper addresses the need to account for the demands of two distinct target groups in triadic systems and demonstrates how factorial survey experiments can be leveraged in this field.

Keywords Packaging-as-a-Service, Access-based services, Triadic frameworks, Reuse, Factorial survey

Paper type Research paper

4.1. Introduction

Initially driven by faster and more convenience-seeking lifestyles (Jiang et al., 2020), the COVID-19 pandemic exacerbated the consumption of single-use packaging for takeaway and delivered food (Kochańska et al., 2021). This poses environmental challenges both in terms of resource use and waste generation (Kleinhueckelkotten et al., 2021). In response, regulators increasingly restrict the use of conventional single-use food packaging and promote reusable alternatives. For example, as of January 2023 most restaurants in Germany have to offer a reusable packaging alternative for takeaway food and drinks (BMU, 2021) and since July 2023, restaurants in the Netherlands have to charge takeaway customers a fee for most single-use plastic packaging and are obliged to offer a reusable alternative (Netherlands Enterprise Agency, 2023).

Life-cycle assessments indicate that reusable food containers deliver environmental benefits compared to single-use packaging as long as containers are reused sufficiently often (Gallego-Schmid et al., 2019; Greenwood et al., 2021). Furthermore, extant research suggests that collectively using shared containers that are professionally cleaned is less energy and water-intensive compared to refilling consumers' own containers that are washed at home (Greenwood et al., 2021). At the same time, sharing containers between restaurants increases usage intensity and reduces the total number of containers required across the system. Thus, environmental break-even points are likely to be reached more quickly in systems that facilitate the collective use of containers by many restaurants and consumers as opposed to using containers owned by individual restaurants or consumers.

Packaging-as-a-Service (PaaS) providers tackle this issue by supplying whole networks of partnering restaurants (including cafés, diners, delis, etc.) with reusable food containers. These restaurants then serve takeaway food to their customers in reusable containers instead of single-use packaging. After finishing their meals, consumers can return

reusable containers to participating restaurants or return stations operated by the PaaS provider. This provides benefits of non-ownership consumption to both restaurants and consumers. By using PaaS systems, restaurants address environmental issues and regulatory demands without having to invest in their own reusable containers or operate a return scheme. At the same time, consumers enjoy the flexibility of not having to own reusable containers suitable for different types of food and not having to bring their own containers to restaurants.

Conceptually, these PaaS systems apply aspects of access-based services (Hazée et al., 2017; Schaefers et al., 2016) because reusable containers are owned by the PaaS provider that offers flexible short-term access to restaurants and consumers without ownership transfer. At the same time, PaaS shares characteristics with triadic frameworks (Andreassen et al., 2018; Benoit et al., 2017) because three actors are involved. While access-based services and triadic frameworks have oftentimes been treated separately in the service literature (e.g., Benoit et al., 2017; Hazée et al., 2017; Hazée et al., 2020), this research investigates the case of PaaS to explore the implications of blending the two in what we call "access-based triadic systems". On a theoretical level, we thereby complement the literature on the adoption of access-based services and triadic frameworks. To this end, we examine PaaS for reusable food containers and are guided by the following case-specific research question: Which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers?

In doing so, this paper responds to calls for research on success factors of platform providers facing two-sided markets (Benoit et al., 2017) in specific contexts (Hazée et al., 2020) and to examine novel systems with platform-provided assets (Wirtz et al., 2019). At the same time, this paper acknowledges that providers of triadic systems need to develop two distinct value propositions to convince service suppliers and consumers to adopt their systems

(Andreassen et al., 2018). As suggested by research on two-sided markets, platform providers have to optimize their services to "get both sides of the market on board" in order to succeed (Rochet & Tirole, 2003, p. 990). Thus, we conduct factorial survey experiments with both target groups, namely, restaurants and consumers. This way, we provide novel quantitative insights using a method that enables a systematic comparison of different market actors' adoption intentions. Importantly, we complement the more commonly studied consumer acceptance by adding the supplier perspective to account for both sides of the market (Andreassen et al., 2018; Hazée et al., 2020). This need to go beyond the consumer perspective is also evident in the literature on reusable food and beverage containers: With few exceptions (Jiang et al., 2020; Lofthouse et al., 2009), research has focused on consumer behavior (Dorn & Stöckli, 2018; Ertz et al., 2017; Greenwood et al., 2021; A. Keller et al., 2021; Loschelder et al., 2019; Novoradovskaya et al., 2021) and does not examine the important role of restaurants that facilitate the use of the system's reusable containers. By consistently measuring influences on restaurants' and consumers' intentions to use PaaS for takeaway food, our insights support PaaS practitioners to scale and establish more effective reusable packaging services that can reduce resource use and waste generation.

This paper proceeds as follows. The next section describes the case of PaaS for reusable food containers. Afterwards, its key commonalities and differences with typical access-based services and triadic frameworks are highlighted and a new conceptual hybrid we call "access-based triadic systems" is introduced. The overall empirical approach is described next. Subsequently, our qualitative pre-study is presented, outlining relevant PaaS system attributes for restaurants and consumers. Next, our quantitative main study tests the effects of these attributes on adoption intentions among restaurants and consumers with two factorial survey experiments. Afterwards, we use results on PaaS for takeaway food to discuss the implications of blending access-based services and triadic frameworks in access-based triadic

systems with regard to theory and practice. Finally, we outline limitations and future research avenues.

4.2. The case of Packaging-as-a-Service for reusable food containers

Currently, two types of PaaS systems for takeaway food are most prevalent on the market: Deposit systems and app-based, digital systems. Both system types involve three actor groups: A PaaS provider, restaurants, and consumers (see Figure 8). As represented by the physical asset flow in Figure 8 (bold arrows), PaaS providers supply reusable containers to a network of participating restaurants. When consumers order takeaway food from participating restaurants by calling or visiting the restaurant directly or through a delivery service, restaurants serve takeaway meals in the PaaS provider's reusable containers. After finishing their meals, consumers return reusable containers to participating restaurants or to return stations operated by the PaaS provider. To ensure that containers are readily available at participating restaurants, PaaS providers also redistribute containers from overstocked to understocked restaurants or from return stations to restaurants.

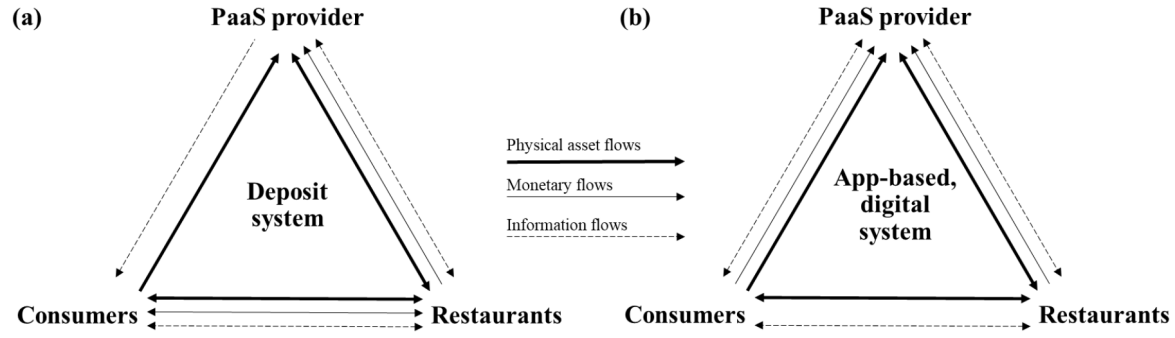

Figure 8. PaaS systems for reusable food containers. Own figure depicting the interactions between PaaS providers, restaurants, and consumers in deposit and app-based, digital systems.

Turning to the monetary flow (solid arrows in Figure 8), restaurants typically pay a fixed or use-based fee to the PaaS provider to access reusable containers. In deposit systems

(panel a), consumers pay a deposit to the restaurant, which is refunded when containers are returned. In app-based, digital systems (panel b), consumers register for free on the provider's app, through which containers are traceable to consumers and upfront deposits are replaced. Yet, in some digital systems consumers also pay small fees to the PaaS provider, for example, to extend container usage periods.

Finally, information (dashed arrows in Figure 8) flows between the PaaS provider and restaurants, for example, when PaaS providers communicate new functionalities to restaurants and when restaurants report their current inventory. At the same time, PaaS providers directly market their service to consumers (e.g., social media, billboard advertising), run websites that list participating restaurants, and, in the case of digital systems, receive information about consumers' system usage through the app. Similarly, information flows between restaurants and consumers, for example, when restaurants inform consumers about the PaaS at the point-of-sale (e.g., posters, personal explanation by staff) and when consumers provide feedback on their experience with the PaaS.

Overall, PaaS systems facilitate the exchange of reusable containers (i.e., physical assets), money, and information between a PaaS provider, restaurants, and consumers. The specific nature and direction of these exchange activities depend on the system type (i.e., deposit or app-based, digital).

4.3. Conceptual foundations: Access-based services and triadic frameworks

This paper examines PaaS for reusable food containers as an example of an increasingly relevant service concept that blends aspects of access-based services (Hazée et al., 2017; Schaefers et al., 2016) and triadic frameworks for non-ownership consumption (Andreassen et al., 2018; Benoit et al., 2017). To outline its conceptual foundations, this chapter matches

PaaS systems' characteristics with accounts of access-based services and triadic frameworks based on the respective service literature. Concepts are defined and their commonalities and differences are highlighted along three guiding questions: (1) *Who* is involved? (2) *What* types of assets are shared? (3) *How* are assets shared? Overall, it becomes evident that PaaS systems are best positioned between access-based services and triadic frameworks, as illustrated in Table 6. On a conceptual level, we propose that PaaS belongs to an unexplored hybrid form of non-ownership consumption we call "access-based triadic systems".

Table 6. Conceptual overview.

Concepts **Key characteristics**		**Access-based services** (Hazée et al., 2017; Schaefers et al., 2016)	**Access-based triadic systems** (unexplored hybrid) Specific case: Packaging-as-a-Service systems	**Triadic frameworks** • **Collaborative consumption** (Benoit et al., 2017) • **Triadic business models** (Andreassen et al., 2018)
WHO?	**Number of actors**	Dyadic: Two actor groups	Triadic: Three actor groups	
	Types of actors	Asset provider (owners) to customers	Asset provider (owner) to businesses customers and end customers	Platform provider matches peers (owners) with peers
WHAT?	**Types of assets shared**	Tangible or intangible assets specifically produced for the service	Tangible assets specifically produced for reuse	Tangible or intangible assets that are underutilized or idle, thus light on assets
	Ownership of assets	Assets owned by professional asset provider		Crowdsourced supply
HOW?	**Technology reliance**	Integral	Varying	Integral

To evaluate PaaS in relation to access-based services and triadic frameworks we begin with summarizing common definitions of each concept. Access-based services (ABS) are characterized by flexible short-term provision of tangible or intangible assets from a service

provider to a customer in return for an access fee, whereby ownership of assets remains with the provider (Hazée et al., 2017; Schaefers et al., 2016). Notably, ABS are distinct from traditional renting as they facilitate more flexible access for shorter time periods using digital technologies (Benoit et al., 2017; Habibi et al., 2016). For instance, one of the most frequently cited applications of ABS is carsharing (Bardhi & Eckhardt, 2012; Hahn et al., 2020; Schaefers et al., 2016). In contrast to traditional car rentals, carsharing users access cars for flexible time periods as short as a few minutes using mobile apps. The term "triadic frameworks" is used in this paper to refer to collaborative consumption frameworks (Benoit et al., 2017) and triadic business models (T-models; Andreassen et al., 2018). They conceptualize triangular systems in which technology-enabled platform providers act as middlemen to match customers with equivalently positioned suppliers (usually peer to peer). These suppliers typically offer temporary access to underutilized assets they own (such as vehicles on Uber or accommodation on Airbnb; Hazée et al., 2020).[13]

With regard to the number and types of actors involved (*who?*), ABS typically rely on two actors, namely, a service provider (e.g., ShareNow) and a customer (e.g., carsharing user). In contrast, triadic frameworks involve three actors, that is, a platform provider (e.g., Uber), a service supplier (e.g., driver), and a customer (e.g., passenger). Thus, as highlighted in Table 6, the number of actors is a key commonality of PaaS systems and triadic frameworks. In both cases, three actors engage in a triangular structure, in which temporary

[13] The terms "access-based services" and "collaborative consumption" have been used in different ways by prior research. On the one hand, "collaborative consumption" is either used as an umbrella term that includes ABS (e.g., Habibi et al., 2016; Möhlmann, 2015), or as a subset thereof (e.g., Wirtz et al., 2019). On the other hand, some authors distinguish between the two as parallel concepts: "Access-based services" are provided by a professional service provider to customers in a dyadic relationship, whereas "collaborative consumption" depicts a triadic relationship based on peer-to-peer exchanges of crowdsourced assets mediated by a matchmaker (Benoit et al., 2017). We follow this distinction and conceptualize the two as separate, parallel concepts rather than a subset of one another.

non-ownership transfers of assets are facilitated. Accordingly, the number of actors is a key difference between PaaS systems and ABS that typically only involve two actors.

The types of actors involved in PaaS systems, however, differs from triadic frameworks because peers do not share assets with fellow peers (Benoit et al., 2017). Instead, reusable containers are provided to and shared among restaurants (i.e., businesses) and consumers. Consequently, whereas triadic frameworks match peer suppliers with peer customers, PaaS systems provide services to two different types of customers (restaurants and consumers). Thus, in terms of actor types, PaaS providers are more similar to ABS providers, with the key difference that they simultaneously serve two distinct customer groups rather than one, that is, business customers (i.e., restaurants) and end customers (i.e., consumers).

Turning to the types of shared assets (*what?*), ABS can involve both tangible (e.g., physical goods) or intangible assets (e.g., labor; Schaefers et al., 2016), which are typically specifically produced or allocated for the service being offered, such as cars designated for carsharing. In contrast, triadic frameworks typically draw on the use of underutilized or idle assets, such as unused vehicles, space, or time (Andreassen et al., 2018; Benoit et al., 2017). PaaS systems for takeaway food provide reusable food containers specifically produced to be shared among restaurants and consumers. Thus, PaaS is limited to tangible assets. As opposed to triadic frameworks, PaaS systems do not draw on underutilized assets, but supply specifically produced goods, similar to ABS for tangible assets.

With regard to the ownership of shared assets, PaaS providers own reusable containers and enable restaurants to offer reusable packaging to their customers by equipping them with containers. This differentiates PaaS providers from platform providers in triadic frameworks in which the supply is usually provided by peers (i.e., crowdsourced; Benoit et al., 2022; Eckhardt et al., 2019) and in which platform providers act as middlemen that match

crowdsourced supply with demand (Andreassen et al., 2018; Benoit et al., 2017). Instead, asset ownership is a core characteristic of PaaS providers, which is a commonality with professional asset providers in ABS, as highlighted in Table 6. In the service literature, this is also referred to as "firm-enabled sharing" (Benoit et al., 2022, p. 208) of "platform-provided assets" (Wirtz et al., 2019, p. 458).

Finally, we examine the way non-ownership transfers are facilitated in different systems (*how?*), specifically focusing on their reliance on digital technologies. ABS typically use digital technologies to facilitate flexible short-term access to assets (e.g., carsharing facilitated through apps). Similarly, triadic frameworks and many broader conceptualizations of the sharing economy rely heavily on the use of technology-based digital platforms to connect supply and demand (Andreassen et al., 2018; Benoit et al., 2022; Perren & Kozinets, 2018; Wirtz et al., 2019). In contrast to ABS and triadic frameworks, some PaaS systems only require limited use of digital technologies. For example, while deposit systems usually operate websites to allow partnering restaurants to be located, consumers simply leave a cash deposit for each reusable container they use. App-based, digital systems, however, fully rely on digital technologies to facilitate exchanges of containers. Thus, the degree of technology reliance varies more strongly in PaaS systems than among typically technology-enabled ABS and triadic systems.

Against this conceptual background, PaaS represents an unexplored hybrid form of non-ownership consumption, which we call "access-based triadic systems". These systems are access-based in the sense that they provide flexible short-term access to specifically produced assets owned by the system provider. At the same time, providers offer their services to two distinct customer groups, resulting in systems that are triadic in nature.

So far, ABS and triadic frameworks have usually been treated as separate concepts (Benoit et al., 2017; Hazée et al., 2017; Hazée et al., 2020). Thus, the implications of blending the two concepts for system adoption are not yet understood. Therefore, this paper empirically investigates PaaS as a type of access-based triadic system to respond to the following case-specific research question: Which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers? This way, we address a number of empirical research needs: On the one hand, we extend research on ABS adoption, which focuses on dyadic relationships between asset providers and customers. On the other hand, we complement studies of triadic frameworks as we look beyond well-researched peer-to-peer platforms and account for the need to study systems that rely on platform-provided assets (Wirtz et al., 2019). At the same time, we include the underexplored yet essential perspective of service suppliers (i.e., restaurants), acknowledging demands to simultaneously consider both market sides in triadic systems (Andreassen et al., 2018; Hazée et al., 2020). The next section presents the methodological approach we applied to answer our research question and to address these research needs.

4.4. Materials and methods

This research empirically investigates influences of system attributes on restaurants' and consumers' intentions to adopt PaaS systems. In line with recent research with a similar methodological approach (Hahn et al., 2020), a qualitative pre-study was used to identify which system attributes are relevant for restaurants and consumers. Afterwards, the effects of these system attributes on adoption intentions were quantitatively tested in factorial survey experiments (FSEs). This follows recommendations by Atzmüller and Steiner (2010) who suggest using qualitative preliminary studies if existing theory is not sufficient to derive relevant dimensions for a FSE.

In FSEs, choice alternatives are described in vignettes, which are systematically varied along a number of dimensions (Aguinis & Bradley, 2014). As opposed to directly asking participants about their preferences regarding individual dimensions, FSEs capture participants' adoption intentions more implicitly based on a holistic impression of a choice alternative (Wallander, 2009). This way, FSEs leverage advantages of survey research and experimental methods, which enhances their internal and external validity (Aguinis & Bradley, 2014) and makes responses less prone to social desirability bias (Auspurg & Hinz, 2015). Moreover, the systematic design of FSEs along vignette dimensions enabled us to survey two distinct target groups (restaurants and consumers) in a consistent way and to systematically compare the effect of PaaS system attributes on adoption intentions of both groups. In addition, a set of questions also captured participants' individual-level characteristics such as demographic information, technology acceptance, and value orientations. This design allowed us to compare effects of system attributes and control for effects of individual-level variables (Oll et al., 2018).

4.5. Pre-study: Interviews and focus groups

To identify PaaS system attributes that are relevant for restaurants and consumers, semi-structured interviews and focus groups were conducted with each target group, respectively. In planning, conducting, and analyzing interviews and focus groups, we followed recommendations by Krueger and Casey (2015). An interview guide was developed covering questions on general perceptions and attitudes as well as drivers and barriers regarding PaaS systems for takeaway food (see Table C1). Participants were recruited through convenience sampling and snowballing, using both lead authors' professional networks. Restaurant representatives were offered a €20 Amazon voucher and consumers were offered a €15 takeaway food voucher for their participation. Due to the limited availability of restaurant

representatives, it was not possible to run focus groups with restaurants. Therefore, we conducted six individual expert interviews (3.25 hours; 32,349 words) with representatives of restaurants located in Germany and three focus groups (2.5 hours; 22,145 words) with 11 German consumers in total. Participating consumers indicated in an online sign-up form whether they had used systems for reusable containers in the past. This way, consumers were assigned to groups with (two groups) and without (one group) prior experience and respective interview guides were adapted accordingly. Interviews with restaurant representatives took place in January and February 2022, consumer focus groups were held in July 2021. Both interviews and focus groups were conducted as online video conferences and were recorded and subsequently transcribed. Afterwards, transcripts were independently coded by both lead authors of this paper before results were jointly discussed and summarized. The following paragraphs present a synopsis of all interviews and focus groups and outline the derived vignette dimensions included in subsequent FSEs. For each dimension two levels emerged from the qualitative pre-study (see overview in Table 7).

Table 7. Dimensions and levels of FSEs derived from qualitative pre-study.

Dimension	Level 1	Level 2
System[a]	Deposit system	App-based, digital, no deposit
Access	Self-pick-up	Self-pick-up and delivery service
Container types	Standard-sized	Customized to meals served
Partner restaurants	5 partners within 2km radius	20 partners within 2km radius
Users	80 users within 2km radius	950 users within 2km radius
Place of return	Restaurants	Restaurants and return stations
Impact information	Collective impact of the system	Restaurant's/consumer's impact

[a] This research's main purpose was to compare the effects of different vignette dimensions on restaurants' and consumers' adoption intentions. In practice, the system type of PaaS systems determines the commercial model and associated costs for restaurants. To increase the experiments' external validity, costs associated with each system type (deposit or app-based, digital) were set based on current price levels and held constant across all respective vignettes (Kleinhueckelkotten et al., 2021). In particular, deposit systems were associated with a monthly fee of €30 and a refundable deposit payment of €5 for each container. App-based, digital systems were

associated with a one-off sign-up fee of €100 and a usage fee of €0.20 for each reusable container filled by the restaurant (see Table C2 for two vignette examples).

Overall, participating restaurant representatives and consumers were familiar with systems for reusable food containers and generally open to adopting them. At the same time, both parties shared concerns regarding the limitations, costs, and efforts associated with such systems compared to single-use solutions. Although some restaurant representatives reported that PaaS systems provide an opportunity to reduce costs compared to more environmentally friendly single-use containers (e.g., from recycled or biodegradable material), others highlighted the costs of offering PaaS systems and the associated efforts of operating the system compared to single-use packaging. Yet, additional operational efforts (e.g., storage, cleaning) were perceived to be acceptable if the system can be easily integrated into existing routines. Regarding different types of systems for reusable food containers, deposit systems were generally perceived as more convenient than app-based, digital systems, especially among consumers (vignette dimension: *System type*). In terms of accessing containers, both restaurants and consumers perceived a potential integration of PaaS systems with established delivery services to be desirable alongside self-pick-up options (vignette dimension: *Access*).

In addition to system type and access, the design of offered containers was also mentioned by both parties. For restaurant representatives it was of utmost importance that reusable containers are not standard-sized but customized to their food (e.g., with partitioning, sushi box, pizza box, etc.), so food quality does not suffer or even benefits from using reusable containers: “If there was a system […] where the food would arrive at the end consumer with the same quality as now, maybe even better, I would be the first one to participate” (Participant R1). Similarly, consumers regarded appealing and durable containers made of safe and flavorless materials as an advantage compared to single-use containers, as

they improve the experience of a takeaway or delivery meal (vignette dimension: *Container types*).

Moreover, consumers' main concerns revolved around the number of participating partner restaurants. Systems that are only available at few restaurants were perceived to limit food choice, invoke search costs, and most importantly, cause additional effort to return containers. For instance, one consumer stated: "If I could use it everywhere it wouldn't be a problem. Then I can always take it [the container] to the next one [restaurant] and exchange it and now I always have to see where I can return it [the container]" (Participant C2). Thus, consumers demanded a dense network of participating partner restaurants at which they could receive and return reusable containers (vignette dimension: *Number of partner restaurants*). Accordingly, restaurant representatives saw an increase in consumer demand for reusables as the main driver for introducing such a system (vignette dimension: *Number of users*).

To simplify the return process, both parties suggested the introduction of return stations as drop-off points outside restaurants' opening hours (vignette dimension: *Place of return*). Additionally, the question of who is responsible for cleaning containers arose. German food safety regulations require containers to be cleaned professionally and PaaS providers typically outsource container cleaning to partnering restaurants. Therefore, this aspect is not a differentiating factor between systems for reusable food containers and, thus, was not taken forward as a separate dimension. Finally, protecting the environment by avoiding waste from single-use packaging was mentioned as a driver of adoption by both groups and was the most widely reported motivational factor by consumers. To substantiate the environmental contribution of reuse, some consumers demanded increased transparency about the impact of using systems for reusable containers, for example, in terms of waste reduction compared to single-use alternatives (vignette dimension: *Impact information*).

4.6. Main study: Factorial survey experiments

4.6.1. Method

The seven identified dimensions of systems for reusable food containers were quantitatively tested in two separate FSEs with restaurants and consumers, as aspects of each dimension were brought up by both groups in our pre-study. Each of the seven vignette dimensions had two levels (Table 7), leading to a total of 128 (2^7) possible combinations, that is, 128 vignettes in the universe (for two vignette examples, see Table C2). Using the R package "FrF2" (Grömping, 2014) we obtained a fractional factorial design, which included a subpopulation of 64 vignettes of the full vignette universe. Furthermore, we used the "FrF2" package to split the 64 vignettes into eight vignette sets, in which dimensions' main effects and two-way interactions were unconfounded with each other and with vignette sets. This provided an advantage compared to randomly drawing vignettes from the full vignette universe whereby the confounding structure of main and interaction effects cannot be controlled (Atzmüller & Steiner, 2010). Additionally, by randomly assigning each participant to one vignette set we were able to control for potential vignette set effects. As different groups of participants were randomly assigned to different vignette sets, but participants within each vignette set were shown the same vignettes, we implemented a mixed design (Atzmüller & Steiner, 2010). The same mixed fractional factorial design was used for the two FSEs with restaurants and consumers to ensure consistency and comparability.

Each FSE was structured as follows: After providing some demographic information, participants were informed about different types of systems for reusable food containers. The introduction included an explanation of the functionality of two main system types currently available on the market: In deposit systems consumers pay a refundable deposit when ordering takeaway food in a reusable container. In app-based, digital systems consumers sign up in an app and reusable containers are assigned to them through their personalized QR code

without having to pay a deposit. To address potential questions about cleaning responsibilities, survey participants were also informed that in both system types, restaurants are required to professionally clean containers before redistributing them by German food safety regulations. To avoid order effects, the order in which the two system types were explained was randomly alternated.

Afterwards, participants were assigned to a vignette set and rated the probability of using eight different systems for reusable food containers on a scale from 1 (very low) to 11 (very high) (see Table C2). Again, the order of presented vignettes in each vignette set was randomized for each participant to prevent order effects. Eight vignette ratings per respondent are well within the acceptable range of rating tasks in FSEs, which often ask participants to rate 10-20 different vignettes (Auspurg & Hinz, 2015). Furthermore, each vignette was presented in a table format and on a separate page to reduce cognitive load (Shamon et al., 2019). Both the introduction of systems for reusable food containers and the vignette descriptions depicted systems from the perspective of restaurants or consumers, respectively (see Table C2). Regarding the rating itself, restaurant representatives were asked to rate the probability that the system would be adopted in their restaurant whereas consumers rated the probability to use the described system themselves. In line with previous research (Hahn et al., 2020), the probability to adopt each system was measured on a scale from 1-11, as recommended to allow for linear modeling (Oll et al., 2018).

After the vignette rating task, we measured a range of restaurant-level and consumer-level control variables. Restaurant representatives were asked about the area in which their restaurant is located, the types of food they serve, the proportion of takeaway food of their total business, and whether they are restaurant managers. Consumers were asked for information about their area of living, income level, and what types of takeaway food they consume. To ensure that respondents were at all familiar with ordering takeaway food, a

screening question recorded consumers' frequency of takeaway orders along with initial demographic information in the beginning of the survey. This allowed us to screen out respondents who never order takeaway food, in line with methodological recommendations to avoid artificial responses (Aguinis & Bradley, 2014).

Following these restaurant and consumer-level control questions, restaurant representatives and consumers were asked about their technology acceptance and environmental values because for many restaurants and consumers, this is a new pro-environmental behavior that is enabled by digital technologies in some cases. Thus, it is conceivable that technology acceptance can influence preferences for an app-based, digital (vs. deposit) system. Furthermore, environmental impact information may be more relevant to people with stronger environmental values. Technology acceptance was measured using the four technology acceptance items of the technology commitment scale by Neyer et al. (2012) and were adopted in German from the original scale. Environmental values were measured using three of the four biospheric value orientation items of the Environmental Portrait Value Questionnaire by Bouman et al. (2018) (see Table C3). These items were translated to German by both lead authors and verified through back-translation by a native English speaker. Depending on whether restaurant representatives managed the restaurant or not, scales in the restaurant FSE were either phrased to refer to participants themselves (if they were managers) or to refer to the restaurant's management. Items of both constructs were measured on a 7-point Likert scale. Finally, both groups were asked if their restaurant or they as consumers had used a system for reusable food containers in the past, and if so, which ones.

It is recommended to collect at least five ratings per vignette in FSEs (Auspurg & Hinz, 2015). However, to be able to measure the effects of individual-level characteristics and cross-level interactions, researchers are advised to take a more conservative approach and

aim for a larger sample (Auspurg & Hinz, 2015). To determine the sample size, we followed recent FSE research and targeted 20 ratings per vignette (Hahn et al., 2020). For the 64 vignettes included in the survey, at least 1,280 vignette ratings (64 × 20) would be needed, which requires a minimum sample of 160 participants given that each participant rates eight vignettes (1,280 / 8). Restaurant representatives were recruited as a convenience sample through communication channels of Germany's largest hospitality industry group covering more than 200,000 hospitality businesses. Responses from this sample were collected in August and September 2022 and participants had the opportunity to win one of five €100 vouchers for a large German food wholesaler. Consumers were recruited through a market research agency and completed the FSE in April and May 2022. The consumer sample was representative of German takeaway consumers by age and gender, based on market research on takeaway food consumption in Germany (VuMa, 2022). Both FSEs were implemented in Qualtrics and pre-tested with small convenience samples of individuals from the hospitality industry (restaurant FSE) and consumers (consumer FSE) before launch.

To analyze both FSEs we followed recommendations to use multilevel analysis, which accounts for the nested data structure that emerges as each respondent provides multiple vignette ratings (Atzmüller & Steiner, 2010). To validate that multilevel models were required, null models were specified with adoption intentions (grand mean centered) as the dependent variable and random intercepts for each participant. Intraclass correlation coefficients of .41 for restaurants and .60 for consumers confirmed that multilevel modeling was appropriate for our datasets (Heck et al., 2014). Afterwards, results for restaurants and consumers were modeled separately but following the same logic. In line with the stepwise modeling approach proposed by Heck et al. (2014) we compiled models in five steps (see overview in Table 8).

Table 8. Stepwise model specifications.

Model parameters	Model 1	Model 2	Model 3	Model 4	Model 5
Random intercepts for all participants	X	X	X	X	X
Vignette set dummy variables	X	X	X	X	X
Main effects of level 1 variables (vignette dimensions)	X	X	X	X	X
Main effects of level 2 variables (individual characteristics)		X	X	X	X
Random slopes for level 1 variables, if applicable			X	X	X
Relevant interaction effects of level 1 variables (vignette dimensions) and level 2 variables (individual characteristics)				X	X
Restaurant or consumer-specific control variables					X

First, we compiled model 1 with adoption intentions (grand mean centered) as the dependent variable and vignette dimensions as explanatory variables, including random intercepts for participants, and vignette set dummies. Second, restaurant representatives' and consumers' individual-level variables (technology acceptance and biospheric value orientation) were added to compile model 2. Third, we tested whether dimensions' effects varied significantly between participants and are therefore more appropriately modeled with random slopes variables. One by one, we included each of the seven dimensions as random slopes variables and inspected the significance of the respective slope variance. This

modeling step provided evidence that two of the seven dimensions were to be included as random slopes variables for both samples (restaurants and consumers). Thus, model 3 introduced required random slopes to model 2. Fourth, we added relevant interaction effects of system attribute variables with individual level factors to specify model 4. Finally, we introduced restaurant and consumer-level control variables in model 5 to ensure that effects were robust to the inclusion of additional controls.[14] We applied maximum likelihood estimation for all models to be able to compare nested models using likelihood ratio tests. For both samples, likelihood ratio tests suggest that model 5 delivers the best model fit. Therefore, the following section presents and interprets parameters of model 5 (see Table 9).

4.6.2. Results

A total of 243 complete responses by restaurant representatives were recorded. The fastest 27.5% of all participants were excluded from our dataset due to concerns that these respondents did not take enough time to fully read and understand the content of the FSE. This proportion was derived from the FSE with consumers, in which 27.5% of participants were faster than the minimum time threshold of eight minutes, which was determined by a pre-test.[15] Characteristics of the final sample of 176 restaurant representatives are presented in Table C4. Each vignette set (and accordingly, each vignette), was rated at least 17 times.

Consumers were asked how frequently they order takeaway food on the first page of the FSE. Consumers who reported that they do not order takeaway food at all did not enter the FSE, due to concerns that they are not familiar with the situation described in the

[14] As is common in experimental research, we included age, gender, and geographic location as demographic control variables. Additionally, models controlled for key activities related to reusable food containers that may influence PaaS adoption intentions: The proportion of takeaway orders (restaurants) or the frequency of takeaway orders (consumers) and past experience with systems for reusable food containers were included to control for potential effects of familiarity with takeaway orders and reusables. Finally, we controlled for vignette set effects, as recommended by the methodological literature on FSEs (Atzmüller & Steiner, 2010).

[15] Due to the complexities of recruiting a sufficiently large sample of restaurant representatives, it was not possible to conduct a large pre-test with restaurants and the time threshold was derived from the consumer pre-test.

vignettes. Thus, the sample included respondents who consume takeaway food, regardless of whether they used PaaS systems for reusable food containers in the past. To ensure that consumers recruited through a market research agency properly read and understood the survey, respondents were excluded from the analyses if they failed at least one of two attention checks, and if they completed the FSE in less than eight minutes. This minimum time threshold was defined based on the pre-test with consumers. Sample characteristics of all 245 complete and valid responses are summarized in Table C4. Each vignette set received at least 27 ratings.

Results of our core models of interest are presented in Table 9. The availability of containers customized to the served food was the key priority for restaurants ($\beta = 0.395$, $p < .001$). Moreover, restaurant representatives preferred more established, widely adopted systems. Both more existing partners ($\beta = 0.044$, $p < .1$) and more existing users ($\beta = 0.075$, $p < .01$) were associated with higher intentions to use a system. Notably, system type, offering delivery options, return stations, or restaurant-specific information about the environmental impact of the system did not show any significant effects on adoption intentions by restaurant representatives. Control variables demonstrated that intentions to adopt PaaS systems decreased as restaurant representatives' age increased ($\beta = -0.117$, $p < .05$) and that those who had used a system in the past had higher adoption intentions ($\beta = 0.246$, $p < .05$).

Table 9. FSE model tables.

Dependent variable[a]: Intention to use offered system for reusable food containers	**Restaurants[b] (*N* = 176)** Coefficients (Standard errors)	**Consumers[b] (*N* = 245)** Coefficients (Standard errors)
Constant	-0.105 (0.165)	0.082 (0.161)
System: App-based, digital (baseline: deposit)[c]	0.028 (0.072)	**-0.414 (0.041) *** **
Access: Delivery included (baseline: excluded)	-0.011 (0.025)	**0.037 (0.021) †**
Container types: Customized (baseline: standard containers)[c]	**0.395 (0.047) *** **	**0.176 (0.029) *** **
Partners: Many (20) (baseline: few (5))	**0.044 (0.025) †**	**0.161 (0.021) *** **
Users: Many (950) (baseline: few (80))	**0.075 (0.025) ** **	**0.053 (0.021) ***
Place of return: Return boxes offered (baseline: no return boxes offered)	-0.005 (0.025)	**0.070 (0.021) *** **
Impact information: Individual/restaurant (baseline: collective)	-0.010 (0.025)	0.018 (0.021)
Technology acceptance	0.062 (0.060)	0.070 (0.053)
Biospheric values	0.078 (0.054)	**0.279 (0.048) *** **
System: Digital[c] x Technology acceptance	0.113 (0.073)	**0.104 (0.041) ***
Impact: Individual/restaurant x Biospheric values	0.006 (0.026)	0.018 (0.021)
Age[a]	**-0.117 (0.050) ***	**-0.099 (0.048) ***
Proportion / frequency of takeaway orders[a, d]	0.058 (0.047)	**0.088 (0.050) †**
Used reusable system in the past: Yes	**0.246 (0.123) ***	**0.345 (0.162) ***
Log Likelihood	-1449.796	-1858.270
Number of vignette ratings	1408	1960

Note. Estimation method: Maximum likelihood

***$p < .001$; **$p < .01$; *$p < .05$, †$p < .1$

[a] Grand-mean centered and standardized by one standard deviation

[b] Control variables: Gender of participant, area of restaurant location or area of living, vignette set effects

[c] Included as random-slopes variable

[d] Measured as the proportion of takeaway orders for restaurants and the frequency of orders for consumers

Consumers' intentions, on the other hand, were most strongly influenced by the system type: The significant negative effect of offering a digital system ($\beta = -0.414$, $p < .001$) demonstrated a strong preference for deposit systems for reusable food containers over app-based, digital systems. We did, however, find a positive interaction effect of technology acceptance and digital systems ($\beta = 0.104$, $p < .05$), indicating that consumers who were more

open to new technologies had higher intentions to use digital systems for reusable food containers.

Moreover, offering customized container types was associated with higher adoption intentions among consumers ($\beta = 0.176$, $p < .001$). Network density, that is, the number of participating partners ($\beta = 0.161$, $p < .001$) and users ($\beta = 0.053$, $p < .05$), also positively affected consumers' use intentions. In terms of container access and returns, we found a small positive effect of offering delivery options ($\beta = 0.037$, $p < .1$) and return stations ($\beta = 0.070$, $p < .001$). Different types of impact information did not have a significant effect on adoption intentions. Finally, control variables showed that older consumers had lower ($\beta = -0.099$, $p < .05$) and more environmentally oriented consumers had higher intentions ($\beta = 0.279$, $p < .001$) to use systems for reusable food containers. Moreover, there was a marginally significant positive association of takeaway order frequency with higher adoption intentions ($\beta = 0.088$, $p < .1$) and a significant positive effect of having used such systems in the past ($\beta = 0.345$, $p < .05$).

4.7. Discussion

Core to this research is the case-specific question of which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers. The results of our FSEs point toward a range of common and divergent influences on both groups' intentions to adopt PaaS systems. Notably, while we identify different effect sizes of system attributes across restaurants and consumers, we do not find evidence for contradicting preferences of both groups that would force PaaS providers to prioritize the needs of one group over those of the other.

Regarding common preferences for system attributes, our results highlight that customized containers and a large network of participating restaurants and consumers are crucial success factors for PaaS systems. On the one hand, customized containers (e.g., with partitioning, sushi box, pizza box, etc.) have a sizeable positive direct effect on both restaurants' and consumers' adoption intentions. On the other hand, we find a positive effect of a larger number of restaurants on users' adoption intentions and vice versa. Thus, considering that customized containers have the largest positive direct effect on restaurants, PaaS providers offering a diverse range of containers could trigger a virtuous cycle of attracting more restaurants, which motivates additional consumers to join the system, with positive effects on restaurant participation, and so forth.

In terms of divergent influences, the type of PaaS system is a system attribute that does not affect restaurants' adoption intentions but shows the strongest effect on consumers. More specifically, we find a strong consumer preference for deposit systems over app-based, digital PaaS systems. The positive interaction effect of technology acceptance and digital PaaS systems, however, supports the existence of different consumer segments (Kleinhueckelkotten et al., 2021). Although consumers generally prefer deposit systems, more technology accepting consumers are more open toward app-based, digital PaaS systems. As a result, the system type chosen by PaaS providers plays a key role in convincing consumers to use the system and must consider the target group's openness to new technologies.

Other system attributes such as delivery services, return stations, or providing environmental impact information play a secondary role for the adoption of PaaS systems. While delivery services and return stations could increase the complexity of managing the system, they only show moderate positive effects on consumers' adoption intentions and no effects on restaurants. Notably, although sustainability benefits were highlighted as

motivating factors in interviews and focus groups by both parties, we did not find significant effects of providing individualized rather than collective information about the restaurant's or consumer's positive environmental impact of using the PaaS system in our FSEs. This discrepancy may be explained by more socially desirable responses in direct in-person interviews and focus groups about personal preferences in the qualitative pre-study, compared to the more subtle questioning embedded in the multidimensional vignettes of the FSEs (Auspurg & Hinz, 2015).

In addition to influences of system attributes, FSEs also enabled us to test effects of restaurant representatives' and consumers' characteristics on their PaaS adoption intentions. In both groups, adoption intentions are higher among those who used PaaS systems before and among younger participants. Furthermore, consumers who order takeaway food more frequently show higher intentions to use PaaS systems. This provides evidence for the importance of system compatibility with lifestyles and usage patterns (Hazée et al., 2017; Hazée et al., 2020). Moreover, biospheric values are positively associated with higher adoption intentions among consumers. This is in line with previous findings that environmental benefits of non-ownership consumption motivate users (Hamari et al., 2016) and contrasts other contributions that do not find associations of intrinsic sustainability motivations with interest in non-ownership consumption (Habibi et al., 2016; Lamberton & Rose, 2012; Möhlmann, 2015). To conclude, next to system attributes it is also relevant for PaaS providers to consider individual characteristics of the different target groups when developing PaaS systems.

4.7.1. Implications for theory and research

Based on these empirical findings on PaaS we now discuss the implications of blending ABS and triadic frameworks for system adoption. To do so, we address the key characteristics outlined in the conceptual foundations and consider the actors (*who?*), shared assets (*what?*),

and systems' technology reliance (*how?*). This way, we evaluate to what extent hybrid access-based triadic systems face novel challenges and opportunities compared to ABS and triadic frameworks.

In terms of the number of actors involved (*who?*), access-based triadic systems are similar to triadic frameworks, which operate in a triangle of actors. One of the challenges of platforms in triadic frameworks is the need to build a critical mass of supply and demand at the same time (Andreassen et al., 2018). The positive effects of additional participating restaurants and consumers on both target groups' PaaS adoption intentions indicate that access-based triadic systems face the same challenge of simultaneously attracting two market sides. These positive effects of more participating restaurants and consumers on adoption intentions also point toward positive network effects in PaaS systems. Notably, we provide empirical evidence that indirect network effects are stronger than direct network effects (Wirtz et al., 2019) in both samples: Consumers' adoption intentions are more strongly affected by additional partnering restaurants than additional consumers and restaurants are more strongly motivated by additional consumers than by additional restaurants.

With regard to the types of shared assets (*what?*), access-based triadic systems resemble ABS with tangible assets. That is, assets are specifically produced to deliver a service and are owned by the system provider. In PaaS, reusable food containers are tangible assets that are produced with the intention to replace single-use containers. Our results show that containers customized to different meals are a key attribute of PaaS systems for both restaurants and consumers. This highlights that asset ownership creates opportunities for access-based triadic system providers to differentiate themselves from competitors as well as alternative solutions and enables them to provide consistent, high-quality services throughout their system. This is an important advantage compared to platform providers in triadic frameworks with crowdsourced supply, which often face challenges regarding the control of

service quality (Eckhardt et al., 2019) because assets are owned and controlled by individual suppliers, which increases heterogeneity (Andreassen et al., 2018; Wirtz et al., 2019).

Nevertheless, to leverage these opportunities, system providers need to take a more active role in product design and distribution, which reduces their flexibility and introduces additional investment costs compared to triadic platform providers that are typically light on assets (Andreassen et al., 2018; Wirtz et al., 2019). Additionally, previous research highlights that non-ownership consumption can promote opportunistic behaviors at the expense of other system participants and shared assets (Bardhi & Eckhardt, 2012; Guyader, 2018; Schaefers et al., 2016). Compared to matchmakers in triadic systems that do not own physical assets, it is particularly important for providers of access-based triadic systems that own physical assets to design appropriate system mechanisms that protect their assets from damages and losses (e.g., through deposits or digital tracking).

This leads over to the question to what extent technologies are employed to manage the system (*how?*). As opposed to ABS and triadic frameworks that typically rely on digital technologies, the extent to which digital technologies are used in access-based triadic systems varies more strongly. In PaaS, this aspect is mostly determined by the system type, which we identify as a key determinant of consumers' adoption intentions. The degree to which a deposit or digital PaaS system relies on technology is essential here: Our results show a clear consumer preference for deposit systems over app-based, digital systems, which links to research identifying system complexity as a functional barrier in ABS and triadic frameworks (Hazée et al., 2017; Hazée et al., 2020). In other words, increasing technical costs of familiarizing oneself with the system (Habibi et al., 2016; Lamberton & Rose, 2012), including upfront registration and the technology-mediated use of the system, can discourage consumers from using app-based, digital PaaS systems. In conjunction with the abovementioned aspect of asset protection, this highlights a trade-off faced by access-based

triadic system providers: On the one hand, technologically complex systems may protect their assets and enable PaaS providers to run their systems more efficiently, but attract fewer customers. On the other hand, more simplified system mechanisms are more popular among customers but may not be sufficient to manage owned assets because they cannot be traced and redistributed as efficiently.

In sum, our findings shed light on the implications of blending access-based service provision with triadic frameworks, accounting for *who* is involved in the system, *what* assets are shared, and *how* they are shared. We show that access-based triadic systems come with additional challenges while introducing opportunities for competitive advantages: On the one hand, actors on two market sides must be attracted simultaneously and owned assets have to meet functional demands. At the same time, system mechanisms have to be sufficiently advanced to protect assets and efficiently distribute them throughout the system without introducing prohibitively high complexities for consumers. On the other hand, asset ownership allows for greater control over service quality and provides opportunities for differentiation from competition. These findings contribute to a growing body of literature that aims to specify characteristics of sharing economy concepts and their implications in more detail (Benoit et al., 2022; Eckhardt et al., 2019; Perren & Kozinets, 2018; Wirtz et al., 2019).

4.7.2. Implications for practice

It is crucial for providers of access-based triadic systems to understand influences on adoption intentions of the two market actors they serve. This paper proposes FSEs as a suitable method to consistently analyze preferences of both market sides. This helps system providers to evaluate their system design choices and identify potential trade-offs. Thus, a first practical implication of this paper is to provide a replicable research framework that could be applied to derive practical insights for businesses in two-sided markets. The

following paragraphs outline several managerial implications for PaaS for restaurants before proposing different contexts to which access-based triadic systems offering PaaS could be applied.

Customized containers are the most important system attribute for restaurants and also have significant positive effects on consumers' adoption intentions. Therefore, developing an adequate container offering is a key concern for PaaS providers. Yet, while customized containers may help to attract both restaurants and consumers, they also increase the complexity of scaling the system due to additional logistical challenges. As opposed to systems with one standard container type for participating restaurants, customized containers may not be useful to all participating restaurants. For example, a sushi restaurant does not see any value in reusable pizza boxes and vice versa. Thus, a more diverse container offering may require PaaS system providers to put additional effort into the tracking and distribution of containers. Notably, not all PaaS system types are equally well-equipped to tackle these issues. Specifically, in systems with cash deposits containers are not tracked, which makes it much more challenging to keep oversight of and distribute containers in the system. At the same time, our results show that consumers prefer less complex systems. Therefore, PaaS providers must strike a balance between offering sufficiently customized containers without introducing unmanageable operational complexities for themselves, restaurants, and consumers.

Apart from questions on logistics and convenience, heterogenous containers may limit the environmental benefits of a PaaS system because individual containers may not reach the required number of uses to deliver environmental benefits compared to single-use. This minimum threshold is even more difficult to reach, the more different providers of reusable food containers enter the market with their own containers, as is currently the case in Germany and Europe (Kleinhueckelkotten et al., 2021). In light of this, policymakers may

want to support a consolidation of systems to ease adoption by restaurants and consumers – and to ensure sustainability benefits by reducing asset heterogeneity between different PaaS systems.

While this work considered the specific, innovative case of reusable containers for takeaway and delivered food as an example for PaaS, we expect the challenges and opportunities PaaS providers face as both asset owner and platform provider to also apply to other use cases: In the food sector packaged food is offered by supermarkets (in particular, fresh food counters), bakeries, canteens (at work, in schools, and at universities), as well as in leisure contexts (e.g., cinemas, festivals, and other events). Outside the food sector PaaS can be introduced for drugstore articles (e.g., shampoo, laundry detergent, etc.), or in e-commerce to enable sellers to ship goods in reusable boxes. However, different use cases may introduce new responsibilities for PaaS providers as well. For example, PaaS systems for restaurants benefit from the availability of dishwashing facilities at restaurants. In contrast, other use cases will require PaaS providers to offer central washing services to clean containers because, for example, supermarkets, cinemas, or drugstores may be reluctant to clean containers. While this adds logistical complexity, it can also be an opportunity for PaaS providers to add value for their users and differentiate themselves from competitors and alternative packaging solutions.

4.7.3. Limitations and future research

Some limitations concerning sample composition and the studied case should be noted. First, while we build on a comprehensive survey dataset of restaurants, it constitutes a convenience sample, which may not be representative for the hospitality sector in Germany and beyond. Moreover, cultural differences may impact adoption intentions of different PaaS systems. This affects both our qualitative pre-study and our quantitative FSEs. Thus, the identification of system attributes and their effects on restaurants' and consumers' adoption intentions most

likely reflect the German context in which data were collected. Specifically, deposit systems may be more popular in Germany because many consumers are familiar with the long-existing bottle deposit system. It is conceivable that introducing a digital system will be easier in countries where none of the two systems is known yet. Thus, it is important to apply our work to other cultural contexts to support PaaS providers successfully expand their businesses globally.

Second, our findings on access-based triadic systems are based on the specific case of PaaS for restaurants and consumers. While we expect the implications of asset ownership in a triadic service system to translate to other contexts as well, we encourage future research to investigate other similar use cases such as PaaS for drugstores or e-commerce. Beyond PaaS, platform business models with platform-provided assets (Wirtz et al., 2019) have emerged in the transportation sector (Eckhardt et al., 2019). For example, Uber has experimented with Uber-owned cars as an alternative to cars owned by drivers. Notably, this example demonstrates the potential downsides of not seizing the opportunities of asset ownership, as Uber was criticized for offering unsafe cars with known defects bought from unauthorized dealers (Horwitz, 2017). If firm-enabled sharing with platform-provided assets (Benoit et al., 2022; Wirtz et al., 2019) gains traction beyond PaaS and transportation in years to come, we encourage future research to evaluate these applications and continue to explore the conceptual spectrum between ABS and triadic frameworks, in which we place “access-based triadic systems”. In doing so, we invite researchers to consider FSEs as a methodological tool to elicit adoption intentions of different target groups in two-sided markets in a systematic way.

4.8. Conclusion

Acknowledging that platform providers in triadic systems have to fulfil demands of two market sides, this paper investigated adoption intentions for PaaS systems for takeaway food that blends aspects of ABS and triadic frameworks. With a qualitative pre-study and quantitative FSEs, we empirically identify and evaluate influences of PaaS system attributes and individual characteristics on adoption intentions of both restaurants and consumers. We find that access-based triadic systems that use platform-owned assets in a triadic framework confront PaaS providers with a new set of challenges and opportunities: On the one hand, PaaS providers need to attract a critical mass of business and end customers while balancing asset protection and system complexity. On the other hand, owning reusable containers presents PaaS providers with opportunities for higher quality control and differentiation from competition. Our insights contribute to a growing body of literature on non-ownership consumption and specifically address access-based triadic systems that apply aspects of ABS and triadic frameworks. Furthermore, our findings support PaaS practitioners to scale their services and increase their positive environmental impacts.

5. Discussion and conclusion

This dissertation contributes to the extant literature by improving our understanding of product-related sustainability information and consumers' perceptions (Paper 1), of consumers' (in)ability to identify greenwashing (Paper 2), and of reusable food containers' system attributes that attract two distinct customer groups (Paper 3). While the first two papers look at a dyadic relationship between companies and end consumers, the third paper examines a triadic relationship between a company, service suppliers, and end consumers. Each paper provides valuable insights to scholars and practitioners on how prospective customers perceive different product-related sustainability information. The specific contributions of each paper have been outlined in the respective chapters. This chapter illustrates the overarching theoretical implications of the dissertation (see Table 10) and presents avenues for future research.

Table 10. Main theoretical contributions of the dissertation.

Implications	Main contributions of dissertation	Papers
Relevance of holistic and targeted sustainability information for effective communication	Empirical evidence on which sustainability information is relevant for different prospective customers	1, 3
	Empirical evidence on how individual characteristics influence effectiveness of sustainability information	1, 3
Challenge to guard against greenwashing perceptions	Key insight that consumers need support to identify greenwashing	2
	Proposition that context-related factors can offer potential solutions	2

5.1. Theoretical implications

As noted in the introduction, perception describes the process by which people select, organize, and interpret information which influences their behavior (Kotler et al., 2020). The broader literature on information processing and persuasion typically draws on two-process models in which information can follow a more rational central route (also systematic processing) or a more affective peripheral route (also heuristic processing) (Buck et al., 2004; Chaiken, 1980; Matthes, 2019; Petty & Cacioppo, 1984). The next sections discuss the present research findings and their contributions in light of these two prevalent information processing perspectives.

5.1.1. Relevance of holistic and targeted sustainability communication

The findings in Paper 1 suggest that holistic, government-certified sustainability information covering different sustainability dimensions and product life cycles increases consumers' sustainability perceptions. This aligns with research showing that providing more verbal sustainability cues positively impacts perceived product quality, purchase intentions, and willingness to pay (Gleim et al., 2013). Similarly, other research finds that offering greater transparency on sustainable product features is valued by consumers such that they choose higher priced sustainable products and punish products with less sustainability information (Meise et al., 2014). These positive effects of providing holistic sustainability information can be explained by the idea that combining multiple congruent sustainability cues can help prospective customers clearly identify sustainable products as such (Magnier & Schoormans, 2015; Pancer et al., 2017). Hereby, it is important that each cue provides additional meaning (i.e., complements extant cues), otherwise "more is less" because overloading consumers with meaningless sustainability information can negatively affect sustainability perceptions (Granato et al., 2022, p. 7). On a more general note, the present findings confirm that

increasing the amount of complementary (sustainability) information increases its persuasive impact (Petty & Cacioppo, 1984), most likely by systematically processing and rationally evaluating verbal sustainability information (Magnier & Schoormans, 2015; Schmuck et al., 2018).

Next to the content and amount of product-related sustainability information, two-process models also take individual-level characteristics into account, as did this research. Specifically, the more personally involved a prospective customer is in the issue at hand (i.e., purchasing sustainable products), the more likely it is that respective informational cues will be considered important and evaluated systematically (Chaiken, 1980; Petty & Cacioppo, 1984; Schmuck et al., 2018). In this context, Paper 1 shows that individual value orientations (e.g., biospheric values) influence the extent to which specific sustainability information (e.g., environmental cues) is relevant to the respective individual. This offers companies the opportunity to tailor product-related sustainability information to different consumer segments (Gleim et al., 2013; Trudel, 2019) and can be expanded to distinct customer groups. In the context of Packaging-as-a-Service, two such target groups were examined in Paper 3, involving end consumers and service suppliers. Notably, biospheric values positively influenced adoption intentions of end consumers, but not of restaurants who offer the service. In addition, while end consumers valued almost all of the seven tested PaaS system attributes (reflecting a need to provide holistic system information), restaurants only valued three to a significant degree (reflecting an opportunity to emphasize selected information). Consequently, the influence of individual-level characteristics on the relevance of product-related sustainability information has important implications for how such information needs to be communicated to each target group to be most effective.

In summary, Paper 1 and 3 contribute to the literature on sustainability perceptions by showing that holistic and targeted sustainability information is most effective in

communicating unobservable sustainability attributes to prospective customers. This reflects a rational perspective on information processing and has relevant implications for companies that tend to focus investments to improve just one or two sustainability attributes while ignoring others (Gershoff & Frels, 2015). Considering the effectiveness of communicating sustainability in a holistic manner, genuine companies are advised to improve the sustainability performance of their products along environmental and social dimensions and the entire life cycle to market sustainable products. In addition, emphasizing specific sustainability information can help address different customer groups more effectively.

5.1.2. Challenge to guard against greenwashing perceptions

The former section suggests that providing multiple congruent sustainability cues can help prospective customers clearly recognize sustainable products as such. Extending this rationale to the evaluation of increasingly prevalent greenwashing cues leads to the assumption that consumers can recognize greenwashed products if these consist of various, clearly greenwashed cues. However, the results in Paper 2 show that presenting multiple greenwashed product cues (such as false and vague claims as well as fake labels) does not guard consumers against the greenwashing trap as long as they are not aware of its potential threat. This counterintuitive finding can be resolved by drawing on the differences between systematic and heuristic information processing:

When people systematically evaluate information, they are cognitively more involved and consider both the quality and quantity of the information at hand (Chaiken, 1980; Petty & Cacioppo, 1984). If participants in Paper 2 had done so, they would have been able to identify the greenwashed product due to the obviously false claims and fake labels. Alternatively, people can use simple heuristics (i.e., decision rules) to infer meaning without much cognitive elaboration of available cues (Chaiken, 1980; Petty & Cacioppo, 1984). The

following two heuristics can explain why participants, who were asked for their purchase intentions in Paper 2, have not recognized greenwashing, albeit multiple greenwashing cues being presented. First, there is evidence that people apply a "the more the better" heuristic and solely consider the quantity of information to infer its persuasiveness (Petty & Cacioppo, 1984, p. 71). In the context of Paper 2 this would imply that the mere number of multiple green(washed) cues was sufficient to (falsely) convince participants of the products' sustainability (without having considered the actual content of the cues). Second, many scholars have shown that visual cues tend to follow an affective persuasion mechanism in which they are processed quickly and automatically (Granato et al., 2022; Magnier & Schoormans, 2015; Schmuck et al., 2018). Compared to Paper 1 and 3 which applied only verbal cues in text vignettes, Paper 2 additionally used visual cues (e.g., green color, nature imagery) in pictorial product stimuli to enhance external validity. Thus, in light of a green overall look of both the sustainable and greenwashed products, it is conceivable that participants relied on the green visual cues as heuristic to infer sustainability (Parguel et al., 2015; Seo & Scammon, 2017). This aligns with research showing that visual sustainability cues activate an affective persuasion mechanism that can even override more systematic processing of verbal sustainability cues and thereby mislead consumers (Schmuck et al., 2018). In summary, the findings of Paper 2 suggest that more heuristic and affective information processing can pose a challenge to protect prospective customers from mistaking a greenwashed product to be sustainable, even though distinct product-related sustainability information is available. This implies that consumers need additional support in order to prevent greenwashed products from crowding out genuinely sustainable ones.

Interestingly, many scholars proposed literacy interventions to help consumers detect misleading sustainable product information (Eng et al., 2021; Fernandes et al., 2020; Naderer & Opree, 2021). These educational measures follow a rational-systematic approach to

information processing by assuming that improving an individual's sustainability knowledge will assist in correctly evaluating the different contents of sustainability information (Fernandes et al., 2020; Parguel et al., 2015). However, the present insights suggest that affective mechanisms involving heuristic processing tend to be at work when consumers fall for greenwashing, which puts the effectiveness of literacy interventions into question. Therefore, it is conceivable that context-related factors (e.g., regulation of sustainability communication, retailers as customer-interfacing entities) may provide opportunities to resolve what product-related and individual-related factors cannot seem to solve yet. Notably, government regulation to prevent greenwashing has generally been considered weak, which can actually drive rather than inhibit further greenwashing practices (Lyon & Montgomery, 2015). Furthermore, policies on sustainability communication have focused on restricting the use of deceptive greenwashing claims and still barerly regulate respective visual cues (Parguel et al., 2015), such as the European Green Claims Directive released in March 2023 (European Commission, 2023). Against this legal background, considering retailers as gatekeepers between consumers and sustainable products seems promising because they can directly influence consumer behavior at the point of purchase (Guyader et al., 2017; Meise et al., 2014; Pancer et al., 2017). Research has shown that retailers can help orient consumers inside the store toward sustainable products through green-colored price tags (Guyader et al., 2017), which could be assigned only to honest green products but not greenwashed ones. Following a heuristic-affective route to information processing, the green price cue added to green-looking products can help consumers visually identify honest green products without much additional processing efforts. A further step could be the selection of a product assortment that excludes greenwashed products in the first place, as intended by organic or fair trade stores that are recognized for their commitment to sustainability (Pancer et al., 2017). Notably, these practices shift the onus to distinguish between greenwashed and honest

green products from consumers to the retailers, which ultimately leads to the question of what influences retailers' product-related sustainability perceptions.

5.1.3. Concluding thoughts on sustainability perceptions

This dissertation shows that what is perceived to be sustainable or not varies strongly depending on different product-related sustainability cues, as well as the individuals and customer groups interpreting this information. On a more general note, these empirical insights contribute to a better understanding of two phenomena that pervade the literature on sustainable consumption and behavior:

First, the frequently observed intention-behavior gap (also attitude-behavior gap) describes prospective customers who state they desire more sustainable products but then do not actually buy them (Guyader et al., 2017; Pancer et al., 2017; White et al., 2019). This gap can be explained by the social desirability of sustainable consumption leading to positive intentions, which stand in contrast to actual behavior, for example, due to sustainable products being perceived to be more expensive, of reduced quality, and/or less accessible than regular products (Luchs et al., 2010; Matthes, 2019). Notably, respective consumers can only form positive purchase intentions if they also perceive the product to be sustainable in the first place (Gershoff & Frels, 2015; Pancer et al., 2017). Therefore, better understanding when consumers perceive a sustainable product as such can provide an additional explanation for an alleged intention-behavior gap. For example, when a consumer who values sustainability does not perceive a product to be sustainable (but non-green or greenwashed), this person understandably may not be interested in buying this product. Hence, before a true intention-behavior gap can be manifested, it needs to be evaluated whether a sustainable product was actually perceived as such by the respective individual.

Second, extant literature often revolves around the discussion of sustainable product attributes to represent an asset or a liability of a product (Chernev et al., 2021; Luchs et al., 2010; Skard et al., 2021). Sustainability tends to be regarded as liability when strength-related product attributes are valued (such as the cleaning performance of detergents), whereas it tends to be regarded as asset when gentleness-related attributes are valued (such as the skincare performance of personal care products) (Luchs et al., 2010; Skard et al., 2021). These differential effects depending on the nature of the product are relevant for companies that consider the introduction of more sustainable processes and products (Gershoff & Frels, 2015). However, irrespective of a product's nature, any product would need to be *perceived* as sustainable in the first place, before it can imply a sustainability asset or liability. As this research has shown, both product-related sustainability perceptions and individuals' sustainability values play an important role in evaluating products. These two factors give rise to four scenarios for a company offering a sustainable product, which determine on a more general level whether a product's sustainability will be regarded as asset or liability:

First, a prospective customer who values sustainability and perceives the product to be sustainable will regard the sustainability attributes as asset and probably purchase the product. Extant research showed that this asset effect tends to be stronger for gentleness-related products, for which sustainability is a desirable product attribute (Chernev et al., 2021; Luchs et al., 2010). At the same time, Paper 2 in this research gives reason for caution because such products may be particularly prone to greenwashing. This means that consumers can perceive the sustainability attributes of such a product to be an asset when in fact, they are none. Second, if the person who values sustainability does not actually perceive the product to be sustainable (but non-green or greenwashed), then his or her purchase likelihood is expected to be lower, which can be mistaken as intention-behavior gap (as outlined above). Third, a prospective customer who does *not* value sustainability, but

perceives the product to be sustainable, will be more inclined to regard the sustainability attributes as a liability and unlikely purchase the product. Extant research showed that this liability effect tends to be stronger for strength-related products, for which product performance is essential (Chernev et al., 2021; Luchs et al., 2010). Accordingly, for this person not perceiving the product to be sustainable will more likely lead to its purchase. Notably, this last scenario revives the old question of whether companies may have a strategic interest in not marketing an actually sustainable product as such, which research has termed "green muting" (Szabo & Webster, 2021, p. 34).

Overall, this dissertation extends knowledge on which sustainability cues can increase sustainability perceptions (Paper 1) and which can decrease them to the point of perceived greenwashing (Paper 2), laying the foundation to better understand prospective customers' intentions and actions. It acknowledges that some sustainable business cases not only involve end consumers, but also intermediate service suppliers for a sustainable product or service to work. Thus, for an exemplary case, this research examines adoption intentions from both perspectives to account for the increased complexity of two customer groups involved (Paper 3).

5.2. Avenues for future research

Each paper points out interesting avenues for future research in the respective chapters. Overall, this dissertation has focused on product-related sustainability perceptions of prospective customers (end consumers and service suppliers), which represent a highly relevant stakeholder group to any company that aims to sell a product or service. As indicated above, it appears worthwhile for companies to consider the sustainability perceptions of additional customers (such as retailers) to effectively market sustainable products. This

proposition extends to other stakeholder groups (such as employees, suppliers, potential investors, audit providers, or NGOs). While these stakeholders may consider product-related sustainability information as well, they most probably will also be interested in a broader picture of the focal company and draw on other communication outlets, such as corporate sustainability reports (Hahn & Kühnen, 2013). Notably, extant research confirms that sustainability information in such reports is valued differently within one single stakeholder group as well as between distinct stakeholder groups. For example, auditors' materiality assessments differ depending on the audited case (Moroney & Trotman, 2016), and potential investors consider the topic of energy more relevant than the topic of biodiversity, while both topics are equally relevant for potential employees (Reimsbach et al., 2020). Furthermore, research has examined factors that can increase the credibility of sustainability reports, which can also involve misleading communication (Baier et al., 2022; Lyon & Montgomery, 2015). Therefore, the initial challenges to identify which sustainability information is most effective to market sustainable products and how companies can best circumvent accusations of greenwashing also apply to corporate communication beyond the product-level. In addition, as sustainability reports typically are intended to address the information needs of more than one stakeholder simultaneously (Reimsbach et al., 2020), the third challenge of how different customer groups can be addressed extends to other stakeholders as well. Considering these parallels, future research can examine how sustainability perceptions of other relevant stakeholders can be shaped by sustainability information provided on a company-level.

In the face of prevalent greenwashing practices, this research suggests that more work is needed on how the misleading effects of heuristic and affective information processing can be countered. This corresponds to more general calls for research on affective consumer decision making in the context of sustainable products (Bangsa & Schlegelmilch, 2020) and to more specific calls for research on the effects of visual sustainability cues (Matthes, 2019).

The findings in Paper 2 show that product-related visual sustainability cues lead to verbal greenwashing cues not being recognized as such, which prevents consumers from identifying greenwashing at hand. In contrast, research in sustainability reporting finds that company-related visual sustainability cues lead to verbal honest green cues not being recognized as such, which fosters impressions of greenwashing when in fact, the verbal cues were true (Baier et al., 2022). Thus, more research on visual sustainability cues is warranted and can help disentangle the differential effects observed in product-related and company-related sustainability information. With regard to studying consumers' heuristic and affective processing of sustainability information, drawing on the tools and insights offered by consumer neuroscience could be valuable: They allow a direct study of brain activities when consumers evaluate sustainable products and, thus, shed light on what is typically called the "black box" in stimulus-organism-response models (Braeutigam & Kenning, 2022, p. 5; Kotler et al., 2020, p. 255). Precisely because the presence of numerous misleading greenwashed products adds complexity to today's consumer decision making, future research can help practitioners to better understand what is going on inside consumers' minds when they are confronted with such products.

5.3. Conclusion

With the continuing rise of consumer interest in more sustainable consumption, companies are challenged with effectively marketing sustainable products and services to different customer groups without falling into a greenwash attempt. This dissertation addressed these challenges by adopting a consumer perspective and examined the influence of different product-related sustainability information on consumers' sustainability perception using experimental designs. The findings show that communicating the multifaceted nature of sustainability by combining different sustainability cues and tailoring these to the needs of

different customer groups helps to bolster sustainability perceptions. However, a similar combination of multiple greenwashed cues does not guard consumers from falling into the greenwashing trap. This research suggests that less rational information processing may be interfering and proposes context-related solutions that make use of this human tendency. Overall, the dissertation adds to the extant literature by providing a better understanding of consumers' perceived sustainability of products. It invites future research on sustainability perceptions of other stakeholders and beyond the product-level as well as on heuristic-affective information processing in the context of sustainable consumption. Furthermore, this research offers guidance to practitioners on introducing genuinely sustainable products that will become even more relevant in the future as the need to transition toward sustainability will continue to drive both corporate and consumer interest therein.

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Appendix A. Paper 1

Table A1. Overview of stimuli (Study 1).

Life-cycle phase	**Sustainability domain**		
	Non-sustainability-related product information	*Environmental product information*	*Social product information*
Sourcing (of raw materials)	The raw materials for the cell phone are purchased on the world market.	Fully recycled materials are used as raw materials for the cell phone.	During extraction of the raw materials for the cell phone the highest human rights standards are maintained.
Production	The cell phone is produced according to common industry standards.	The production of the cell phone is from 100% renewable energy.	The cell phone is produced in strict compliance with the highest occupational safety standards.
End-of-Life	Legal requirements are met for the disposal of the cell phone.	When returned through the retailer, the modular components of the used cell phone are reused.	When returned via the retailer, by refurbishing the used cell phone, jobs are created in social institutions.

Validation
Each of these nine combinations of information on life-cycle phase and sustainability domain was supplemented by validation information as the third dimension in the vignette experiment:
Not externally validated: This information has been provided by the manufacturer.
Validated by NGO: This information has been validated by a non-governmental environmental/social organization.
Validated by governmental institution: This information has been validated by a governmental institution.

Table A2. Measures and reliabilities.

		Study 1 (*N* = 164)		**Study 2** (*N* = 251)	
Construct	**Items**	**Mean (*SD*)**	**α**	**Mean (*SD*)**	**α**
Biospheric value orientation (Bouman et al., 2018)	*Please indicate the extent to which each portrayed person is like you.* It is important to that person to prevent environmental pollution. It is important to that person to protect the environment. It is important to that person to respect nature. It is important to that person to be in unity with nature.	5.2 (1.2)	.84	5.2 (1.2)	.87
Altruistic value orientation (Bouman et al., 2018)	It is important to that person that every person has equal opportunities. It is important to that person to take care of those who are worse of. It is important to that person that every person is treated justly. It is important to that person that there is no war or conflict. It is important to that person to be helpful to others.	5.4 (1.1)	.84	5.4 (1.0)	.83
Information-processing capacity (Sproles & Kendall, 1986)	I am confused by all the information on different products. The more I learn about products, the harder it seems to choose the best. There are so many brands to choose from that I often feel confused. Sometimes it's hard to decide in which stores to shop.	3.5 (1.6)	.89	3.7 (1.6)	.86
Greenwashing skepticism (Leonidou & Skarmeas, 2017)	Most companies mislead with words about the environmental features of their products. Most companies mislead with visuals or graphics about the environmental features of their products. Most companies provide vague or seemingly unprovable environmental claims for their products. Most companies overstate or exaggerate the environmental features of their products. Most companies leave out or hide important information about the real environmental features of their products.	5.0 (1.1)	.80	5.1 (1.2)	.84

Note. All instructions were measured on a 7-point bipolar scale.

Table A3. Test for differences in product categories in Study 1.

	Model 1			Model 2			Model 3		
	β	***SE***	***t***	**β**	***SE***	***t***	**β**	***SE***	***t***
Intercept	-0.02	0.22	-0.09	0.24	0.21	1.13	-0.22	0.21	-1.05
Cell phone				-0.26	0.30	-0.85	0.20	0.30	0.66
Jeans	-0.20	0.30	-0.66	-0.46	0.30	-1.54			
Cereals	0.26	0.30	-0.85				0.46	0.30	-1.54

Note. Dependent variable: Sustainability perception.

Table A4. Test for differences in life-cycle phase content (Study 2).

Sourcing	Production	End-of-Life	Sourcing + Production	Sourcing + End-of-Life	Production + End-of-Life	all
4.63	4.87	5.14	6.09	6.35	6.41	7.61
$F = 355.03$, $p < 0.00$						

Note. Dependent variable: Sustainability perception.

Appendix B. Paper 2

Table B1. Overview of scales used in the pilot study.

Construct	Items	Mean (*SD*)	Cronbach's alpha
Personal Involvement Inventory (Zaichkowsky, 1985)	For me [product][a] generally are… *(on a scale from 1 to 7)*	M_{tc} = 4.38 (1.47)	α_{tc} = .910
	Important – unimportant	M_{hc} = 4.61 (1.34)	α_{hc} = .867
	Irrelevant – relevant	M_{sp} = 6.07 (0.97)	α_{sp} = .867
	Uninteresting – interesting		
	Of no concern – of concern to me		
Consumer Involvement Profiles (Laurent & Kapferer, 1985)	*(On a scale from 1 = strongly disagree to 7 = strongly agree)*	M_{tc} = 3.52 (1.50)	α_{tc} = .887
	[Product] are very important to me.	M_{hc} = 4.23 (1.51)	α_{hc} = .933
	For me, [product] do not matter.[b]	M_{sp} = 5.58 (1.14)	α_{sp} = .897
	[Product] are an important part of my life.		
	I choose my [product] very carefully.		
	Which [product] I buy matters to me a lot.		
	Choosing [product] is an important decision for me.		
Strength vs. Gentleness (Luchs et al., 2010)	Please rate how important each of the following features is to you when purchasing [product]:	$M_{tc\text{-}gs}$ = -1.10 (1.16)	
	(On a scale from 1= not important at all to 7 = very important)	$M_{hc\text{-}gs}$ = 0.20 (0.92)	
	Strong, powerful, tough, effective, gets the job done		
	Gentle, safe, healthy, good for children, mild		

Note. Within the same construct the respective question items were presented in random order.

tc = toilet cleaner, hc = hand cream, sp = smartphone, gs = difference score gentleness - strength.

[a] Insert toilet cleaners, hand creams, or smartphones as product. Exception: Strength and gentleness were not queried for smartphones.

[b] This item was reverse-coded.

Table B2. Product stimuli for toilet cleaner (Study 1a) based on extant green product categories (Simula & Lehtimäki, 2009; Szabo & Webster, 2021).

Product	Honest green product	Greenwashed product	Regular product
Original stimuli presented in German, see translated cues below			
Claim 1	***Specific:*** "Formula without microplastics"	***Vague:*** "Does something good for the environment"	"Long-lasting freshness"
Claim 2	***True:*** "Surfactants based on renewable raw materials"	***False:*** "More environmentally friendly than pure water"	"Powerful against dirt and limescale"
Claim 3	***Relevant:*** "99.9% biodegradable"	***Irrelevant:*** "99.9% without formaldehyde"[c]	"Eliminates 99.9% of bacteria"
Color	Green	Green	Orange
Imagery	Leaves	Leaves	Bubbles of soap
Eco-labels	Official European eco-label[a] and V-Label[b]	Fake labels stating "eco-product" and "vegan"	None

[a] The European eco-label signals that a product or a service has a lower environmental impact than comparable ones (European Union, 2009).

[b] The European V-Label is one of the two most widespread labels for vegan products in the European Union (Stremmel et al., 2022).

[c] This represents an irrelevant claim because the carcinogenic preservative formaldehyde is forbidden in cleaning products in a proportion over 0.2% (SCCNFP, 2002).

Table B3. Product stimuli for hand cream (Study 1b) based on extant green product categories (Simula & Lehtimäki, 2009; Szabo & Webster, 2021).

Product	Honest green product	Greenwashed product	Regular product
Original stimuli presented in German, see translated cues below			
Claim 1	***Specific:*** "Ingredients from controlled organic cultivation"	***Vague:*** "Does something good for the environment"	"Nourishes and protects your hands"
Claim 2	***True:*** "Formula without microplastics"	***False:*** "No ecological footprint"	"Long lasting moisturizing care"
Claim 3	***Relevant:*** "Certified natural cosmetics"	***Irrelevant:*** "Without animal testing"[c]	"Quickly absorbed"
Color	Green	Green	Orange
Imagery	Grass	Grass	Hand
Eco-labels	Official Vegan Trademark[a] and Natrue label[b]	Fake labels stating "vegan" and "natural beauty"	None

[a] The Vegan Trademark is one of the two most widespread labels for vegan products in the European Union (Stremmel et al., 2022).

[b] The Natrue label is a leading certification standard for natural and organic cosmetic products (Bozza et al., 2022).

[c] This represents an irrelevant claim because animal testing of cosmetic products has been banned in the European Union (Bozza et al., 2022).

Table B4. Product stimuli for smartphone (Study 1c) based on extant green product categories (Simula & Lehtimäki, 2009; Szabo & Webster, 2021).

Product	Honest green product	Greenwashed product	Regular product
Original stimuli presented in German, see translated cues below			
Claim 1	***Specific:*** "Modular design - Components can be reused after use"	***Vague:*** "Sustainable Design - Does something good for the environment"	"Modern design – The perfect combination of form and function"
Claim 2	***True:*** "Case made from 100% recycled material"	***False:*** "100% biodegradable"	"100% charged within one hour"
Claim 3	***Relevant:*** "Free repair service for a long lifetime"	***Irrelevant:*** "Does not contain banned chemical substances"	"High-resolution cameras with optical zoom"
Color	Green	Green	Blue
Imagery	Natural elements	Natural elements	Technical elements
Eco-labels	Official German Blue Angel[a] and European eco-label[b]	Fake labels stating "angel product" and "eco-product"	None

[a] The German Blue Angel label represents the oldest eco-label worldwide and addresses environmental and health-related aspects of products and services (Rubik et al., 2022).

[b] The European eco-label signals that a product or a service has a lower environmental impact than comparable ones (European Union, 2009).

Table B5. Overview of scales used to measure constructs in Studies 1a-c.

Construct	Items	Cronbach's alpha		
		Toilet cleaner (N = 153)	**Hand cream** (N = 157)	**Smart-phone** (N = 162)
Purchase intention (Bian & Forsythe, 2012; based on Dodds et al., 1991)	If I were going to purchase a [product][a], I would consider buying this product. If I were going to buy a [product], the likelihood I would purchase this product is high. My willingness to buy this product would be high if I were going to buy a [product]. The probability I would consider buying this product is high.	α_{hg} = .962 α_{gw} = .967 α_{reg} = .962	α_{hg} = .939 α_{gw} = .933 α_{reg} = .947	α_{hg} = .966 α_{gw} = .977 α_{reg} = .976
Perceived greenness (Gershoff & Frels, 2015)	This product deserves to be labeled 'environmentally friendly'. Purchasing this product is a good environmental choice. A person who cares about the environment would be likely to buy this product. How environmentally friendly is this product?[b]	α_{hg} = .940 α_{gw} = .957 α_{reg} = .914	α_{hg} = .913 α_{gw} = .936 α_{reg} = .905	α_{hg} = .946 α_{gw} = .941 α_{reg} = .953
Perceived green-washing (Chen & Chang, 2013; Schmuck et al., 2018)	The text shown on this product is misleading in regard to its environmental features. The visuals or graphics pictured on this product are misleading in regard to its environmental features. This product possesses a green claim that is vague or seemingly unprovable. This product exaggerates how green it actually is. This product leaves out or masks important information, making the green claim sound better than it is. This product includes claims about its environmental features that are false.	α_{hg} = .936 α_{gw} = .929 α_{reg} = .908	α_{hg} = .920 α_{gw} = .940 α_{reg} = .906	α_{hg} = .931 α_{gw} = .938 α_{reg} = .948

Note. All but one item were measured using 7-point Likert scales from 1 = strongly disagree to 7 = strongly agree.
hg = honest green, gw = greenwashed, reg = regular.

[a] Insert toilet cleaner, hand cream, or smartphone as product.

[b] This item was answered on a seven-point Likert scale from 1 = not at all environmentally friendly to 7 = extremely environmentally friendly.

Table B6. Manipulation check for labels.

Product	Selected as official label				Do not know
	Official label 1[a]	Official label 2[b]	Fake label 1	Fake label 2	
Study 1a: Toilet cleaner (N = 153)	60.8%	78.4%	15.7%	9.2%	11.1%
Study 1b: Hand cream (N = 157)	56.1%	51.6%	8.9%	14.0%	22.9%
Study 1c: Smart-phone (N = 162)	56.2%	82.7%	24.7%	3.1%	7.4%
Study 2: Toilet cleaner (N = 228)	53.1%	64.0%	21.1%	9.2%	14.9%

Note. More than one label could be selected, therefore, the sum of the percentage scores can exceed 100%.

[a] Study 1a, 1c, 2: European eco-label; Study 1b: Natrue label.

[b] Study 1a, 2: European V-Label; Study 1b: Vegan label, Study 1c: "Blauer Engel" label.

Table B7. Manipulation check for claims.

Product	Claims	Mean	SD	SE of Mean	95% Confidence Interval for Difference: Lower Bound	95% Confidence Interval for Difference: Upper Bound	T	df	p (two-tailed)
Study 1a: Toilet cleaner	False claim (rated as false - vague)	.392	1.815	.147	.102	.682	2.673	152	.008
(*N* = 153)	Vague claim (rated as vague - false)	.359	2.169	.175	.013	.706	2.050	152	.042
Study 1b: Hand cream	False claim (rated as false - vague)	-.306[a]	1.682	.134	-.571	-.041	-2.278	156	.024
(*N* = 157)	Vague claim (rated as vague - false)	.624	1.827	.146	.336	.912	4.280	156	<.001
Study 1c: Smart-phone	False claim (rated as false - vague)	.438	2.207	.173	.096	.781	2.528	161	.012
(*N* = 162)	Vague claim (rated as vague - false)	1.012	2.121	.167	.683	1.341	6.076	161	<.001
Study 2: Toilet cleaner	False claim (rated as false - vague)	.303	2.233	.148	.011	.594	2.046	227	.042
(*N* = 228)	Vague claim (rated as vague - false)	.904	2.149	.142	.623	1.184	6.350	227	<.001

[a] The claim "No ecological footprint" was rated significantly higher as vague than as false, contrary to the intended effect. Because it was not our goal to test the effects of individual claims, this discrepancy was deemed acceptable.

Table B8. Repeated measures ANOVAs for purchase intention.

Product	Stimulus	Comparison product type	Mean Difference	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Study 1a: Toilet cleaner (N = 153)	Honest green	Greenwashed	.214	.095	.078	-.016	.444
		Regular	1.613*	.150	<.001	1.250	1.975
	Green-washed	Honest green	-.214	.095	.078	-.444	.016
		Regular	1.399*	.152	<.001	1.030	1.767
	Regular	Honest green	-1.613*	.150	<.001	-1.975	-1.250
		Greenwashed	-1.399*	.152	<.001	-1.767	-1.030
Study 1b: Hand cream (N = 157)	Honest green	Greenwashed	.008	.111	1.000	-.260	.276
		Regular	1.342*	.161	<.001	.954	1.731
	Green-washed	Honest green	-.008	.111	1.000	-.276	.260
		Regular	1.334*	.160	<.001	.948	1.721
	Regular	Honest green	-1.342*	.161	<.001	-1.731	-.954
		Greenwashed	-1.334*	.160	<.001	-1.721	-.948
Study 1c: Smart-phone (N = 162)	Honest green	Greenwashed	.336*	.110	.008	.070	.603
		Regular	.407*	.135	.009	.080	.735
	Green-washed	Honest green	-.336*	.110	.008	-.603	-.070
		Regular	.071	.138	1.000	-.262	.404
	Regular	Honest green	-.407*	.135	.009	-.735	-.080
		Greenwashed	-.071	.138	1.000	-.404	.262
Study 2: Toilet cleaner (N = 228)	Honest green	Greenwashed	.261	.192	.535	-.210	.731
		Regular	.739*	.237	.008	.159	1.320
	Green-washed	Honest green	-.261	.192	.535	-.731	.210
		Regular	.479	.260	.208	-.158	1.116
	Regular	Honest green	-.739*	.237	.008	-1.320	-.159
		Greenwashed	-.479	.260	.208	-1.116	.158

Note. Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table B9. Repeated measures ANOVAs for perceived greenness.

Product	Stimulus	Comparison product type	Mean Difference	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Study 1a: Toilet cleaner (N = 153)	Honest green	Greenwashed	.337*	.106	.005	.080	.593
		Regular	2.722*	.129	<.001	2.409	3.036
	Green-washed	Honest green	-.337*	.106	.005	-.593	-.080
		Regular	2.386*	.148	<.001	2.028	2.743
	Regular	Honest green	-2.722*	.129	<.001	-3.036	-2.409
		Greenwashed	-2.386*	.148	<.001	-2.743	-2.028
Study 1b: Hand cream (N = 157)	Honest green	Greenwashed	.194	.115	.284	-.085	.474
		Regular	2.753*	.141	<.001	2.411	3.096
	Green-washed	Honest green	-.194	.115	.284	-.474	.085
		Regular	2.559*	.152	<.001	2.191	2.927
	Regular	Honest green	-2.753*	.141	<.001	-3.096	-2.411
		Greenwashed	-2.559*	.152	<.001	-2.927	-2.191
Study 1c: Smart-phone (N = 162)	Honest green	Greenwashed	.015	.105	1.000	-.238	.269
		Regular	2.593*	.147	<.001	2.237	2.949
	Green-washed	Honest green	-.015	.105	1.000	-.269	.238
		Regular	2.577*	.156	<.001	2.199	2.955
	Regular	Honest green	-2.593*	.147	<.001	-2.949	-2.237
		Greenwashed	-2.577*	.156	<.001	-2.955	-2.199
Study 2: Toilet cleaner (N = 228)	Honest green	Greenwashed	.468*	.144	.005	.114	.821
		Regular	2.231*	.215	<.001	1.704	2.758
	Green-washed	Honest green	-.468*	.144	.005	-.821	-.114
		Regular	1.763*	.207	<.001	1.256	2.270
	Regular	Honest green	-2.231*	.215	<.001	-2.758	-1.704
		Greenwashed	-1.763*	.207	<.001	-2.270	-1.256

Note. Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table B10. Repeated measures ANOVAs for perceived greenwashing.

						95% Confidence Interval for Difference[b]	
Product	**Stimulus**	**Comparison product type**	**Mean Difference**	**Std. Error**	**Sig.[b]**	**Lower Bound**	**Upper Bound**
Study 1a: Toilet cleaner (N = 153)	Honest green	Greenwashed	-1.346*	.158	<.001	-1.730	-.963
		Regular	1.641*	.150	<.001	1.276	2.005
	Green-washed	Honest green	1.346*	.158	<.001	.963	1.730
		Regular	2.987*	.169	<.001	2.578	3.395
	Regular	Honest green	-1.641*	.150	<.001	-2.005	-1.276
		Greenwashed	-2.987*	.169	<.001	-3.395	-2.578
Study 1b: Hand cream (N = 157)	Honest green	Greenwashed	-1.182*	.151	<.001	-1.548	-.815
		Regular	1.462*	.152	<.001	1.094	1.829
	Green-washed	Honest green	1.182*	.151	<.001	.815	1.548
		Regular	2.643*	.174	<.001	2.222	3.065
	Regular	Honest green	-1.462*	.152	<.001	-1.829	-1.094
		Greenwashed	-2.643*	.174	<.001	-3.065	-2.222
Study 1c: Smart-phone (N = 162)	Honest green	Greenwashed	-1.102*	.149	<.001	-1.461	-.742
		Regular	1.442*	.133	<.001	1.121	1.764
	Green-washed	Honest green	1.102*	.149	<.001	.742	1.461
		Regular	2.544*	.165	<.001	2.144	2.944
	Regular	Honest green	-1.442*	.133	<.001	-1.764	-1.121
		Greenwashed	-2.544*	.165	<.001	-2.944	-2.144
Study 2: Toilet cleaner (N = 228)	Honest green	Greenwashed	-1.146*	.218	<.001	-1.678	-.613
		Regular	1.139*	.212	<.001	.620	1.659
	Green-washed	Honest green	1.146*	.218	<.001	.613	1.678
		Regular	2.285*	.264	<.001	1.640	2.930
	Regular	Honest green	-1.139*	.212	<.001	-1.659	-.620
		Greenwashed	-2.285*	.264	<.001	-2.930	-1.640

Note. Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table B11. Details on the coding procedure for Study 2.

Codes		Responses…	Examples (Respondent number) (translated from German)
Group: Greenwashing thoughts			
0	No	- do not refer to sustainability or - refer positively to sustainability or - refer negatively to sustainability	- I would buy that (R10) - Appearance not appealing (R15) - Environmentally friendly (R18) - Green is "in" (R10) - Bad for the environment (R10)
1	Yes	- indicate mistrust or doubts such that participants question the product's sustainability or - clearly indicate greenwashing by concluding that a product is deceptive	- Possibly not entirely credible (R3) - Is it possible to verify the claims? (R4) - How can a product be more environmentally friendly than water? (R51) - Misleading (R128) - False claim on the label (R66) - Looks like greenwashing (R217) - "Better for the environment than water" is a lie (R58)
Group: Visual cues[a, c]			
0	No	- do not indicate visual cues at all - if "green" is used as synonym to "sustainable" it does not count as visual cue in terms of color	- Anyone can claim to be environmentally friendly (R9) - These products advertised as "green" are just annoying (R133)
1	Yes	- mention visual cues on a general, abstract level or - refer to specific visual cues	- Pleasant appearance (R82) - Nice color (R55) - Green color (R36) - What do images of leaves have to do with toilet cleaning? (R28)
Group: Verbal cues[b, c]			
0	No	- do not indicate verbal cues at all	- Looks sustainable (R54) - Do not know this product (R101)
1	Yes	- mention verbal cues on a general, abstract level or - summarizes specific statements or - refer to keywords from specific verbal cues as stated in Tables B2-B4	- Exaggerated description of the product (R141) - I cannot judge whether the information is correct (R169) - Without harmful chemistry (R134) - Contains surfactants (R47) - No microplastic, very good (R56)

Note. Across all responses from one participant, the highest numerical code denotes the final code within one code group (i.e., greenwashing thoughts). If participants mentioned more than one thought related to the same numerical code, this was counted only once.

[a] Labels were coded as zero for visual cues because they differed between the green products. This counters the idea that visual cues would inhibit participants from distinguishing between the green products (as opposed to color and imagery).

[b] References to the brand names (Clean green, Clean right) were coded as zero for verbal cues because they did *not* differ between the green products. This counters the idea that verbal cues would help participants distinguish between the green products (as opposed to the three different claims).

[c] Responses solely referring to the packaging itself (e.g., its form, material, recyclability etc.) were coded as zero because packaging features were not part of the experiments and not manipulated. If responses referred to visual or verbal cues *on the* packaging, this was coded as outlined above.

Table B12. Frequency of greenwashing thoughts across conditions (Study 2).

Greenwashing thoughts		**Purchase intention**	**Perceived greenness**	**Perceived greenwashing**
No	Frequencies	48_a	45_a	22_b
	Proportion within condition	67.6%	57.7%	27.8%
	Adjusted residual	3.5	1.6	-5.0
Yes	Frequencies	23_a	33_a	57_b
	Proportion within condition	32.4%	42.3%	72.2%
	Adjusted residual	-3.5	-1.6	5.0

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

Table B13. Frequency of shared visual cues across conditions (Study 2).

Visual cues mentioned (color and imagery)		**Purchase intention**	**Perceived greenness**	**Perceived greenwashing**
No	Frequencies	25[a]	49[b]	44[b]
	Proportion within condition	35.2%	62.8%	55.7%
	Adjusted residual	-3.4	2.4	0.9
Yes	Frequencies	46[a]	29[b]	35[b]
	Proportion within condition	64.8%	37.2%	44.3%
	Adjusted residual	3.4	-2.4	-0.9

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

Table B14. Frequency of distinct verbal cues across conditions (Study 2).

Verbal cues mentioned (three claims)		**Purchase intention**	**Perceived greenness**	**Perceived greenwashing**
No	Frequencies	27[a]	28[a]	20[a]
	Proportion within condition	38.0%	35.9%	25.3%
	Adjusted residual	1.1	0.7	-1.8
Yes	Frequencies	44[a]	50[a]	59[a]
	Proportion within condition	62.0%	64.1%	74.7%
	Adjusted residual	-1.1	-0.7	1.8

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

Table B15. Pairwise comparison of condition for response time to categorize the greenwashed product (Study 2).

Product category	Condition 1	Condition 2	Test Statistic	Std. Error	Std. Test statistic	Sig.	Adj. Sig.[a]
Study 2 Toilet cleaner (N = 228)	Perc. greenness	Perc. Greenwa-shing	-1.712	10.529	-.163	.871	1.000
	Perc. greenness	Purchase intention	26.071	10.820	2.410	.016	.048
	Perc. Greenwa-shing	Purchase intention	24.359	10.787	2.258	.024	.072

Note. Each row tests the null hypothesis that the Condition 1 and Condition 2 distributions are the same. Asymptotic significances (2-sided tests) are displayed. The significance level is .050.

[a] Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table B16. Frequency of correct categorization of greenwashed product across conditions (Study 2).

Categorization of greenwashed product		**Purchase intention**	**Perceived greenness**	**Perceived greenwashing**
Incorrect	Frequencies	27[a]	35[a]	28[a]
	Proportion within condition	38.0%	44.9%	35.4%
	Adjusted residual	-0.3	1.2	-0.9
Correct	Frequencies	44[a]	43[a]	51[a]
	Proportion within condition	62.0%	55.1%	64.6%
	Adjusted residual	0.3	-1.2	0.9

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

Appendix C. Paper 3

Table C1. Interview guides used in qualitative pre-study.

Question type	Questions to restaurant representatives and consumers <u>without</u> past experience of using systems for reusable containers for takeaway food	Questions to restaurant representatives and consumers <u>with</u> past experience of using systems for reusable containers for takeaway food
Introduction	• Which systems for reusable containers do you know? • Can you briefly describe the reuse system? • How do these systems differ?	• Which systems for reusable containers do you know, do you currently use, or did you use in the past? • Can you briefly describe the reuse system? • When, where, and how do you use it? • How do these systems differ?
Main questions: Attributes of reuse systems General	• What do you think of such reuse systems? • If you were to tell a friend about reuse systems, what would you say?	• What do you think of such reuse systems? • If you were to tell a friend about reuse systems, what would you say?
Drivers	• Which attributes would motivate you to use such a system? • What must the system fulfill for you to use it? • What must not be missing from the system in any case?	• What works well? • Which positive/good experiences did you have? • Which attributes motivated you to use such a system? • What does the system fulfill that makes you use it?
Barriers	• Which attributes would keep you from using such a system? • What kept you from using a reuse system in the past?	• What works less well? • Which negative/bad experiences did you have? • Which attributes would keep you from using such a system? • Did you ever switch systems? Why?
Ideal system	• What would an ideal reuse system look like (for you)?	• What would an ideal reuse system look like (for you) • What could be better about the system you use? How could the system still be improved?
Wrap-up	• Of all the things we've talked about, what is most important to you? • All in all: Would you participate in a reuse system? • If yes, which one? • If not, what would you use instead?	• Of all the things we've talked about, what is most important to you?

Note. The interview guides were translated from German to English and were identical for interviews with restaurant representatives and focus groups with consumers. The questions only varied depending on whether respondents had used any system for reusable containers for takeaway food before (right column) or not (left column).

Table C2. Two exemplary vignettes showing PaaS system attributes.

	Vignette for restaurants		Vignette for consumers
Is it a deposit or digital system?	Digital system: Customers who are registered in the system provider's app can borrow the containers free of charge for 14 days. Costs for my restaurant: • Usage fee of 20 cents for each reusable container filled • One-time entry fee of 100 euros	**System type**	Deposit system: You can borrow reusable containers from participating partners for an indefinite period for a deposit of 5 euros. After returning them, you will get the deposit back.
How can I offer the system?	• Via delivery services to the customers • Via self-collection directly at the restaurant	**Access to containers**	You receive containers when you order your food directly from partners for self-collection
Which container types exist?	• Containers customized to my dishes (e.g., with partitioning, sushi box, pizza box, etc.)	**Container types**	The system provides access to standardized 1250ml containers
How many partners participate?	• 20 partners within a 2km radius around my restaurant	**Partners**	Currently, 5 partners participate in the system within a 2km radius around you
How many active users are there?	• 950 active users within a 2km radius around my restaurant	**Users**	Currently, there are 80 active users of the system within a 2km radius around you
How are containers returned?	• At any time at stationary return stations • During opening hours at all participating partners	**Place of return**	You can return borrowed containers to all participating partners during opening hours
What do I learn about the environmental impact?	• Number of single-use containers saved by all partners	**Impact information**	You regularly learn how many single-use containers you have personally saved by using the reuse system
The probability that we would use the described system in my restaurant is:		**The probability that I would use the described system is:**	
Very low Very high		Very low Very high	
1 2 3 4 5 6 7 8 9 10 11		1 2 3 4 5 6 7 8 9 10 11	

Note. All seven PaaS system attributes reflected in the vignettes of our FSEs were derived from our qualitative pre-study (see Table 7 for an overview of results). The specific wording of vignettes was adapted to the perspective of the respective sample (i.e., restaurants or consumers). To decrease cognitive load, vignettes for restaurant representatives (see example on the left) were simplified by formulating each system attribute as a straightforward question and by using bullet points to reduce the amount of text.

Table C3. Measured constructs.

Construct	Items	Restaurant sample (N = 176)	Consumer sample (N = 245)
Technology acceptance[a] (Neyer et al., 2012)		M = 4.328 SD = 1.689 α = .926	M = 4.484 SD = 1.527 α = .931
	[I am / My restaurant's management is] very curious about new technological developments.		
	[I quickly take / My restaurant's management quickly takes] a liking to new technological developments.		
	[I am / my restaurant's management is] always interested in using the latest technological devices.		
	If [I / my restaurant's management] had the opportunity, [I / they] would use tech products much more often than [I / they] currently do.		
Biospheric values[b] (Bouman et al., 2018)		M = 6.095 SD = 0.963 α = .896	M = 5.698 SD = 1.153 α = .891
	It is important to [this person / to my restaurant's management] to prevent environmental pollution.		
	It is important to [this person / to my restaurant's management] to protect the environment.		
	It is important to [this person / to my restaurant's management] to respect nature.		

Note. In the restaurant sample, question items referred to a restaurant's management if the participant indicated that he or she has no management role.

[a] Items were answered on a 7-point Likert scale from 1 = strongly disagree to 7 = strongly agree.

[b] Items were answered on a 7-point Likert scale from 1 = not like me at all to 7 = very much like me. The item "It is important to this person to be in unity with nature" was dropped because the pre-test of our restaurant FSE showed that its meaning was unclear to some participants.

Table C4. Characteristics of restaurant and consumer samples.

	Restaurant sample (N = 176)		**Consumer sample** (N = 245)	
Gender	Female	45.5%	Female	46.5%
	Male	54%	Male	53.5%
	Non-binary	0.6%	Non-binary	0%
Age	*M*: *SD*:	52.6 11.1	*M*: *SD*:	40.1 14.6
Location of restaurant **Area of consumer's residence**	Rural community	38.6%	Rural community	20.4%
	Small city	25%	Small city	22.4%
	Mid-sized city	14.8%	Mid-sized city	20.8%
	Large city	8%	Large city	15.1%
	Major city	13.6%	Major city	21.2%
Hotels		35.2%		
Manager role		86.4%		
Education			None	0.4%
			High school	14.7%
			Qualified to go to university	16.3%
			Apprenticeship	40%
			University degree	28.2%
			PhD	0.4%
Net income			Less than €500	4.5%
			€501-€1.000	10.6%
			€1.001-€1.500	10.2%
			€1.501-€2.000	12.2%
			€2.001-€3.000	22.4%
			€3.001-€4.000	14.7%
			€4.001 or more	16.3%
			Prefer not to say	9%