Green Consumption Assistant

Working Paper

Driving sustainable choices for consumer electronics: The influence of sustainability cues on purchasing decisions

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Content

Introduction

Reducing the environmental impact of household consumption is an important step toward achieving the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change (UNFCCC). GHG emissions must decline rapidly to meet the overall target of reducing emissions by 65% by 2030 (Germany: Amendment of Climate Change, n.d.). However, this goal is threatened by growing consumption, i.e. the increase of online shopping by an average of 9% per year over the last decade (Online Monitor 2022, 2022). Effective, large-scale action is needed to help consumers make more sustainable choices online. The Green Consumption Assistant is a joint research project funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection that aims to help consumers make more sustainable consumption choices online and thereby reduce their individual consumption impact. The partner institutions TU Berlin, BHT Berlin, and Ecosia are iteratively developing different versions of the Green Consumption Assistant, which are continuously implemented and tested on Ecosia's search engine. In addition, a comprehensive product database – the GreenDB - with sustainability information is being built and a machine learning model is being developed that recognizes the purchase intentions of users on the internet and shows them sustainable alternatives.[1] As part of the goal to scale sustainability advice, the project has developed and outlined an approach to recommend best-in-class products to consumers who are searching for shopping information through Ecosia.[2] Products are considered best-in-class when they are more sustainable than other products in their category. Best-in-class products are ranked based on their sustainability label information and evaluated whether these labels have been issued by trustworthy institutions (Gossen et al., 2022).

Many studies aim to identify ways to communicate the sustainability performance of products to the consumer so that their sustainability intentions translate into actual behavior. Sustainability communication can involve different forms of sustainability cues. In particular, product labeling has been discussed as a useful tool to reduce information asymmetries, especially between consumers & producers, and thus help consumers make more sustainable purchasing decisions (e.g. Nikolaou & Kazantzidis, 2016). Most sustainability labels focus on specific environmental or social aspects of sustainability and are stand-alone, single-issue labels (Torma & Thøgersen, 2021). A recent systematic literature review suggests that labels do have positive effects on psychological and behavioral outcome variables in several areas of consumption (Majer et al. 2022). However, the comprehensibility of sustainability labels, their excessive number, and their lack of credibility are often flagged as disadvantages for consumers (Dendler, 2014; Futtrup et al., 2021). At the same time, the sustainability of products can be communicated through other cues, such as sustainability tags. Such tags, for instance "ecological" or "sustainable", reduce and simplify the attributes of products to short phrases which can be displayed on product websites. However, knowledge about the effectiveness of labels and other types of sustainability cues in driving sustainable consumer behavior, especially for electronic products, is limited. To address this research gap, we formulate our research question as follows:

How effective are different types of sustainability cues to drive sustainable choices for electronic products?

Through an online survey completed in Germany (n = 354), we tested the effectiveness of five different sustainability cues (sustainability labels, a multi-level Eco-Score, a CO2-Score, and two types of sustainability tags). Our results show that all of the five sustainability cues tested increase sustainable

[1] For more information see https://calgo-lab.github.io/green-db/

[2] For more information see the working paper on "Scaling sustainability advice - Options for generating large-scale green consumption" on the GCA website.

product choices. However, the positive effect of sustainability labels is not statistically significant, compared to the control group. The Eco-Score has the largest effect on increasing sustainable purchasing decisions, followed by sustainability tags and the CO2-Score. The study contributes to the academic discourse on the effectiveness of sustainability labeling schemes and provides empirical evidence on the effectiveness of the Eco-Score, carbon labeling, and sustainability tags in promoting more sustainable consumer choices for electronic products. In particular, online marketers are encouraged to use integrated sustainability labeling schemes, such as the Eco-Score, carbon labeling, and easy-to-understand sustainability tags to promote more sustainable product choices in digital market environments. In addition, the study encourages policymakers to test the implementation of an Eco-Score label in consumer electronics.

Theoretical Background

The following section reviews existing literature on sustainability communication for products using different forms of sustainability cues and presents the hypotheses for the study.

Given the strong negative impact on sustainability, change in the consumer electronics industry is inevitable to achieve sustainable development goals (Griese et al., 2005). However, research on sustainable consumer electronics has been limited to testing single aspects of sustainability, such as the energy efficiency (e.g. EU energy efficiency label) of washing machines (Sammer & Wüstenhagen, 2006) and televisions (Heinzle & Wüstenhagen, 2012). In addition, hypothetical product lifetime information for mobile phones (Wilhelm, 2012) and washing machines (Jacobs & Hörisch, 2022) and a hypothetical circular economy score for mobile phones (Boyer et al., 2021; Hunka et al., 2021) were examined. Recent research suggests that factors inherent in sustainability labels may moderate their effectiveness in promoting environmentally friendly purchasing behavior (Majer et al., 2022). For instance, the type and amount of additional information provided through the labeling scheme is an important factor for the effectiveness of sustainability labels (Majer et al., 2022). Generally, sustainability labels can be categorized as *reductive* or *interpretative*. While reductive labels communicate detailed information about specific product attributes (e.g., greenhouse gas emissions per product), interpretative sustainability labels summarize the sustainability performance of specific product attributes. This makes them less complex and easier for consumers to understand. Sustainability labeling is very popular in many consumption areas, as shown for example on the directory website ecolabelindex.com and in surveys on consumer attitudes toward labeling schemes (European Commission, 2020). Based on the previous literature, our research interest is to test different reductive and interpretative sustainability cues and their influence on sustainable purchasing decisions for consumer electronics.

H1: *Sustainability labels have a positive influence on purchase decisions for sustainable consumer electronic products.*

A recent systematic literature review by Torma and Thøgersen (2021, p. 1) suggests that “the current sustainability labeling landscape is up against the challenge of too much, too complex, too similar, and too ambiguous information”. Instead, integrated sustainability labels are suggested as a solution. These labels go beyond the categorical (yes or no) compliance with a minimum set of sustainability attributes, cover multiple dimensions of sustainability, and are preferably multi-level. Therefore, integrated labeling schemes offer a more holistic approach and allow consumers to better understand how well a product performs in terms of sustainability (Torma & Thøgersen, 2021). In this vein, a color-coded Eco-Score rating has recently been discussed and investigated in studies on sustainable food consumption (e.g., De Bauw et al., 2022; De Bauw et al., 2021; Marette, 2022). The Eco-Score aims to integrate several environmental or ecological dimensions of a product's sustainability. The environmental performance of a product is rated on a traffic light scale with letters from 'A' (green) to

'E' (red). A product with an Eco-Score of 'A' is considered a more sustainable option (i.e., with less environmental impact) than a product with a lower Eco-Score (cf. De Bauw et al., 2022). The Eco-Score is already used in practice for food in some European countries, such as France, and has been shown to help consumers identify sustainable food choices and thereby promote sustainable consumption (e.g., De Bauw et al. 2022; Marette, 2022). However, it has not yet been introduced or tested for other product categories. We, therefore, propose the following hypothesis for the influence of the Eco-Score in consumer electronics:

H2: *The Eco-Score has a positive influence on purchase decisions for sustainable consumer electronic products.*

Other lines of research have addressed the effectiveness of communicating the environmental impact of purchasing decisions, e.g. through carbon labeling. For example, Goucher-Lambert and Cagan (2015) found that customers change their preferences for product attributes when they know the environmental impacts based on a product's life cycle analysis. They argue that adding this information makes the decision a social or moral one (Goucher-Lambert & Cagan, 2015). In addition, Kilian and Mann (2020) found in an online experiment that participants were likely to engage in self-serving moral reasoning (i.e., moral disengagement) when a consumption option with poor socio-ecological performance was perceived as desirable. However, Zhao et al. (2018) show that urban Chinese consumers had an overall low perception of carbon-labeled products. The framing of information on the environmental impact of products appears to be a key factor in making a difference to consumers (White et al., 2019). Based on the previous literature, we propose the following hypothesis on the effectiveness of carbon labeling:

H3: *Carbon labeling has a positive influence on purchase decisions for consumer electronic products.*

Research on specific elements of sustainability messages (e.g., the design and wording of simplified sustainability cues in the form of product tags) is limited. Interestingly, Tang et al. (2004) found that wording and design independently contribute to the effectiveness of an ecolabel. Other researchers have found that both the specificity and amount of information in a message influence its effectiveness (Teisl, 2007; Teisl et al., 2008; Atkinson & Rosenthal, 2014). These findings suggest that labels can be designed in various ways, such as by presenting numerical values (e.g., CO2 emissions in kilograms or water usage in liters) or through semantic descriptions (e.g., "energy-efficient product"). These sustainability tags as simplifications of environmental performance attributes of products have been shown to help environmentally-conscious consumers to make more sustainable food choices (Berger et al., 2020; Sigurdsson et al., 2022). In contrast, a recent online experiment examined consumer apparel choices using sustainable and non-sustainable apparel cues in Poland and found no effect of simple sustainability cues. These results suggest that consumers would not purchase a sustainable or 'green' product if it did not provide enough aesthetic, functional, and financial benefits to satisfy their needs and aspirations (Rahman & Koszewska, 2020). Since sustainability cues can be generated based on product attributes and tailored to consumer preferences (e.g. Kwok & Harrison, 2015), we propose two final hypotheses that test two variants of sustainability tags.

H4: *Sustainability tags based on product attributes have a positive influence on the purchasing decisions for sustainable consumer electronic products.*

H5: *Sustainability tags tailored to consumer search queries have a positive influence on the purchasing decisions for sustainable consumer electronic products.*

Method

Study Design & Sample

We conducted an online experiment to test the effect of five types of sustainability cues on electronic product purchase decisions (see Figure 1). In a between-subjects design, participants were randomly allocated to one of five treatment conditions or the control group. We compared the mean difference between all independent groups to assess the effect of each of the sustainability cues in comparison to an untreated control group. The choice screens for both the treatment groups and the control group have been designed to resemble the beta-version of the Green Consumption Assistant (a browser extension for Chrome with the name "Koala - Ecosia Assistant").[3] We recruited a total of 354 individuals through the service provider Prolific (https://www.prolific.co/). Participants had to meet the screening criteria of German nationality and fluency in the German language. The participation completion rate was 98.8%. To ensure a minimum standard of data quality we removed eight participants who were either speeding through the survey or were too slow to fill out the survey. The final sample size was N = 346. The sample consisted of 66.8% female and 32.9% male participants, with a mean age of 26.4 years (SD = 8.8). Most participants (56%) were between the ages of 20 and 30, and 58.7% of the sample were students. As such, the sample is not representative of the German population.

Figure 1. The five sustainability cues used in the choice experiment: (1) a multilevel, color-coded Eco-Score, (2) a set of stand-alone sustainability labels used for consumer electronics, (3) carbon labeling in form of a CO2-Score, (4) sustainability tags, and (5) user-generated sustainability tags

Procedure

The study was conducted in August 2021 using Unipark's online survey software. Participants were asked to complete a total of 12 choice tasks, each containing two product options. Choice tasks were presented for a total of four electronic product categories. Three choice tasks were presented for laptops, smartphones, tablets, and TVs respectively. Products were presented in a randomized order. Each choice task presented two product options – one with one of the five sustainability cues, and the other without. We selected six products for each of the categories that were available in German online

[3] For more information on the Koala, see one of our working papers or the Product Update I, Product Update II or Product Update III on the GCA website.

stores. Three of the six products per category were selected as best-in-class products based on an assessment of their sustainability attributes. These best-in-class products were presented together with different sustainability cues in the treatment conditions (see Appendix B for all of the choice tasks used in the study). We included products for the two options within each of the choice tasks that were similar in price because research shows that customers aren't willing to compromise on quality for eco-friendly products (e.g., Rex & Baumann, 2007; Peattie, 2001). However, the products did vary to some extent in their functional attributes, e.g., the megapixel of smartphone cameras or the amount of storage space on laptops. The following section presents the materials used and provides examples of choice screens for the choice tasks in the five treatment conditions and the control group.

Material

Treatment groups

Sustainability labels

We selected relevant sustainability labels from the label directories Siegelklarheit[4] and Label Online[5] based on their credibility. As the label directories did not offer a sustainability label for each of the product categories, we additionally selected labels that were used in the online shop for the respective products. We assessed the sustainability of products based on the evaluation of the sustainability labels and then enhanced the more sustainable product in each product choice with a depiction of relevant sustainability labels. See Table 1 for the sustainability labels used for each product category in this experiment. Figure 2 shows an example of a choice screen in this treatment group.

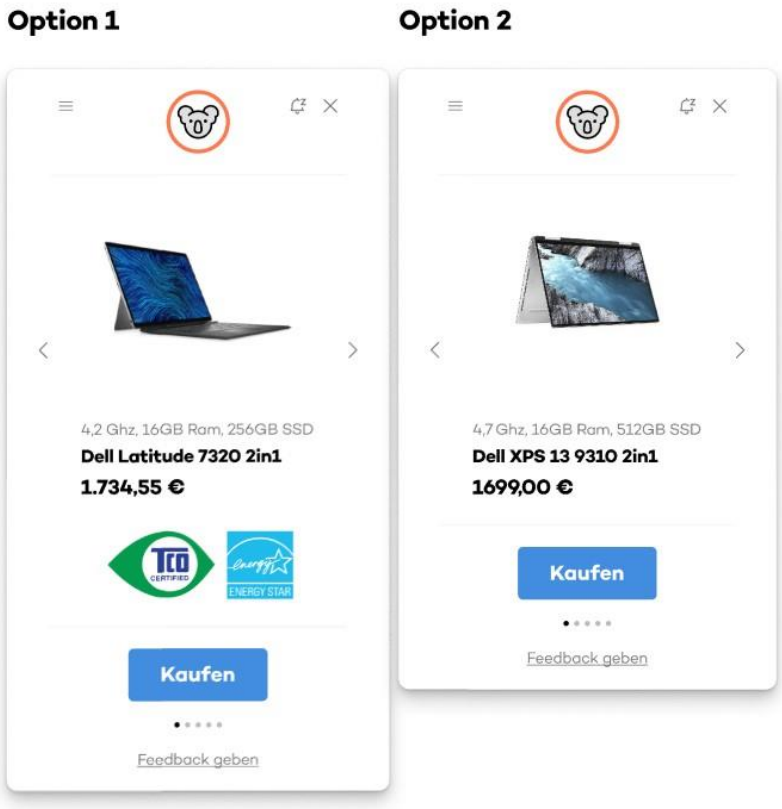


Figure 2. Example for a choice screen in the sustainability label group between two different smartphones.

[4] https://siegelklarheit.de
[5] https://label-online.de

Table 1. Sustainability labels used in the choice experiment.

Sustainability Label	Label design	Product categories
Epeat Gold		Smartphones, tablets
Bundespreis Ecodesign		Smartphones
Fairtrade Gold		Smartphones
Ecovadis Gold		Smartphones
Energy Star		Laptops, tablets
EU energy label		TVs
TCO certified		Laptops, tablets

Eco-Score

The Eco-Score label resembles the established Nutri-Score label, with a color-coded scale ranging from a green “A” to a red “E”. The score assigned to each product was roughly estimated to match the sustainability attributes of the presented products. The more environmentally friendly choice was awarded a higher Eco-Score level in each of the choice tasks. See Table 2 for the Eco-Score levels and visual representations used in the study. Figure 3 shows an example of a choice screen in this treatment group.

Table 2. Eco-Score levels and visual representations used in the choice experiment.

Eco-Score level	Visual representation in the experiment
A	
B	
C	
D	
E	

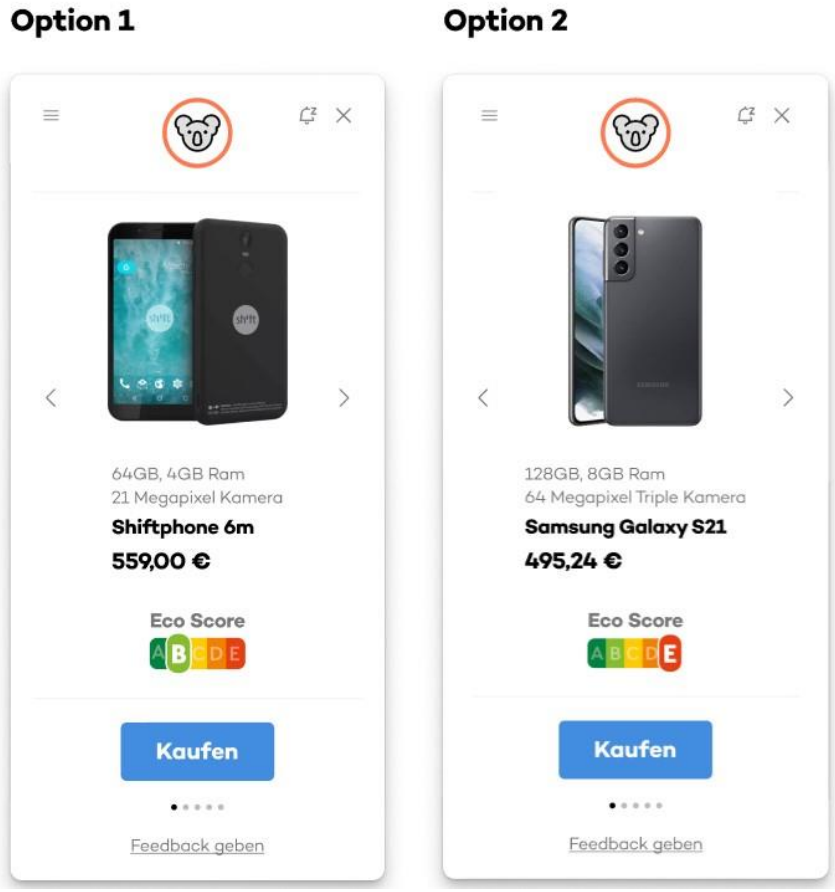


Figure 3. Example for choice screen in the Eco-Score group between two different smartphones.

Carbon labeling – CO2-Score

To communicate the environmental impact of the product choices, we used a CO2-Score to display the kilograms of carbon emitted during a product's lifecycle. We roughly estimated these values using life cycle information of the presented products. The more sustainable choice was awarded a lower CO2-Score in each of the choice tasks. See Table 3 for the values used in each of the product categories. Figure 4 shows an example for a choice screen in this treatment group.

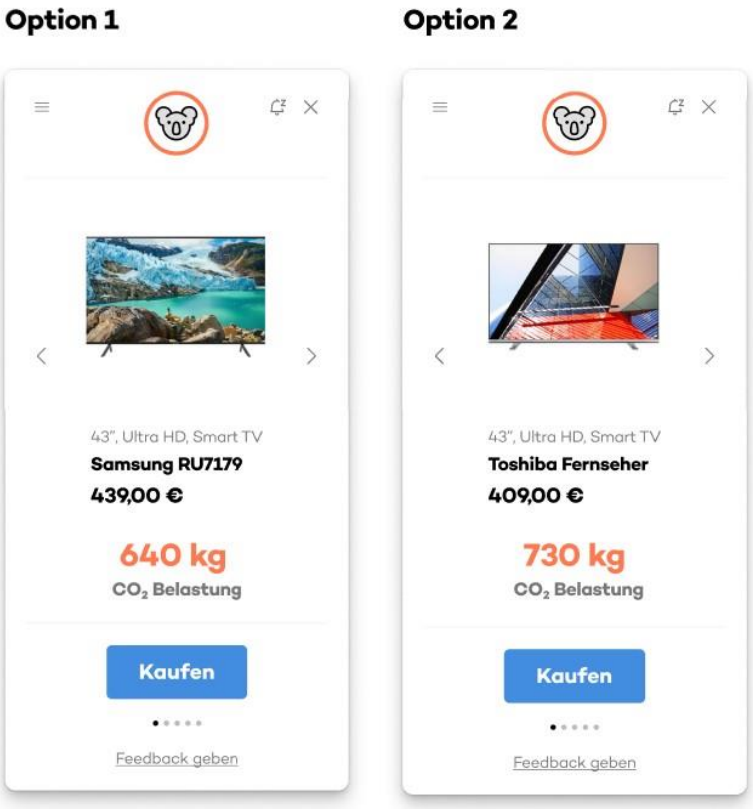


Figure 4. Example for a choice screen in the CO2-Score group between two different TVs.

Table 3. C02-Score values used in the choice experiment per product category.

Product categories	**Values of carbon emissions used**
Laptops	240 kg, 270 kg, 300 kg
Smartphones	50 kg, 60 kg, 80 kg, 90 kg
Tablet	190 kg, 220 kg, 230 kg, 250 kg, 300 kg, 380 kg
TVs	620 kg, 640 kg, 720 kg, 730 kg

Sustainability tags

Sustainability tags retrieved from sustainability label information

To create the first set of sustainability tags, we used the aforementioned sustainability labels as a foundation. We then simplified the sustainability attributes of the labels into short semantic phrases. The product within a choice task that resembles a more sustainable choice was awarded at least one but no more than three sustainability tags at a time. Table 4 shows the sustainability tags used for each of the product categories (see Table A1 in Appendix A for the translation of sustainability labels into generic sustainability tags. Figure 5 shows an example of a choice screen in this treatment group.

Table 4. Sustainability tags used in the online experiment per product category - tailored from sustainability labels.

Product categories	Sustainability label	Sustainability tags
Smartphones	Fairtrade Gold, Ecovadis Gold, Epeat Gold, Bundespreis Ecodesign	Fair traded Gold, ecological, sustainable, durable, ethical business, easily repairable
Laptops, Tablets	Energy Star, TCO certified	Environmentally friendly, energy efficient, better working conditions
TVs	European Union energy label	Energy efficient

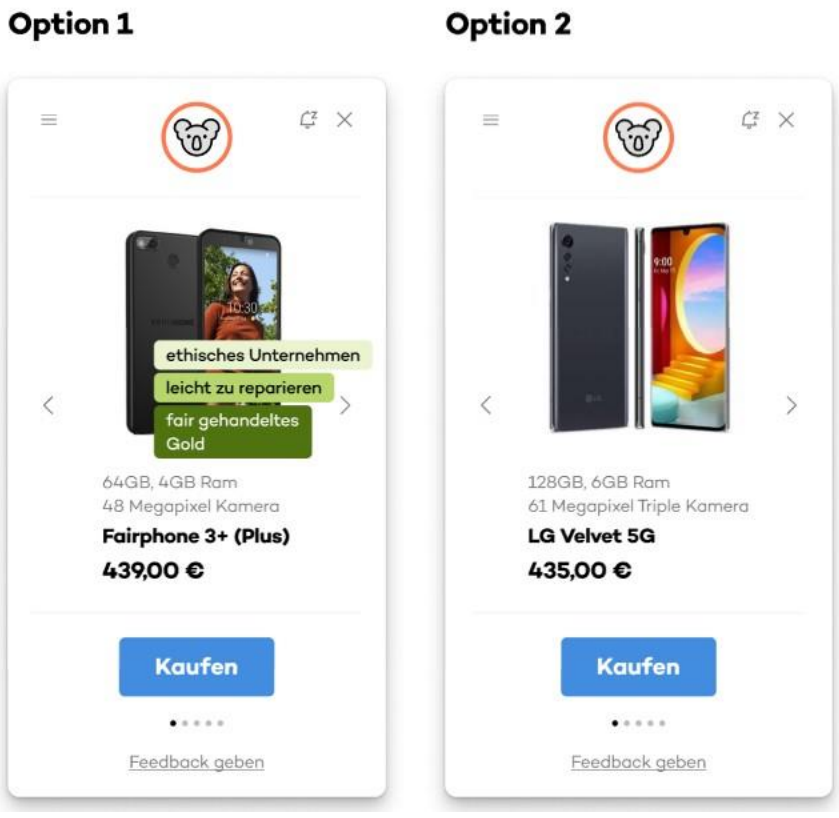


Figure 5. Example of a choice screen in the sustainability tag group for smartphones.

User-generated sustainability tags

Visually, these tags are very similar in design to the previously introduced set of sustainability tags. However, the set of user-generated sustainability tags was generated by analyzing search queries on Ecosia. We analyzed German queries for seven months, counting the volume of queries that contained relevant keywords, e.g., “organic”, “vegan”, “sustainable”, “eco”, “refurbished”, “ecological”, and “co2” to formulate and assign sustainability tags to the tested products. Again, the product within a choice task that resembles a more sustainable choice was awarded at least one but no more than three sustainability tags at a time. See Table 5 for an overview of user-generated sustainability tags. Figure 6 shows an example of a choice screen in this treatment group.

Table 5. User-generated sustainability tags used in the choice experiment per product category.

Product categories	**User-generated sustainability tags**
Laptops	Ecological, sustainable, fairtrade
Smartphones	Ecological, sustainable, fairtrade, environmental friendly, energy efficient, particularly durable,
Tablets	Ecological, sustainable, fairtrade
TVs	sustainable

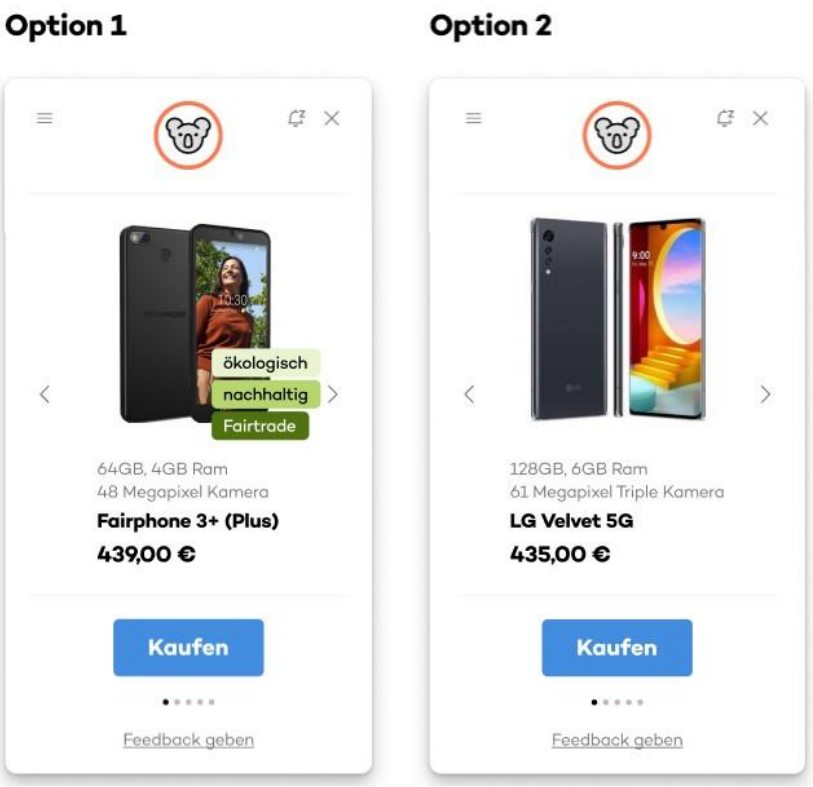


Figure 6. Example for choice screen in the user-generated sustainability tag group for smartphones.

Control group

Participants in the control group were given the same choice tasks as the experimental groups. However, no sustainability cues were present in any of the choice tasks. Figure 7 shows and example for a choice screen in the control group.

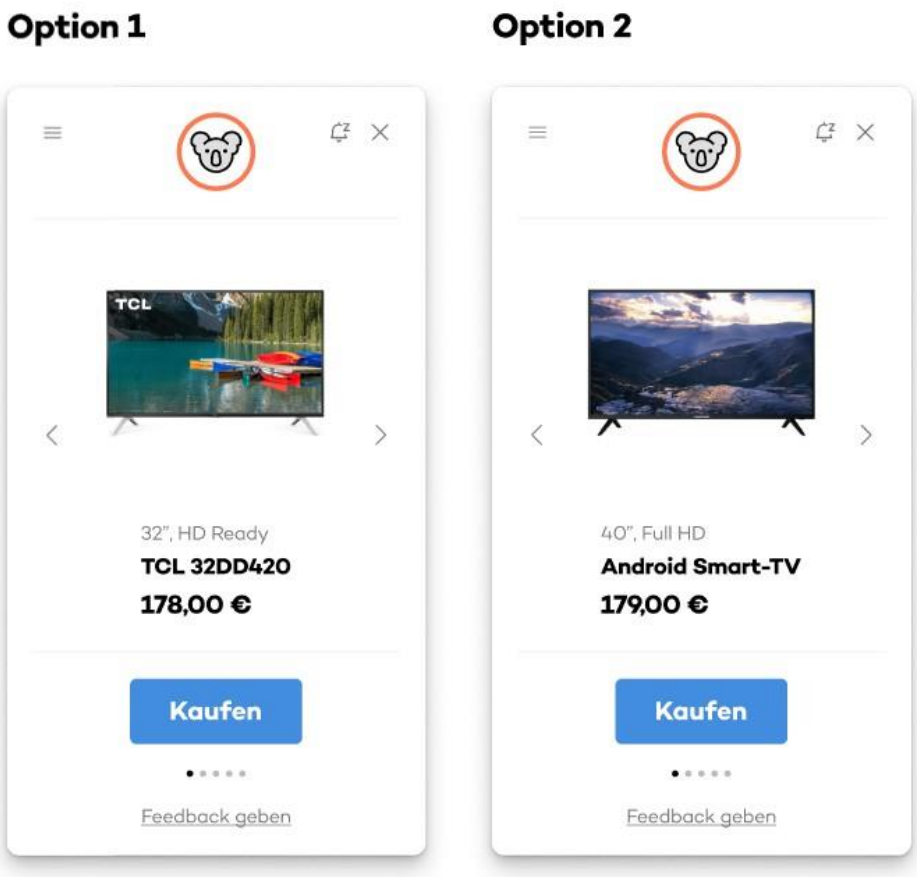


Figure 7. Example for the choice screen in the control group for TVs.

Measures

Sustainable purchase decisions

Each choice in the 12 choice tasks was assigned a score - of 0 for a choice of a non-sustainable product and a score of 1 for a choice of the more sustainable option - for each of the five treatment groups. As a next step, the mean score for all 12 choices is calculated as the outcome variable sustainable purchase decisions. To test the effectiveness of the different sustainability cues, we specified the following multiple linear model:

$$y = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n + \epsilon$$

where *y* is the predicted value of the outcome variable, β_0 the *y*-intercept (the value of *y* when all other parameters are set to 0), $\beta_1 X_1$ the regression coefficient of the first treatment condition (the effect that an increasing the value of the first treatment condition has on the predicted *y* value), $\beta_n X_n$ the regression coefficients of the last of the treatment groups, and *e* the model error (how much variation there is in the estimate of *y*). The outcome variable indicates the share of purchase decisions for which

participants chose the more sustainable of the two presented options. The dummy-coded variables indicate the treatment groups to which the participants were assigned.

Results

The results of the linear regression model show that all sustainability cues, except for the sustainability labels, significantly increased the share of sustainable electronics chosen compared to the control group. See table 6 for the results of the regression model. Sustainability labels increased the share of sustainable electronics chosen by 6.6 percentage points (H1). However, this effect was not statistically significant. In contrast, the Eco-Score had a far bigger, and statistically significant, impact. Higher levels of the Eco-Score increased the share of sustainable choices from 30% in the control group to 60.2% in the treatment group (see Figure 8). Thus, the results confirm our hypothesis that the Eco-Score has a positive impact on sustainable purchase decisions (H2).

Table 6. Results of the regression model

	Dependent variable
	Sustainable purchase decisions
Sustainability labels	0.066*
	(0.038)
Eco-Score	0.302***
	(0.040)
CO2-Score	0.273***
	(0.038)
Sustainability tags	0.241***
	(0.037)
User-generated sustainability tags	0.300***
	(0.028)
Control group (constant)	
Observations	346
R^2	0.230
Adjusted R^2	0.219
Residual Std. Error	0.199 (df = 340)
F Statistic	20.316*** (df = 5; 340)

Note: *p < 0.1; **p < 0.05; ***p < 0.01

The CO2-Score also increased the share of sustainable choices by 21 % compared to the control group, confirming the hypothesis that carbon labeling has a positive effect on sustainable purchasing decisions for electronic products (H3). Finally, sustainability tags derived from sustainability labels and user-generated sustainability tags both increased the share of sustainable product choice by 27% and 24% respectively. Interestingly, the tags derived from sustainability labels did not perform better than

those generated through user queries. However, these findings confirm that both sets of sustainability tags have a positive impact on purchasing decisions of electronic products (H4, H5). In summary, all sustainability cues, except for the sustainability labels, significantly increased the share of sustainable electronics chosen compared to the control group.

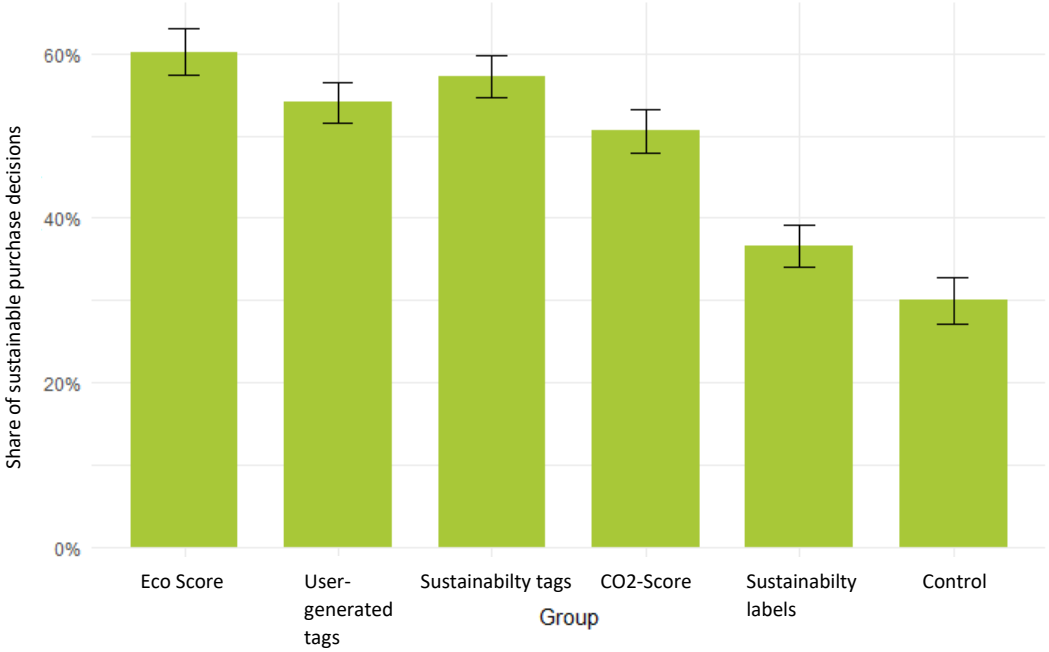


Figure 8. Regression results model.

Discussion

Our results provide strong evidence that different sustainability cues increase the number of sustainable options selected in an online shopping context. In particular, the multilevel, color-coded Eco-Score label doubled the share of sustainable products chosen. Thus, our study provides evidence for the effectiveness of an Eco-Score in promoting sustainable purchases of electronic products and supports initial findings of a positive impact of the Eco-Score in the food sector (e.g. De Bauw et al. 2022; Marette, 2022). Furthermore, the results suggest that the Eco-Score can be transferred to the consumer electronics sector as an integrated sustainability scheme to help consumers make more sustainable product choices. In addition, both types of sustainability tags and a CO2-Score indicating the carbon footprint of products were also effective in increasing the share of sustainable choices. Interestingly, the commonly used sustainability labels did not result in a statistically significant increase in sustainable choices. These findings support previous research that consumers may struggle to comprehend the actual sustainability performance of products behind traditional sustainability labeling schemes (Dendler, 2014).

This study also offers avenues for future research. For example, specifying the influence of different levels of the Eco-Score and determining how consumers respond to specific levels would provide valuable insights into how to effectively promote an integrated sustainability labeling scheme for electronic products. Thus, it may be important to investigate which levels of sustainability are considered optimal by consumers. In addition, our results suggest that the relative importance of specific sustainability dimensions communicated by sustainability tags of electronic products should be investigated and whether the number of sustainability tags makes a difference in consumer decisions. We know that green shoppers' value credible sustainability information. Thus, it might be

important to investigate the effect of different senders including online stores and trustworthy third parties for the effectiveness of sustainability tags and the testes scores. In addition, the study design offers several areas for improvement. Firstly, the design of the labels in our experiment was not based on actual analysis of sustainability attributes for some of the treatment groups, i.e. the carbon footprint of the products was not available to us. Secondly, the convenience sample used in our experiment is not representative in terms of demographics, as it oversamples women, younger people, and students. Further research would be needed to generalize the results to a wider population. Additionally, we did not distinguish between environmentally-focused and socially-focused sustainability labels, although some research suggests that the reactions to these labels may differ (Loureiro & Lotade, 2005; Brécard et al., 2012). Finally, we measured purchase decisions in an experimental online context, not actual purchases. We suspect that the association we found would be less strong in real-life settings and other factors, such as price, would be more important for actual purchases.

Practical recommendations

Sustainability cues can play a crucial role in influencing consumer choices. In addition, their design and presentation appear to have a significant impact on consumer purchasing decisions. Online marketers are particularly encouraged to use easy-to-understand integrated sustainability labeling schemes, such as the Eco-Score, carbon labeling, and easy-to-understand sustainability tags to promote more sustainable product choices in digital market environments. In addition, the results of our study encourage policymakers to test the implementation of an Eco-Score label in consumer electronics. Moreover, our study suggests not to use standard, stand-alone sustainability labels with no additional information as they appear to be the least effective labeling strategy.

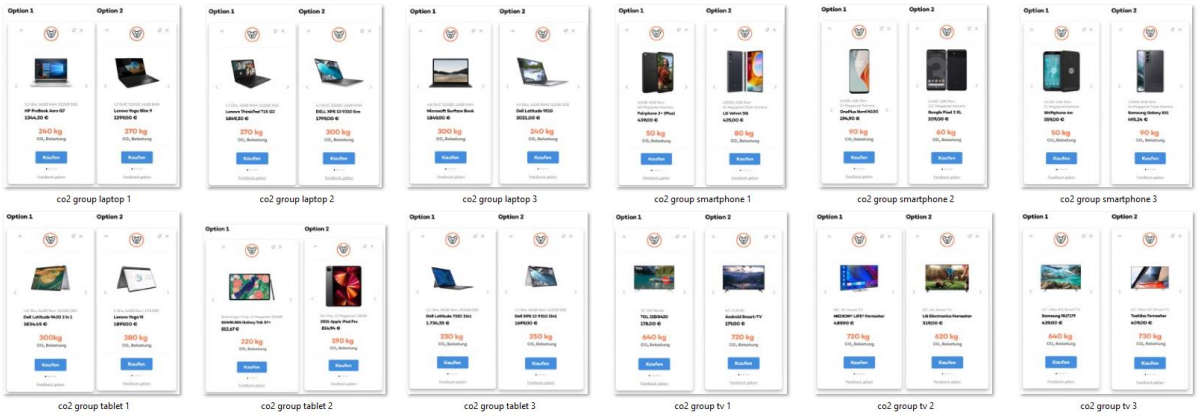
Appendix A

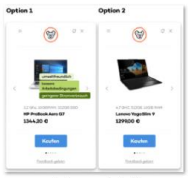
Table A1. Translation of sustainability labels into semantic labels used in this study.

Sustainability Label	**Scientific Semantic Label**	**Technology-generated Semantic Label**
epeat Gold	Environmentally friendly („umweltfreundlich“)	Ecological(“ökologisch”) and sustainable (“nachhaltig”)
Fairtrade Gold	Fair traded gold („fair gehandeltes Gold”)	“Fairtrade”
ecovadis Gold	Ethical company („ethisches Unternehmen“)	Sustainable (“nachhaltig”)
epeat Gold, Energy Star, EEK	Less electricity consumption („weniger Energieverbrauch”)	Ecological (“ökologisch”)
TCO, Fairtrade Gold	Better working conditions („bessere Arbeitsbedingungen“)	„Fairtrade“

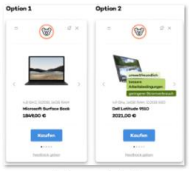
Appendix B

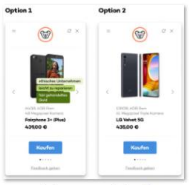
Choice tasks for the treatment and control groups

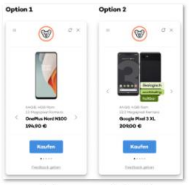


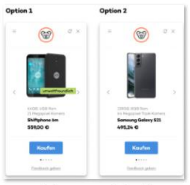

badge group laptop 1


badge group laptop 2

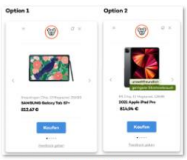

badge group laptop 3


badge group smartphone 1

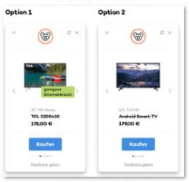

badge group smartphone 2


badge group smartphone 3


badge group tablet 1


badge group tablet 2


badge group tablet 3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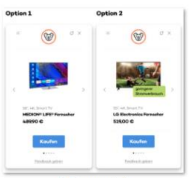
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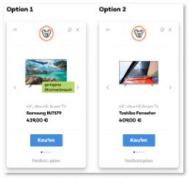
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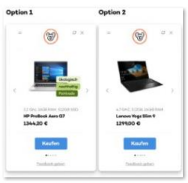
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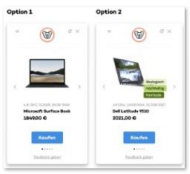
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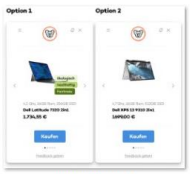
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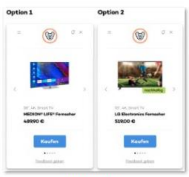
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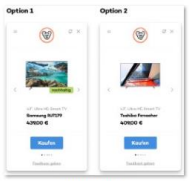
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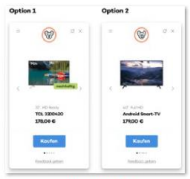
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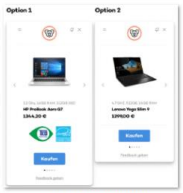
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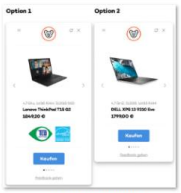
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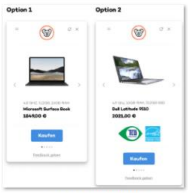
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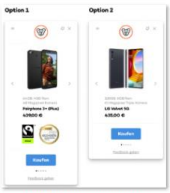
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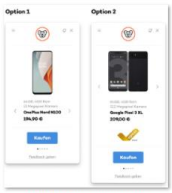
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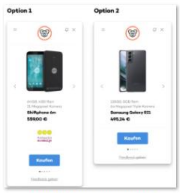
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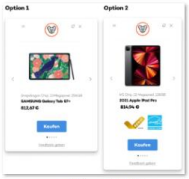
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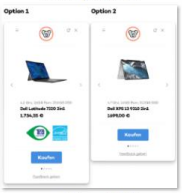
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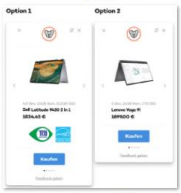
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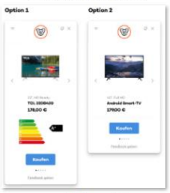
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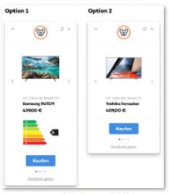
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ecoscore group laptop 1


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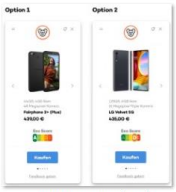
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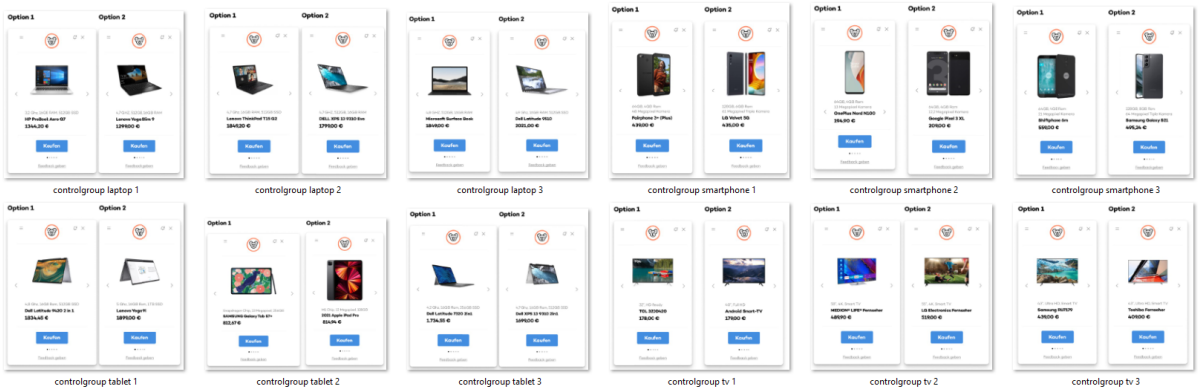

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