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Consumers' knowledge gain through a cross-category environmental label☆

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ABSTRACT

Consumers' food choices play a crucial role in the shift toward increased sustainability. However, consumers' knowledge about daily food items is not sufficient to evoke environmentally friendly food choices. To facilitate a shift towards more sustainable food consumption, providing understandable information about the environmental impact of products in an easily accessible and effective way seems to be promising. With this outcome in view, we created a new label and tested its effectiveness in improving people's accuracy in evaluating the environmental friendliness of food products. The proposed label is based on life cycle assessment (LCA) and designed to compare food items across food categories through a color-coded scheme. In an online choice task, participants were asked to choose the more environmentally friendly product of two options. Depending on the condition, the products were either labeled or not. As expected, the number of correct choices was significantly higher when the products were labeled (vs. not). Moreover, participants had a positive attitude toward the cross-category label; they evaluated it as comprehensible, credible and useful. The majority of participants indicated that they would be willing to include the label in their shopping decisions, if it were introduced to the market. Altogether, the present research provides evidence that a color-coded sustainability label is suitable for informing consumers about the environmental impact of food products and helps them identify environmentally friendly products.

1. Introduction

The world's agricultural sector is an important contributor to climate change, biodiversity loss and soil degradation (Tilman et al., 2001). The impact of the sector is expected to grow due to the shift of global eating patterns toward the Western standard, characterized by a high intake of meat products, sugars, salt, fat, and refined cereal grains (Astrup et al., 2008; Carrera-Bastos et al., 2011; Tilman and Clark, 2014). Independent from the future development of eating patterns, the western eating habits as such are already resource-intensive and harmful for the climate (Carlsson-Kanyama, 1998; Hu et al., 2000; Kearney, 2010; Tilman et al., 2011).

Thus, changing consumption patterns toward a more sustainable level seems to be a critical goal to achieve for a sustainable future (Bradshaw and Brook, 2014; Goodland, 1997; Helms, 2004). The present research aims to contribute to this important goal by investigating the applicability of a newly developed sustainability label that could enable consumers to identify the environmental impact of different products more easily.

1.1. Potential of changes in food consumption

The environmental impact could be reduced by changes in consumption behavior (Gerbens-Leenes and Nonhebel, 2002; Popp et al., 2010; Stehfest et al., 2009; Westhoek et al., 2014). For instance, the environmental impact of meals with the same calorie, protein and mineral content could vary dramatically, depending on ingredient composition (Carlsson-Kanyama, 1998). Therefore, guiding consumers toward more sustainable consumption has been positioned as a goal in various policy statements, and accessible product information was identified as essential for achieving this goal (Nash, 2009; Upham et al., 2011).

Consumer knowledge is known to be a driver for environmentally friendly behavior (Peschel et al., 2016), but the current food market does not provide enough information regarding the environmental impact of different products (Bleda and Valente, 2009; Schumacher,

☆ The data set of the current study is available upon request.

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2010). Another problem is that consumer sometimes lack the necessary background information to interpret the information correctly – as observed for example in recent research of Hartikainen et al. (2014) in which only 7% of the participants associated 'product carbon footprint' spontaneously with greenhouse gas emissions. Consumers are also prone to several misconceptions. They usually underestimate the impact of animal products, especially meat and dairy products, while overestimating the impact of country of origin (Lazzarini et al., 2016; Shi et al., 2018). Accordingly, the absence of clearly visible and easily understandable information might explain why consumers do not always act or buy as environmentally friendly (Grunert et al., 2014; Vermeir and Verbeke, 2008; Vlaeminck et al., 2014) as one would expect, given that there is a general preference for environmentally friendly products, and awareness of the environmental impact of food consumption is increasing (Shao, 2016; Tully and Winer, 2014). Accordingly, increasing consumers' knowledge by providing clearly recognizable product information might reduce or close the attitude–behavior gap between pro-environmental attitudes and the respective buying behavior.

1.2. Sustainability labels as a means of informing consumers

Environmental product labels could be a promising strategy for closing the knowledge gap, though the process of developing and establishing a sustainability label is more difficult than one might think (Dendler, 2014). Current labels usually focus only on single environmental indicators, such as the production method (e.g., integrated production vs. organic farming) or product origin (e.g., locality vs. foreign) (Goossens et al., 2017), or on a combination of a few indicators (Lukas et al., 2016). Thus, the labels do not provide sufficient information and therefore, are not optimal for guiding consumers' product choices (Goossens et al., 2017; Van Amstel et al., 2008). The same applies to footprint labels displaying the product's impact in a specific environmental domain (e.g., carbon, water) (Peschel et al., 2016). Another problem is the lack of consensus regarding definitions; for example, while some include only local products in their definition of seasonality, others expand seasonality to other European countries (Röös and Karlsson, 2013).

In the case of existing labels focusing on single indicators, the positive impact of the promoted attributes (e.g., local and organic) is often overestimated by consumers, compared to non-targeted, but other crucial variables, such as resource use and mode of transportation (Coley et al., 2011; Edwards-Jones, 2010; Edwards-Jones et al., 2008; Shi et al., 2018; Thibert and Badami, 2011; Tobler et al., 2011b). As a result, misconceptions regarding the environmental impact of food prevail (Lazzarini et al., 2016; Tobler et al., 2011a) pointing to the need for an adequate, comprehensible label that provides relevant information.

Although there are several studies about labels that are *based on specific dimensions* (e.g., a carbon footprint label), the literature on *labelling based on the overall environmental impact* in the food sector is scarce. Moreover, as different research groups often use different methods and label designs, comparability is limited, and conclusions are difficult to draw. In the following, we present the methods and findings of two studies and the implications for the present research. Both studies used labels to display the environmental impact and tested the effect in an experimental setting.

Vlaeminck et al. (2014) developed a color-coded label and tested its effects on consumers' product preference (i.e., choice) in a semi-controllable, semi-realistic field experimental setting, embedded in a local supermarket, imitating the grocery store experience. The environmental impact was displayed separately for domains (carbon, energy use, water use, land use and soil) as well as through an overall rating based on a rating scheme by Gloria et al. (2007). The ratings were displayed as a share of the possible maximum on a scale ranging from 1 to 10 (e.g., 8.5/10). While the products were labeled for the label group, the control group received only the information normally provided by a conventional Belgian supermarket (e.g., organic labels). The subjects were allowed to select from different food categories; therefore, cross-category substitution was possible. The overall environmental friendliness of the selected food items was about 5.3% higher in the label group than in the control group (i.e., provided only with information usually found in a conventional Belgian supermarket, e.g., organic labels).

Another approach for investigating the effectiveness of labels was undertaken by Lazzarini et al. (2018). They conducted an online survey, in which participants were asked to select the environmentally friendlier product (basically a similar task as in the present study). The label group received help via a sustainability label, while the control group relied on their own judgment and a third group relied on some guidelines that were communicated to them beforehand (e.g., avoid air-transported products). Lazzarini et al. (2018) found that participants were better in choosing the more environmentally friendly product in the conditions with labels or guidelines than in the control condition. The label used by Lazzarini et al. (2018) did not use color-coding or gradations; thus, differentiation between two labeled products was not possible. Accordingly, the label was used only to highlight the most environmentally friendly share of the products instead of being present on every item. Furthermore, the food items were split into the categories: vegetables, fruits and protein-rich products. Only pairs of the same category were formed. Participants, who were presented with labels, performed only marginally better than the group who were not presented with labels. Lazzarini et al. (2018) discussed that the results could be different if the study were conducted with a more comprehensive label with more complex indicators.

Vlaeminck et al. (2014) also discussed different criteria regarding the constitution of sustainability labels. They recommend using color coding and an overall environmental rating, normalized to the whole range. To allow for cross-category substitution, items from different food categories should be measured with the same scale.

The present study now aims to examine the effectiveness of a newly developed sustainability label by combining the findings of the two studies described above. Thus, we applied the label design recommendations of Vlaeminck et al. (2014) and test methods similar to those used by Lazzarini et al. (2018) on a broad range of products.

2. How to create a new sustainability label?

2.1. Label design

Various studies have indicated that standardized color coding can improve label effectiveness and efficiency, because laypeople lack the ability to assess raw environmental information (such as the emitted carbon dioxide amount) (Sharp and Wheeler, 2013; Thøgersen and Nielsen, 2016; Vlaeminck et al., 2014). Color-coded schemes are usually easily understood at first sight. The most prominent examples are the traffic light system and the A–G scheme used by the European Energy Label. While the traffic light system differentiates among only three different grades, the European Energy Label provides a sufficient number of gradations needed to display the impact range of the vastly different food items. Therefore, we used the European Energy Label as a basis for our label design.

Apart from the obvious similarities, the European Energy Label and the newly developed sustainability label differ regarding the comparison elements. The European Energy Label allows comparisons within categories; e.g., different SUVs are compared only with one another but not across different vehicle classes. Thus, an SUV can achieve a better energy impact rating on the European Energy Label compared to a small personal car, despite having higher total emissions, because the evaluation process does not take into account how exemplars from other categories perform (Noblet et al., 2006; Waechter et al., 2015). In contrast, the newly developed sustainability label (see Fig. 1) is based on cross-category comparisons. This means that the environmental impact of the food products is measured equally for every food item, regardless

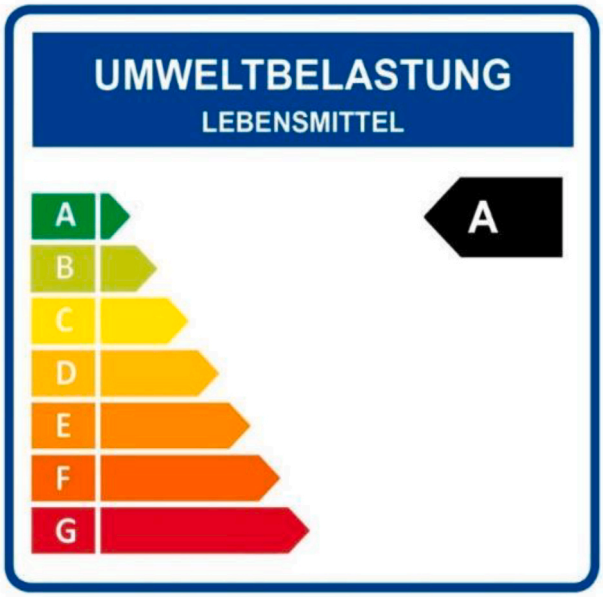


Fig. 1. Proposed label design, translations: "environmental impact" and "food".

of any nutritional differences.

Regarding the environmental impact of food products, substantial differences between food categories (e.g., meat and vegetables) can be observed (Leach et al., 2016). Although generally smaller, considerable impact differences also exist within food categories (e.g., beef vs. chicken) (Merrigan et al., 2015; Head et al., 2014). To target both types of impact differences, the newly developed environmental food label was designed to compare across food category borders and to provide a reasonable number of gradations. By using this approach, we aim to account for the differences between food categories and simultaneously differentiate between food items within a single group. In this manner, all key levers can be included.

2.2. Indicators of sustainability

In the literature, the most relevant key levers for reducing environmental impact are the reductions in meat consumption (Pimentel and Pimentel, 2003; Popp et al., 2010; Stehfest et al., 2009), animal products in general (Leach et al., 2016; Westhoek et al., 2014), air-transported goods and heated greenhouse products (Jungbluth et al., 2000, 2012a, b; Thibert and Badami, 2011). A comprehensive environmental label should be designed in accordance with the key levers and their respective importance.

A reliable labeling scheme should be performance-based, cover the entire agri-food chain and include all kinds of in- and outputs (Goossens et al., 2017). We therefore suggest, to use a Life Cycle Assessment (LCA) approach. Using LCA for evaluating environmental impact was proposed in several papers (Goossens et al., 2017; Vlaeminck et al., 2014). There is a large body of research regarding LCA (Shewmake et al., 2015), and the European Union (EU) recognized LCA as the best framework for assessing environmental impact (Nissinen et al., 2007).

Although more simplified indicators, such as the carbon footprint, have achieved broad popularity recently, LCA is still the most complete method for measuring environmental impact and should, if possible, be preferred (Weidema et al., 2008).

Environmental impact can occur in different forms, such as the exploitation of natural resources, emissions and environmental pollution. For communication to the consumer, the different kinds of environmental damage could either be cumulated into a single value or displayed as impacts on different environmental domains. Separating the damage into domains is beneficial if there is no consensus on how to weight different kinds of damage (as proposed by Leach et al. (2016) and Lukas et al. (2016)). However, this method works only with a few well-known domains, such as water or carbon dioxide. More complex information could overstrain laypeople and be counterproductive, as was shown in the health area with labels (Ikonen et al., 2020). Thus, we suggest displaying the environmental impact as a single measure, incorporating several complex indicators.

2.3. EP: the currency of the label

Eco-points (environmental impact points [EP]; in German, *Umweltbelastungspunkte* [UBP]) as defined by Frischknecht and Buesser-Knoepfel (2013) represent the cumulation of different kinds of pollution and the depletion of natural resources in one value obtained with LCA (see also Jungbluth et al., 2012a,b). Thus, EPs are a suitable basis for a sustainability label. They are based on the threshold values regarding environmental protection defined by the governments of the producing countries and therefore, are adjusted to the local conditions. However, to a certain degree, influence by the political situation on site is possible. Less stringent environmental objectives of certain countries can translate into a better rated local production process (Krtschil, 2015). As is usually the case in environmental impact rating schemes, the loss of biodiversity is not measured directly but depicted in other variables as land use requirements.

3. Method

3.1. Participants

The sample consisted of German-speaking Swiss participants from the market research institute Respondi. They received no information about the survey's content before starting and earned a reward for participating. Quota sampling based on age and gender was applied.

In total, 623 participants completed the online survey. Participants finishing after less than 40% of the median time for control (Mdn = 6.08 min) and label group (Mdn = 6.71 min) respectively, were excluded (n = 2) from the analysis. The resulting data set of 621 participants consisted of 320 (51.5%) female and 301 (48.5%) male participants with a mean age of 46.5 years. Their educational background was comparable to the Swiss average, except for the underrepresentation of people with compulsory school as their highest educational degree (Bundesamt für Statistik, 2018).

3.2. Product selection and presentation

Twenty products from the two main Swiss retailers Migros and Coop were selected. The products contained fruits, vegetables, grains, dairy products, meats and sweets, local, European, as well as foreign products imported by air, freighter or truck (see Table 1). To establish price equality, only mid-range-priced products from the home brands Qualité & Prix by Coop and M classic by Migros were selected. Organic labeled products were not included in the study to prevent confusing participants with additional information about the sustainability of the products. In addition, including products with additional organic labels could have impeded clear interpretation of the results.

To emulate the grocery store experience, the product information was provided in a way a customer could encounter in real life in a store. Food items were presented as product images or package frontsides. Self-weighable fruits and vegetables were accompanied by the respective identification plates, with the printed-on country of origin. Because of readability issues, some information (origin) had to be enlarged. Otherwise, the package frontside and identification plates remained unaltered. As the label presented in this study is designed to compare equal product amounts (in weight), equal amounts of 500 g were also displayed in the images. Approximate equality was achieved by displaying more than one package if the package weight required it.

Table 1
Product selection with name, origin, Eco Points and label category.

Name	Origin	UBP/kg	Category
Carrots	Switzerland	738	A
Tomatoes	Spain	1066	A
Kiwis	New Zealand (by ship)	1603	A
Fries (frozen)	Switzerland	2309	A
Chocolate Yoghurt	Switzerland	3088	A
Minced Soy	unknown	3643	A
Falafel	unknown	3808	A
Strawberries	Egypt (by air)	4056	B
Pasta (dried)	Switzerland	6418	B
Cheese Ravioli	Switzerland	6768	B
Rice	USA	7408	B
Gruyere Cheese	Switzerland	11107	C
Parmigiano Reggiano	Italy	11377	C
Chicken Nuggets	Switzerland	13107	D
Chicken Filet	Switzerland	15144	D
Chocolate	Switzerland	16969	E
Bacon Cubes	Switzerland	20215	F
Asparagus	Peru (by air)	22643	F
Lamb Filet	New Zealand (by air)	51702	G
Minced Beef	Switzerland	59909	G

To prevent effects due to price differences, prices were removed digitally from the package frontsides and identification plates. Because price and environmental friendliness tend to correlate (as elaborated in the Discussion), exclusion of the prices enhanced the robustness of the test results.

3.3. Environmental rating

The environmental ratings were based on the EP scores (see Section 2.3.) provided by ESU Services (Jungbluth et al., 2012a,b). These scores are based on LCA analyses that examine the environmental impact over all stages (i.e., production stages from the seeding to the finished product in the grocery store) in the life cycle of a product. The products shown in the selection displayed major differences in eco-point scores ranging from around 700 EP (carrots) up to around 60,000 EP (beef). The distribution of the products was asymmetrical, with a large portion of products in the lower EP range and a small portion in the upper range. Dividing the whole range into similarly sized label categories would have resulted in empty medium categories (C–E) and overfilled categories representing the lowest environmental impacts (A and B). Therefore, the lowest category (G), representing the highest environmental impact, was enlarged to accommodate the two most environmentally harmful products, namely, minced beef and lamb filet. Unfortunately, the notable difference of around 30,000 EP between the two could no longer be conveyed by the label.

3.4. Questionnaire

The online study consisted of the assessment of demographics, a choice task, and the evaluation of the new sustainability label. Participants gave their consent at the beginning at the study and were thanked afterwards.

3.4.1. Choice task

The participants' task was to select the environmental friendlier product of two options (see Fig. 2a and 2b). The question above the two items pictured in the photograph read: "*Which of these two products is more environmentally friendly, if you bought them in January in Switzerland?*". In the subsequent analyses, we considered a) how often their choice was correct (i.e., selecting the environmentally friendlier product), and b) the relative error accounting for the impact of the products (i.e., for incorrect choices, the respective products' impact differences (in EP) were computed and summed up).

Half of the participants were presented with labeled items (i.e., label group, n = 319), while the other half received the unlabeled version of the products (i.e., control group, n = 302) and thus, had to rely on their own judgment. To control for order effects, the order of the pair presentation was randomized. Before the choice task, the label group received a short label introduction, including a user manual and a description of the underlying indicators (EP). The control group received the label introduction after the choice task for the subsequent label evaluation at the end of the study.

In total, 190 pair combinations of the 20 products were possible. To avoid dropout, participants rated only half of all possible pair combinations. The possible 190 combinations were randomly split into two selections of 95 product pairs (i.e., Selection 1 and Selection 2). These two selections were counterbalanced across the two participant groups (i.e., Label & Control group) resulting in the following four groups: Selection 1 and Label, Selection 1 and Control, Selection 2 and Label, and Selection 2 and Control.

Note, that even with the use of a label with several gradations, not every item comparison was an obvious choice: 16% of the item pairs were composed of two products of the same label category (e.g., two products of label category B) and could thus not be differentiated through the label.

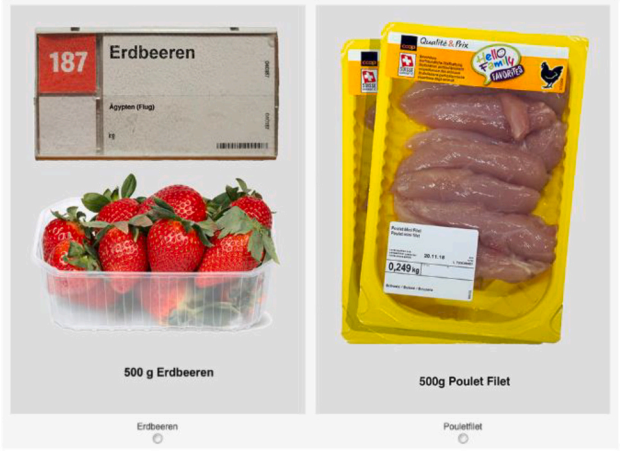
3.4.2. Label evaluation section

In the second part of the study, we assessed participants' attitude toward the label, their pro-environmental identity, and their general consideration of food products' environmental friendliness in purchase situations. To assess the evaluation of the label, participants were asked to rate the label regarding *comprehensibility*, *credibility* and *usefulness* in communicating the food item's environmental friendliness and their *approval of a potential market introduction*. We used the following items: "*How do you rate the comprehensibility/credibility/usefulness of the presented label in assessing the environmental impact* of the food products?" (response options ranged from 1 = *not at all comprehensible/credible/useful* to 6 = *extremely comprehensible/credible/useful*). Participants quantified their *approval of an introduction* to the market with the following item: "*Would you be in favor of the introduction of the presented label to the market?*" (1 = *not at all;* 6 = *totally*). All 4 items regarding the evaluation of the label correlated highly with one another ($r = 0.54$ to 0.76, $p < .001$). We averaged the scores from these variables to yield an overall evaluation of the label; the attitude score (Cronbach's alpha = 0.87).

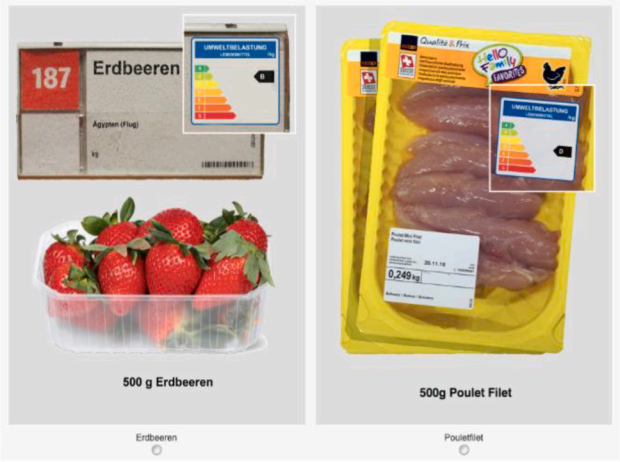
Behavioral intention of using the label was measured with the item: "*To what degree would you include the label in your shopping decisions in case of an introduction?*" The response options ranged from 1 *(never*) to 6 (*always*).

Participants' environmental self-identity was assessed with three items: "Acting *environmentally friendly is an essential part of myself.*"; "*I am the kind of person who acts environmentally friendly.*"; "*I consider myself an environmentally friendly person.*". The response options ranged from 1 (*completely disagree*) to 6 (*completely agree*). These items were adapted from previous studies (Fielding et al., 2008; Van der Werff et al., 2013). The mean score was calculated for these items. Cronbach's alpha for this scale was 0.92.

We additionally assessed intentional shopping behavior regarding the consideration of products' environmental friendliness with the item: "*During shopping, I consider the environmental friendliness of the products.*" Participants could indicate their agreement with the item on a 6-point



a. Example of a product comparison, as presented to the control group participants.



b. Example of a product comparison, with the label, as presented to the label group participants.

Fig. 2. a. Example of a product comparison, as presented to the control group participants.
b. Example of a product comparison, with the label, as presented to the label group participants.

scale ranging from 1 (*completely disagree*) to 6 (*completely agree*).

All of our items/scales were self-generated and are based on previous attempts to assess similar constructs.

4. Results

4.1. Mean accuracy

Data analysis was conducted with IBM SPSS Statistics, version 23. Participants' performance in the choice task was basically measured by summing up their correct choices. More specifically, the choices were compared to the ecopoints (EP) data set and coded as correct and incorrect choices. A choice was coded as correct, whenever the product that was selected as the environmental-friendlier product had fewer ecopoints (EP) than the other product. Averaging the number of correct choices (divided by the total number of choices) yielded the main dependent variable: the mean accuracy score. As expected, mean accuracy did not differ across Selection 1 and Selection 2 ($t(603) = -0.99$, $p = .320$). Thus, we collapsed the data across the two selections.

A *t*-test[1] for independent samples was carried out to analyze whether

[1] The assumption of normal distribution was violated; therefore, we also used nonparametric tests to analyze the data. As the sample size was large enough, we used Welch's *t*-test for the analysis and conducted the Mann-Whitney *U* test. According to Welch's *t*-test, the accuracy of the label group was significantly higher (*Mdn:* 0.84) than the accuracy of the control group (*Mdn:* 0.57), $t(546) = -22.57$, $p < .001$. The Mann-Whitney *U* test showed the same pattern of results ($U = 11{,}231$, $p < .001$).

the expected differences between the two groups (i.e., label vs. control group) regarding their performance in the choice task were present. The results revealed that the mean accuracy was significantly higher in the label group ($M_{label} = 0.80$, $SD = 0.15$) than in the control group ($M_{control} = 0.57$, $SD = 0.10$, $t(546) = 22.57$, $p < .001$, Cohen's $d = 1.54$ [1.35; 1.71]; see Fig. 3). Interestingly, the accuracy in the control group condition was only slightly better than chance (0.57 vs. 0.50).

4.2. Average error per choice

In contrast to the mean accuracy score, the average error per choice also accounted for the specific environmental impact of the products. As the impact difference between the products pairings could vary considerably (27–14,372), it appeared necessary to take these differences into account. Thus, the average error per choice can be regarded as an accuracy assessment with a correction for the inequality of the impact difference. For each choice, participants could either make no error (= 0) by choosing the product with the lower environmental impact or make an error, with the magnitude of the respective products' impact difference (in EP). For the average error, all errors were summed up and divided by the total number of choices. Again, there were no differences between Selection 1 and Selection 2 ($t(619) = -0.41$, $p = .685$); thus, the data were collapsed for the subsequent analysis.[2]

The *t*-test[3] for independent samples showed a significant difference between the label group and the control group ($t(619) = 19.12$, $p < .001$, Cohen's $d = 1.81$ [1.62; 2.00]; see Fig. 4). The performance of the label group ($M_{label} = 2{,}169$, $SD = 2{,}524$.) was better (i.e., relative error rate was lower) than the performance of the control group ($M_{control} = 5{,}851$, $SD = 2{,}257$). As this pattern of results corresponds to the results of the mean accuracy analysis and the correlation between both accuracy measures was very high in both conditions ($r > -0.910$, $p < .001$), we assume that accounting for the relative impact of the products does not lead to different results. If only, according to Cohen's *d,* the difference between the groups seems a bit more pronounced, when accounting for the relative impact of the errors.

4.3. Environmental friendliness and accuracy

We suspected that the degree of participants' personal environmental friendliness would influence their accuracy in the choice task, because high engagement and interest in the environment are assumed to go along with more knowledge about the sustainability of products. Thus, we conducted correlational analyses based on the control group only[4] (as the performance of the label group was strongly impacted by the labels). A significant positive correlation of pro-environmental identity and mean accuracy was revealed ($r = 0.25$, $p < .001$) indicating that accuracy was higher the more participants described themselves as pro-environmental. The results did not differ when using the other accuracy measure (accounting for the relative impact of the errors).

A similar correlation was found between accuracy and participants' consideration of products' environmental friendliness during shopping ($r = 0.25$, $p < .001$). The more the participants considered the environment during shopping (which was also positively related to pro-environmental identity $r = 0.74$, $p <. 001$) the better was their performance in the choice task. Again, the results did not differ when using the accuracy measure accounting for the relative impact of the error.

4.4. Evaluation of the label

We conducted *t*-tests to analyze participants' evaluation of and attitude toward the label. Independent from the conditions, the average ratings of all variables (i.e., *comprehensibility*, *credibility*, *usefulness, approval)* were significantly different from the scale mean (i.e., = 3.5), all $t_s > 5$, $p < .001$; (*see* Fig. 5). Accordingly, the attitudes toward the labels across all conditions and dimensions were clearly positive.

There were unexpected significant differences between the control and label groups regarding *comprehensibility, credibility, usefulness and approval* (all $t_s > 2.70$, $p < .01$) indicating that the label group was more critical about the label than the control group.

Additional correlation analyses revealed that participants with more positive attitudes towards the label described themselves as more pro-environmental ($r = 0.31$, $p < .001$) and indicated that they more often considered the environment during shopping ($r = 0.24$, $p < .001$). The same pattern was found for all sub-facets of the attitudes towards the label (i.e., usefulness, comprehensibility, credibility, approval; all $r_s > 0.15$, $p < .001$). Moreover, the performance in the choice task was also positively related to the attitudes toward the label; participants with a higher mean accuracy evaluated the label more positive ($r_{control} = 0.24$, $p < .001$; $r_{label} = 0.35$, $p < .001$). Again, the same pattern emerged for the sub-facets (all $r_s > 0.14$, $p < .02$). The results were the same when accounting for the relative impact of the errors.

[2] Even though there was no difference between the two selections in the first place, we tested for a potential moderating influence of the selection. We conducted two additional analyses (i.e., one for the accuracy measure and one for the error measure) including both the condition and the selection version as factors as well as the interaction term. Both analyses show the expected large effect of the condition ($F > 364.6$, $p < .001$) and no main effect of the selection version ($F < 2.55$, $p > .11$). Additionally, in the analyses with the dependent variable mean accuracy we found a significant interaction of condition X selection ($F = 4.59$, $p = .032$). No such interaction effect emerged for the other performance measure that accounted for the relative impact of the products ($F = 0.43$, $p = .513$). More detailed analyses regarding the interaction found in the mean accuracy analyses showed that the condition effect was highly significant in case of both selection versions ($F > 206.6$, $p < .001$). Additionally, there was a significant difference between Selection 1 and 2 within the control condition ($F = 6.76$, $p = .010$) indicating that accuracy for Selection 2 was slightly higher, while there was no such difference in the label condition. The fact that this additional difference occurred in the control condition does not change the conclusion of our analyses substantially.

[3] According to the Mann-Whitney *U* test, the average errors per choice differed significantly between the control and label groups ($U = 13{,}283$, $p < .01$). The comparison of medians reveals a significantly lower error rate (5.35-fold) for the label group (*Mdn*: 1081 EP) compared to the control group (*Mdn*: 5786).

[4] Pro-environmental identity had an improving influence on the accuracy performance independently from the condition, as was shown by an ANCOVA that yielded two significant main effects ($F_s > 10$, $p_s < .01$), but no interaction of condition x pro-environmental identity ($F = 1.79$, $p = .181$). Another ANCOVA testing the main and interactive effects of label evaluation and condition, showed the effect of the condition and the effect of the label attitude on the accuracy (both $F_s > 5.00$, $p_s < .021$) as well as an interaction of the two variables ($F = 56.16$, $p < .001$) indicating that the relationship between the attitudes and the accuracy performance was stronger in the label-condition. Perhaps the participants with more positive attitudes towards the label also relied their judgment more often on the label when selecting the environmental friendlier product leading to a better performance. Two additional ANCOVAs, one with the covariate intentional shopping behavior and one with behavioral intention, revealed that the condition effect always was significant (both $F_s > 37$, $p_s < .001$). The effect of the covariate intentional shopping behavior was significant ($F = 19.47$, $p < .001$), while the effect of behavioral intention did only reach a marginal level of significance ($F = 3.14$, $p = .077$). There was no interaction of behavioral intention X condition ($F < 1.00$, $p = .890$), but the interaction term of condition X intentional shopping reached significance ($F > 8.53$, $p = .004$): a positive relation between intentional shopping and accuracy was found in the control condition ($r = 0.25$), while no such relation is observable in the label condition ($r = -0.04$).

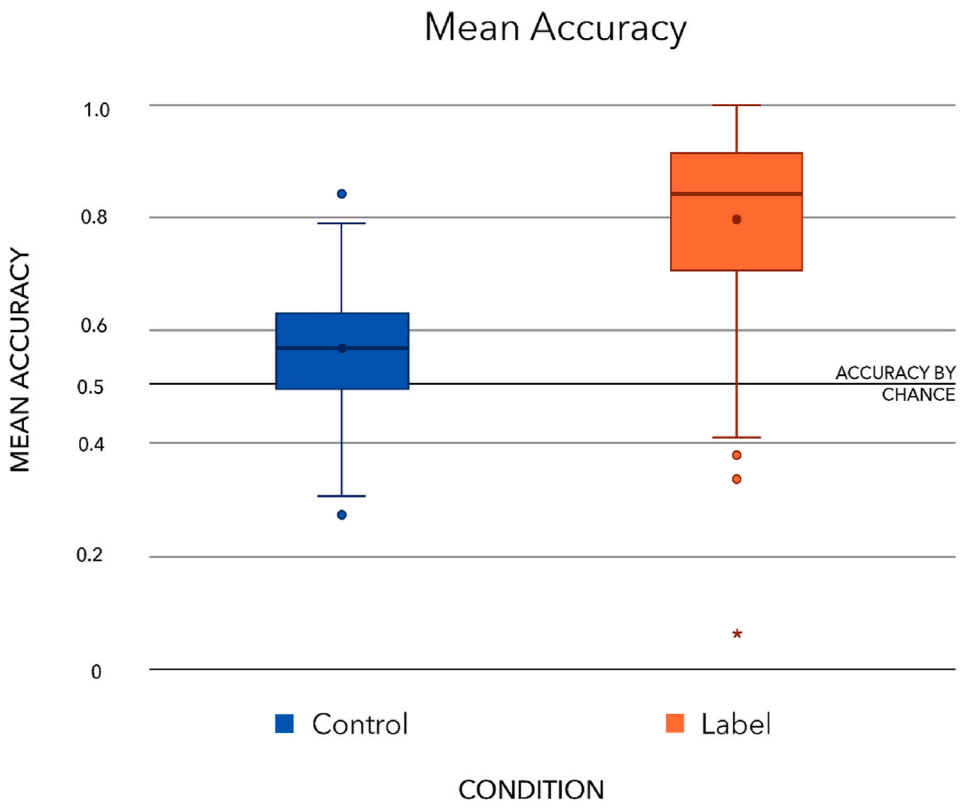


Fig. 3. Boxplots displaying the mean accuracy as a function of group condition. Note that the black line represents the accuracy by chance (0.50). The dot within the boxes represents the mean.

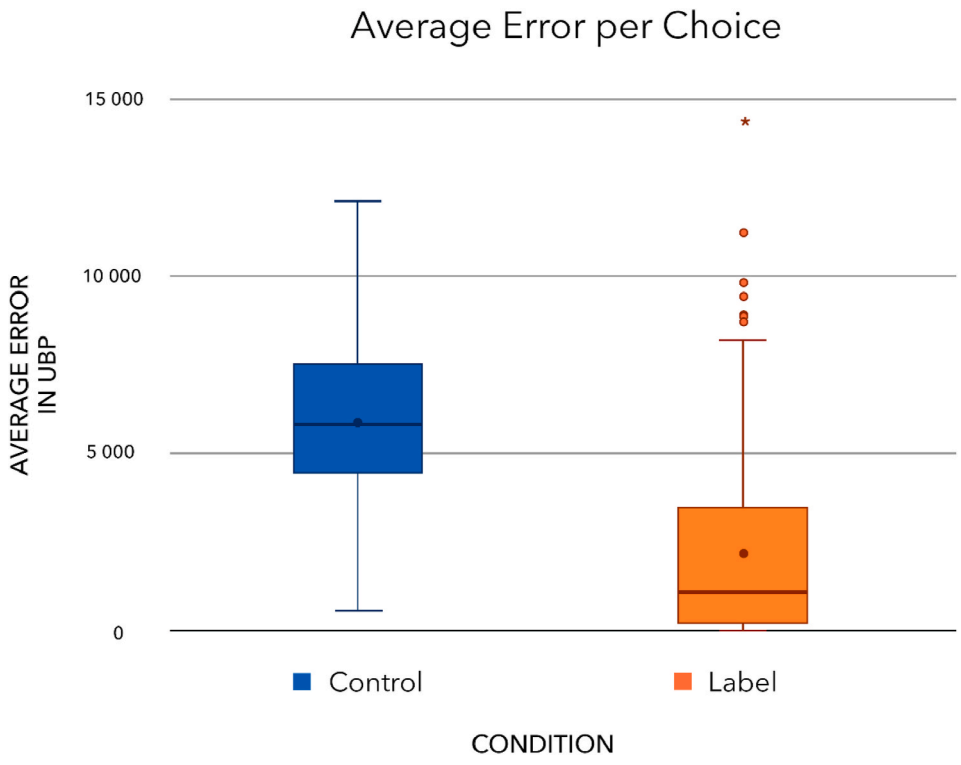


Fig. 4. Boxplots displaying the average error per choice as a function of condition. The dots within the boxes represent the mean. UBP ~ environmental impact points (EP).

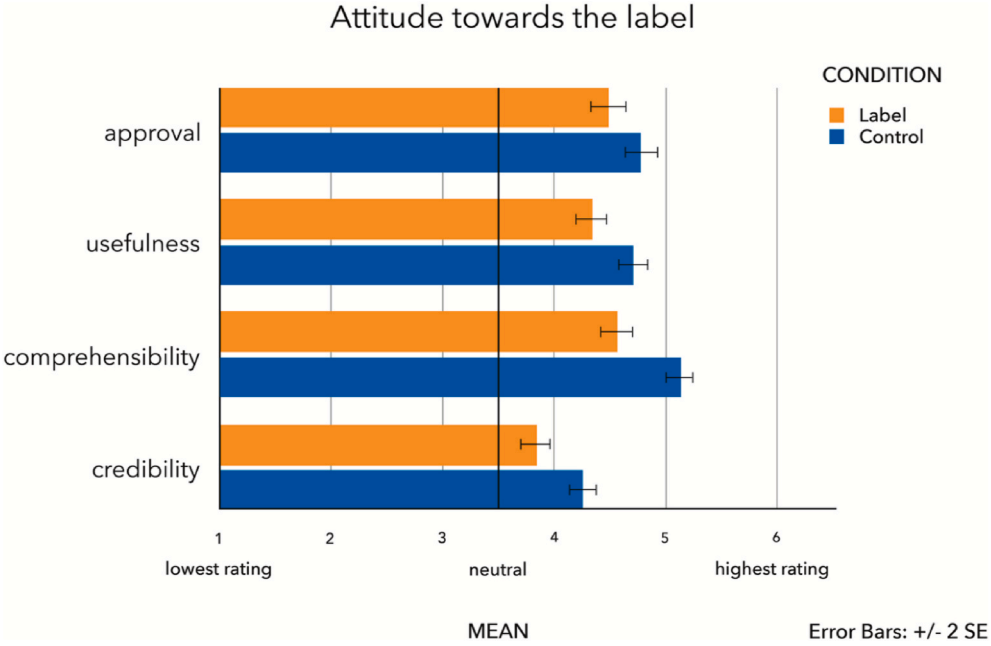


Fig. 5. Approval of the introduction of the label, usefulness, comprehensibility and credibility.

4.5. Willingness to implement

Most of the participants stated that they would include the label in their shopping decisions if it were introduced to the market "often or almost always" (Control: 65%, Label: 62%) (see Fig. 6). Only 3.5% responded that they would "never" use it.

No statistically significant difference was found between the control group and the label group ($t(619) = 1.31$, $p = .192$), indicating that although the label group was more skeptical about the label (see Section 4.4.), both groups would equally likely use the label, if it would be introduced to the market.

Unsurprisingly, participants with a more positive attitude towards the label would be more willing to include the label in their shopping decisions ($r = 0.65$, $p < .001$). Also, those participants describing themselves as more environmentally friendly would more often consider the label for purchase decisions ($r = 0.48$, $p < .001$) and those, who scored high on intentional shopping behavior indicated a higher willingness to include the label in their shopping decisions as well ($r = 0.51$, $p < .001$). Moreover, there was a positive relation between the performance in the choice task and the willingness to implement the label in both conditions; the more accurate participants performed in the choice task, the higher was the stated likelihood that they would use the label when introduced to the market ($r_{control} = 0.22, p < .001$; $r_{label} = 0.16, p < .01$). These results did not differ when accounting for the relative impact of the errors.

Fig. 6. Clustered bar plot of people's willingness to adapt their shopping behavior to the label.

4.6. Common mistakes

For the evaluation of common mistakes in the control group (i.e., without label), we conducted an error assessment for each food item. A choice error could be the result of an underestimation of a high product impact and an overestimation of a low product impact. For every food item, all possible comparisons with the other items were assembled. For each comparison, the share of wrong choices was calculated. Depending on whether the chosen product was the one with the higher or lower environmental impact, the error rate was attributed to either the overestimation or underestimation error column. Subsequentially, in both columns the error rates were summed up and divided by 19 (i.e., the total number of possible comparisons containing a certain item). Fig. 7 gives insight to what extent the impact of the food items was over- and/or underestimated.

The products that were overestimated the most were imported vegetables and fruits (kiwis, tomatoes and strawberries) as well as vegetarian meat alternatives. The impacts of local animal products (minced beef, Swiss cheese, bacon cubes) and chocolate were underestimated. Carrots, asparagus and lamb filet were rated most accurately.

5. Discussion

5.1. The label effect

The first purpose of this research was to examine whether the newly developed sustainability label is effective in informing people about the environmental friendliness of different food products. The second purpose of this study was to investigate people's attitudes toward the new label, for example in terms of comprehensibility, and willingness to include this label in their shopping decisions if it were introduced to the market.

The experiment, using cross-category comparisons, provides evidence that the label enabled more accurate decision making regarding the environmental friendliness of the different products. Of two product options, the more environmentally friendly products were chosen statistically significantly more accurately, when the proposed label was included on the package than when the label was not included. The performance was 23% better in the label condition. This effect was also significant, when accounting for the relative environmental impact of the products (i.e., the relative error rate was more than two times higher in the control condition). With a high Cohen's d (>1), the effect is large. According to these results, the label was able to inform consumers adequately about the environmental impacts of the product selection. These results can be regarded as evidence that the label is technically able to inform and guide consumers toward more environmentally friendly food choices.

The data showed that the participants' accuracy in the control group (i.e., without label) barely exceeded the accuracy by chance, leading to the conclusion that people, in general, have great difficulty comparing the environmental impacts of food items of different product categories. This finding points to consumers' need for easily accessible information that could be provided by such a label as ours.

Previous studies also found positive effects of environmental labeling (Vlaeminck et al., 2014). In contrast, some studies did not provide a clear confirmation of the positive effect of labels. The results in Lazzarini and colleagues' (2018) online study, for example, did not show a clear advantage of the label. In that study (similar to the present study), participants' task was to select the environmental friendlier product. The test group received help through an EP-based label, while the control group relied on their own judgment. However, the study differed from our research approach in the present study in two aspects. First, the

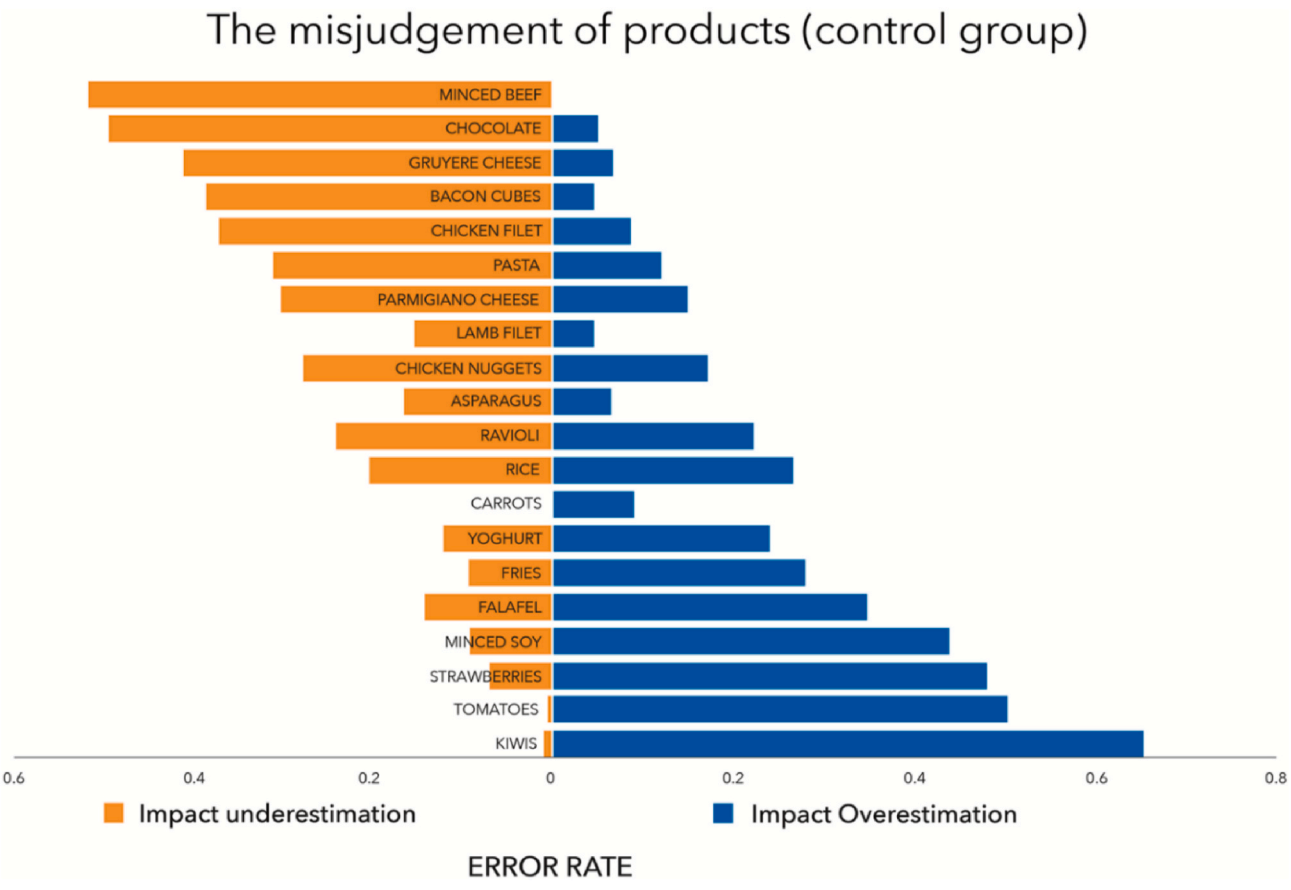


Fig. 7. Average error rates for single food items, divided into under- and overestimation errors (control group only).

label used by Lazzarini et al. (2018) did not use color-coding or gradations; therefore, differentiation between two labeled products was not possible. Accordingly, the label was used only to highlight the most environmentally friendly share of the products instead of being present on every item. Second, the food items were split into the categories vegetables, fruits and protein-rich products, and only pairs of the same category were formed. In contrast to the present study, only marginally higher accuracy was achieved in the label group. Lazzarini et al. (2018) discussed and proposed that their results could be different if the study were conducted with a more comprehensive label with more complex indications. In the present study, we applied such a more complex framework that enabled a successful test of the new sustainability label. Based on the results, we conclude that using cross-category comparisons and a color-coded scheme with a sufficient range of gradations represents a promising approach for the creation (and investigation) of a future sustainability label.

The importance of a proper label design for label efficacy was also highlighted by authors of other studies in this field (Thogersen and Nielsen, 2016; Sharp and Wheeler, 2013; Vlaeminck et al., 2014). In a similar vein, we assume that a label with reduced gradations or complexity would not be suitable for displaying the vast environmental impact differences in cross-category comparisons. One could consider expanding label complexity to accommodate extreme outliers such as beef. However, the most important feature should, nonetheless, be that the label must remain as easy to understand as possible, as otherwise consumers would likely refrain from including the label in their shopping decisions.

5.2. Cross- and within-category labels

There is an ongoing debate about whether sustainability ratings should be based on within- or across-category comparisons, as both strategies have benefits and drawbacks.

Within-category comparisons seem plausible, as consumers are expected to intuitively exchange products within category. Additionally, within-category comparisons allow for finer differentiation between the products of a given category.

Subtle within-category variations (e.g., seasonal fluctuations in the vegetable category) could no longer be communicated to consumers and thus, might be overlooked, if the comparisons were moved to the higher, cross-category level. However, as the environmental impact differences between categories are substantially larger than the differences within categories, from the viewpoint of the concrete environmental impact, it is more efficient to replace products from different categories with each other than to make replacements within categories. It is anticipated that the cross-category comparison eventually allows consumers to develop a more comprehensive understanding of the whole product range to enable an environmentally relevant behavior change. This goal is likely to be achieved if consumers are not limited to a single product exchange method but instead, replaced whole menu plans. Once consumers have the opportunity to learn that the alternatives from other categories are more environmentally friendlier, consumers might be more likely to consider them: Consumers could, for example, choose a vegetable-based risotto instead of spaghetti Bolognese, at least from time to time.

On another note, one might argue that it is probably more convenient (and thus more likely) for consumers to switch within categories than across categories. However, a single cross-category switch often makes such a huge difference that in comparison, there would be so many within-category switches needed to achieve the same beneficial effect that it seems unlikely to achieve the same effect by within-category changes. However, future research is needed to clarify this issue more thoroughly.

5.3. Pro-environmental behavior

We analyzed the choice-task performance of the control group participants, who had to rely on their own judgment (i.e., without labels) separately to test whether their individual accuracy was dependent on their reported respective pro-environmental identity. The results show a significant correlation between pro-environmental self-perception and accuracy; the more participants described themselves as maintaining an environmentally friendly identity, the better their performance in the choice task. This result suggests that these consumers likely were more interested and therefore, had more knowledge regarding environment friendliness. Moreover, our analyses also revealed that individuals describing themselves as more environmentally friendly had a more positive attitude towards the label and were more willing to include the label in their shopping decisions if it would be introduced to the market.

Analyzing the data of the control group in more detail, only around 10% stated they had no interest in environmental friendliness. Nevertheless, although the majority described themselves as having an environmentally friendly identity, there seemed to be a general lack of information on the consumer side. The best performance in the control group without labels was by a person with slightly more than 80% correct choices (this score was outnumbered by more than 50% of the participant group with labels). Accordingly, the information provided by a label such as the one developed seems necessary, and the benefit is quite obvious.

5.4. Attitude toward the label and behavioral intention

The present study provides clear evidence that a sustainability label, such as the one in this study, is likely to be accepted by consumers. Across both conditions (i.e., with vs. without label), consumers' attitude toward the label was positive. Participants evaluated the label as comprehensible, credible and useful. Moreover, the majority reported that they would use the label when it would be introduced to the market. Interestingly, the analyses revealed that independent from the condition a better performance in the choice task was going along with a more positive evaluation of the label and more willingness to include the label in their shopping decisions. These findings suggest that especially those individuals who already have more knowledge on environmental issues (in the food domain) and those, who place importance on environmental issues (see Section 5.3.), are more open for new implementations like a sustainability label that could be helpful for the environment.

We found an unexpected difference between the label and the control condition regarding the attitudes towards the label. Participants who had to rely on their own judgment for the execution of the choice task rated the label (which they learned about only after the task) more positively than the participants who were presented with labeled products in the choice task. Perhaps the participants without the labels noticed how difficult it is to assess the environment friendliness of the product without any additional information or help. Accordingly, they had a more positive attitude toward a label that could deliver the necessary information. Another explanation is that the participants with the labels might have felt criticized when their established beliefs about specific products deviated from the respective rating conveyed by the label. A label that challenges consumers' knowledge or conflicts with their beliefs could create skepticism. Nevertheless, independent of the conditions (i.e., choice task with vs. without label), the potential for acceptance of the label in real life was very high; more than 96% of the participants reported that they would include the label in their shopping decision if it were introduced in the market. This is important, because aside from knowledge issues, consumers' motivation plays a vital role regarding sustainable product choices. Thus, given that participants stated a high willingness to use the label, both prerequisites (i.e., knowledge and motivation) seemed to be fulfilled. Future studies are needed to clarify whether these assumptions are transferable to a more realistic shopping setting (perhaps without an explicit introduction of the label).

5.5. Common mistakes

It is assumed that participants have an internal set of rules, which are applied when choosing the more environmentally friendly product (Scheibehenne, 2007). However, these rules do not always lead to the correct decision. Accordingly, participants committed some errors when judging the products. For example, the environmental impact of foreign products was overrated. This phenomenon has been observed in other studies (Vlaeminck et al., 2014; Lazzarini et al., 2018).

Evaluating animal products accurately also seemed to be problematic for consumers. The present results revealed that animal products were generally underestimated regarding their environmental impact. This error was also reported in several previous studies (Lazzarini et al., 2018). Additionally, people especially failed to acknowledge the low environmental friendliness of meat products when comparing them with foreign fruits and vegetables.

As proposed by Lazzarini et al. (2018), the provision of guidelines (e.g., avoid air-transported products, reduce or renounce meat consumption, choose in-season vegetables …), might be a valuable alternative to inform consumers about the environmentally friendliness of products and guide their shopping decisions towards environmentally friendly choices. Based on our findings, the following guidelines are suggested:

- Avoid meat in general
- Avoid ruminant meat
- Avoid animal products in general.
- Avoid air-transported food.

The use of guidelines, however, bears some drawbacks: First, it becomes difficult to decide based on guidelines, when multiple rules apply (e.g., the comparison between local meat and fruits transported by air) and second communicating them to consumers is complicated. In contrast, it is far simpler to just stick a label on a product that is (a) clearly visible and (b) communicates the relevant information in an easily understandable way.

5.6. Limitations

In this study, consumer knowledge was assessed for only a limited number of products and categories. Thus, future studies should examine the effectiveness and efficiency of the label in a broader range of products and categories to determine the validity of the effect. Moreover, it would be important to test whether consumers use the label in a real-world setting and without making them explicitly aware of the label.

Another issue that needs to be addressed in the future is the trust towards new labels. Assuming an expected accuracy of 100% for the obvious choices (i.e., when a product is clearly labeled with a better or worse label gradation) and an accuracy by chance of 50% for the difficult non-obvious choices (i.e., same-category pairs; e.g., when two products of the label category B are presented), the overall expected accuracy of a hypothetical fully trusting label group would be 92%. The mean accuracy of 80% in the label group shows, that some participants decided not to follow the instructions of the label blindly but were skeptical in some cases. We propose that for establishing trust, a newly created label has to be introduced properly and extensively. To a limited extend this can be imitated by introducing the label briefly as we did in our experiment, but still, it has to be expected, that the lack of trust remains an issue and the full potential of a label may not be visible in the experimental setting.

The majority of participants stated that they would include the label in their shopping decisions. However, according to previous literature there can be discrepancies between stated and actual environmental behavior (Grunert, 2014). Also, we cannot say by now if people would be less fond of the label when they would have to pay more for the products due to the introduction of the label. Nevertheless, we are convinced that even if some people would not use the label in real life, as the number of participants stating openness to using the label was remarkably high (>93%), it is unlikely that it would not be taken into account if it were introduced to the market. In addition, environmental consciousness is a topic of increased social awareness; therefore, social desirability bias could even increase the use of such a label in real life (Peschel et al., 2016).

Another limitation is that we did not account for price differences between the products in this study. However, the purpose of the present research was to study the comprehensibility and the perceived helpfulness/usefulness of the new label to assess the environmental friendliness of food products. A consideration of the potential influence of prices is of course important for future research, especially when investigating peoples purchase behavior and willingness to pay in real-life settings. Studies showed that the effectiveness of carbon labels is apparently influenced by financial issues (e.g., Shuai et al., 2014, Vanclay et al., 2011). However, when it comes to cross-category comparisons the more sustainable product is not necessarily the more expensive one (e.g., minced beef or chicken filet per kg are far more expensive than carrots, tomatoes or pommes frites). Yet, more research is warranted to examine whether and how the effectiveness and efficiency of sustainability labels is influenced by price issues, as there is a lack of studies focusing on cross-category purchase options using labels other than carbon labels. Previous studies demonstrate that carbon labels do not seem to be as easily understood by all consumers (e.g., Spaargaren et al., 2013), so an investigation of consumers purchase behavior with a sustainability label that is more easily comprehensible, seems to be a viable endeavor.

The costs and effort of the implementation and maintenance of such a label might be perceived as a serious obstacle preventing stakeholders from considering the label as an opportunity to influence people's shopping behavior. In the long term, stakeholders could, however, increase their market share if they shifted to more sustainable products (Vandenbergh et al., 2011) – as there is a substantial percentage of consumers that are willing to pay more for sustainable products as reported in recent research (de-Magistris and Gracia, 2016; and see Li and Kallas, 2021 for a recent meta-analysis).

6. Conclusion

Food production and consumption have a strong impact on our environment (Carlsson-Kanyama and Gonzàlez, 2009; Gerbens-Leenes and Nonhebel, 2002). Especially as food production is becoming increasingly intensive due to population growth (Godfray et al., 2010) and to due to the Westernization of eating habits (Tilman and Clark, 2014), it is important to find ways to guide consumers to make environmentally friendly food choices.

According to previous research, consumers systematically make errors in evaluating the environmental impact of different food products, such as meat, foreign fruits or vegetables from heated greenhouses (Lazzarini et al., 2018; Tobler et al., 2011). Therefore, it is important to investigate the possibilities that would enable consumers to make more correct judgments regarding the environmental friendliness of different food products, which subsequently, would affect their shopping decisions.

Considering the high cost of introducing a new label, high effectiveness and efficiency is an indispensable prerequisite of a sustainability label. Therefore, we suggest introducing a label only when consumer knowledge is low. This circumstance is given when food items of different categories are compared with each other. In addition, impact differences are the largest among different product categories. Thus, the reduction potential is high when the label is based on cross-category comparisons.

Based on this research, we are convinced that introducing a sustainability label would be an efficient way of increasing consumers' ability to make environmentally friendly food choices. For an efficient

label, we suggest using multiple color-coded impact categories, present on every product, comparing food items across food categories. Previous studies that investigated labels without a graded structure were not successful in showing a clear advantage of labels over guidelines (Lazzarini et al., 2018). The present research based on a graded color-coded scheme, however, provides evidence that a cross-category environmental label can improve the consumers' food evaluation significantly. Previous research on labels concerning the healthiness of products reported results that support our assumptions regarding the difference between graded labels and their ungraded counterparts. For example, the color-coded Nutri-Score outperformed other labels: It enabled more accurate healthiness evaluations than other labels (Egnell et al., 2018; Hagmann and Siegrist, 2020). Future studies in the sustainability domain are warranted to compare the effectiveness of the new color-coded graded sustainability label and nongraded labels more systematically.

In a nutshell, the present findings suggest that a label could be a suitable option for enhancing consumers' ability to assess the environmental impact of products correctly. Participants were not only better at evaluating the impact, but a majority also stated that they were willing to adopt the advice of the label if it were introduced to the market.

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CRediT authorship contribution statement

Marius Dihr: Investigation, Conceptualization, Methodology, Data curation, Writing – original draft, preparation, Visualization. **Anne Berthold:** Formal analysis, Writing – review & editing. **Michael Siegrist:** Conceptualization, Methodology, Writing – review & editing, Supervision. **Bernadette Sütterlin:** Conceptualization, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

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

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