

# The effects of green nudges on consumer valuation of bio-based plastic packaging

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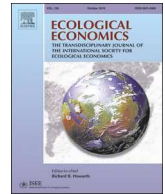
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## Analysis

## The effects of green nudges on consumer valuation of bio-based plastic packaging

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## ABSTRACT

Plastic packaging is widely associated with negative environmental consequences, which is why the food industry is increasingly interested in pro-environmental packaging alternatives- such as bio-based plastic. As the market share for bio-based plastic packaging is still small, strategies to raise consumer awareness and willingness to pay (WTP) are needed. This study integrates insights from environmental psychology and behavioral economics into choice models to assess which green nudges are most effective to increase consumer WTP for bio-based packaging. We tested a total of four strategies by providing consumers with nature pictures, reflection questions, information on bio-based plastics and normative information. Using a sample of 1019 German consumers, our results indicate that the strongest effects are generated when the nudging strategy matches the characteristic of consumers' cognitive style. For example, providing nature pictures only seems to increase WTP for bio-based packaging when consumers base their decision on their emotions and intuition. On the other hand, the strategies that provide normative information and activate the reflection about environmental consequences of plastics are most effective for consumers who enjoy cognitive deliberation.

## 1. Introduction

Plastic packaging is increasingly associated with negative environmental consequences including fossil fuel usage, high amounts of waste and environmental pollution (European Commission, 2018). As such, bio-based plastic packaging produced on the basis of renewable resources is gaining attention as the more sustainable alternative with the potential to reduce greenhouse gas emissions and to alleviate climate change (Bos et al., 2010; van den Oever et al., 2017). To date, the overall market share for bio-based plastic packaging remains limited (European Bioplastics, 2020) due to the high research and development costs as well as low fossil oil prices. Yet, an increasing market demand of bio-based plastic packaging could facilitate more efficient large-scale production systems and, in turn, lower prices (Cutter, 2006; Pan et al., 2016; European Bioplastics, 2020). Despite so, bio-based plastic packaging suffers from competition with conventional alternatives (Carus et al., 2014; European Bioplastics, 2020). Thus, new marketing strategies are needed to raise consumer awareness and to increase their willingness to switch to bio-based packaging alternatives (Kainz, 2016; Herbes et al., 2018). Recent advancements in behavioral economics and environmental psychology identified green nudges as promising tools to

increase consumers' demand for pro-environmental products, e.g. by making green products as the default option or by making their green attributes more salient (Kahneman, 2003; Thaler and Sunstein, 2009; Venkatachalam, 2008; Schubert, 2017). However, there is a lack of empirical evidence for the success of such green nudges in the case of increasing the demand of bio-based plastic packaging.

This study combines insights from environmental psychology and food choice to explore if and how consumer preferences and willingness to pay (WTP) for bio-based plastic packaging are influenced by different green nudges. To this end, a between-subjects discrete choice experiment was conducted where German consumers were asked to choose a preferred alternative among multiple options of cherry tomatoes that had varying packaging. We chose German consumers as they are among the heaviest packaging waste producers in the EU with 24.9 kg of plastic packaging per inhabitant in 2016, adding up to a total of 2.05 million tons per year (German Environment Agency, 2018; Eurostat, 2019).

The contribution of this study to the field of ecological economics is twofold. First, we elucidate consumer WTP for food with bio-based plastic packaging, which is made from renewable biomass (Peelman et al., 2013). Compared to conventional fossil-based plastic packaging,

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bio-based plastic packaging has the potential to reduce greenhouse gas emissions in the production process (European Bioplastics, 2020). For this reason, the German government introduced the new Packaging Act (VerpackG) on January 1st, 2019. This act urged companies to contribute to the environmental costs of packaging. Therefore, the food industry is becoming increasingly interested in bio-based plastics as a substitute for more conventional plastics (Peelman et al., 2013). In fact, bio-based plastic contains a wide variety of properties that are similar to conventional plastics. This similarity makes bio-based plastics applicable as packaging material for a wide range of food products (Peelman et al., 2013). However, bio-based plastics are more expensive than their fossil-based counterparts (Carus et al., 2014; van den Oever et al., 2017). Hence, it is important to explore how much consumers are willing to pay for bio-based plastic packaging to see if it will be feasible for food companies to implement these products. While some studies investigated consumer perceptions of food products using bio-based plastic packaging (Steenis et al., 2017; Herbes et al., 2018), this is the first study investigating consumer preferences and WTP for food with bio-based plastic packaging.

The second contribution is how our results contribute to the behavioral economics and environmental psychology literature by comparing the effectiveness of different green nudges, i.e. nature pictures, reflection questions, information on bio-based plastics and normative information. Based on empirical insights about human perception and decision-making, nudges are promising tools that modify the choice architecture in which a decision is taken to change people's behavior in a predictable way (Thaler and Sunstein, 2009; Schubert, 2017). Green nudges in particular are interventions which trigger people to engage in environmental behavior (Schubert, 2017). For example, relevant literature suggests that nature pictures, informational videos, or normative information encourage consumers to purchase pro-environmental products (Nolan et al., 2008; Steg and de Groot, 2010; Hahnel et al., 2014). However, it is not clear which of these green nudges works best. Therefore, our paper aims to compare the impact of green nudges on consumers' willingness to pay for bio-based plastic packaging. Understanding what tools are needed to raise WTP is crucial for food companies and policy makers to expand the market share of bio-based plastic packaging.

The article is organized as follows: the next section summarizes prior research on pro-environmental behavior and green nudges. The methods section, which describes the experimental procedure and behavioral treatments, follows. Next, we present the econometric models and results. The final section concludes with theoretical implications for environmental psychology and behavioral economics as well as practical implications for companies, policy-makers. Moreover, it discusses the limitations of this study and gives recommendations for further research.

## 2. Pro-environmental behavior: a background

Pro-environmental behavior is defined by Kollmuss and Agyeman (2010) as "...behavior that consciously seeks to minimize the negative impact of one's actions on the natural and built world" (p. 240). Research rooted in environmental psychology argues that the underlying individual motivation to engage in this type of behavior is altruism—which drives people to base their decisions on costs and benefits for other people and/or the biosphere (Schwartz, 1977; Stern et al., 1995; Schultz, 1999; Nordlund and Garvill, 2002; Steg and Vlek, 2009). The effect of altruistic values on pro-environmental behavior is assumed to be mediated by an ecological worldview, pro-environmental beliefs and personal norms (Stern et al., 1999). However, recent insights from behavioral and experimental economics indicate that humans do not always behave in line with their values, worldview, beliefs, and norms (Simon, 1979; Tversky and Kahneman, 1992). For instance, Kahneman (2003) suggests that under uncertainty, people tend to act intuitively and use situational cues ("fast thinking") as opposed to actively deliberating about their choices ("slow thinking").

Green nudges make use of the insight that human decision-making is heavily context dependent by modifying the choice architecture, i.e. the situation in which a decision is taken (Kahneman, 2003; Thaler and Sunstein, 2009; Schubert, 2017). Based on previous studies from psychology and marketing (Cacioppo and Petty, 1984; Hovland et al., 1953; Olson and Reynolds, 1983), nudging strategies utilize people's cognitive biases to consciously or unconsciously influence their behavior (Thaler and Sunstein, 2009). Specific examples of green nudges are pro-environmental product labels which are assumed to direct people's attention and, thereby, also guide their decision-making (Schubert, 2017). Green nudges might be especially effective when activating internal values, worldviews, beliefs and norms that generally motivate environmental behavior (Schwartz, 1977; Stern et al., 1995; Schultz, 1999; Nordlund and Garvill, 2002; Steg and Vlek, 2009). The following summarizes potential strategies to activate these internal motivations based on existing empirical studies.

Values are rather stable across time and situations and are not subject to change in the short term (Schwartz, 1977). Even if individuals consider particular values as central in their life, these values need to be in the focus of their attention in order to become activated (Verplanken and Holland, 2002). Thus, biospheric-altruistic values need to be made more salient to encourage people to act in line with this value orientation (Steg and de Groot, 2010). Indeed, previous studies found that biospheric-altruistic values can be activated by providing people with visual pro-environmental cues such as pictures of nature (Verplanken and Holland, 2002; Hahnel et al., 2014).

An ecological worldview reflects the belief that humans are part of the natural system and that their behavior can have direct and indirect consequences for plants and animals as well as for the environment as a whole (Stern et al., 1995). This kind of systemic understanding can be activated by drawing people's attention to interconnections, e.g. by asking them to create models or causal diagrams (Hmelo-Silver et al., 2017; Cox et al., 2019).

Beliefs about the existence of environmental problems can be strengthened by providing information about environmental issues in the moment of choice (Schubert, 2017). Extant studies demonstrate that providing consumers with relevant informational videos increases their willingness to pay for environmentally-friendly products (Francisco et al., 2015; Lusk, 2018). For example, Klaiman et al. (Klaiman et al., 2016; Klaiman et al., 2017) found that showing participants an infographic or video about recycling enhances their preference for recyclable sandwich containers and willingness to pay for fruit drinks with recyclable packaging respectively.

Social norms have been found to be among the most powerful behavioral antecedents (Schwartz, 1977; Cialdini and Trost, 1998). Empirical studies suggest that providing normative information stimulates people to act in line with their peers (Schultz et al., 2007; Goldstein et al., 2008). Building on these insights, normative information such as information about the behavior or preferences of others appears to be a powerful tool to mobilize action against social and pro-environmental problems (Parks et al., 2001; Cialdini et al., 2006; Hafner et al., 2019). In fact, Nolan et al. (2008) found that normative information was more effective in changing households' conservation behavior compared to other types of information.

However, the effectiveness of the presented green nudges seems to depend on individual differences in cognitive styles. This is due to the effect of how situational manipulations might differ between people who usually engage in more deliberate slow thinking rather than in intuitive fast thinking (Smith and Levin, 1996; Carnevale et al., 2011). One approach to measure people's cognitive style is the "Need for cognition" (NFC) scale developed by Cacioppo and Petty (1982). People scoring high on the NFC scale base their decision on cognitive deliberation and rational arguments, whereas people low in NFC rather base their decisions on their intuition and emotions (Cacioppo et al., 1996). Previous studies found contradictory results regarding the moderating effect of NFC on the susceptibility of decision-makers to variations in

the choice context (Mandel and Kapler, 2018). Hence, this study aims to evaluate the effects of the presented green nudges on consumer WTP for bio-based plastic packaging while taking individual differences in NFC into account.

### 3. Methods

This study draws upon an online survey with a discrete choice experiment (DCE) and a between-subject design approach to assess the effectiveness of green nudges to increase consumer WTP for bio-based plastic packaging. The survey consists of three sections. The first section included questions about socio-demographics, consumption habits, and food values. In the second section, participants were randomly assigned to one of the treatment groups. Each treatment group was represented by behavioral tasks followed by DCE questions. The last section consisted of the German need for cognition scale (Bless et al., 1994) based on Cacioppo and Petty (1982). Finally, we asked for respondents' beliefs about the innovativeness, healthiness, naturalness, environmental-friendliness, and affordability of cherry tomatoes with the bio-based label. The target population is composed of German consumers responsible for food purchases in their households and who purchased the product of interest within the last three months. The following subsections describe the procedures that were followed to design the DCE survey and the treatments.

#### 3.1. Online choice experiment

During the online DCE survey, respondents were asked to make discrete choices between two options of packaged cherry tomatoes and a no purchase option. Vegetables are in general viewed as a promising application field for bio-based plastic packaging (Peelman et al., 2013) as they are short shelf life products and have low requirements regarding their packaging functionalities (e.g. water and oxygen barriers). Most importantly, tomatoes were chosen as the product of interest for this study as they are the most frequently purchased fresh vegetable among Germans (Statista, 2018).

The attributes and attribute levels of the product in question were selected based on relevant literature (Koutsimanis et al., 2012; Klaiman et al., 2016), and a focus group discussion conducted prior to the experiment. The four attributes were bio-based plastic packaging label, disposal method, organic label, and price, as shown in Table 1.

Since bio-based plastic is not distinguishable from conventional plastic, a label was designed to indicate that the plastic packaging is bio-based. In addition, prior studies indicate that consumers are willing to pay a price premium for biodegradable containers (Yue et al., 2010) or recyclable packaging of fruit drinks (Klaiman et al., 2016). Hence, we also included labels indicating that the packaging is industrially compostable or mechanically recyclable.<sup>1</sup> Further, the organic label was also used, as its presence has been found to be an important factor in the purchase decision of fresh produce (Kim et al., 2018; Baum and Weigelt, 2019). Finally, the price levels were selected to reflect actual market price ranges, which were also validated by the results of a pre-test.

Given the attributes and attribute levels selected, a full factorial design with two alternatives would require  $(4^1 \times 2^2 \times 3^1)^2 = 2304$  different choice questions. Following Street et al. (2005), the full factorial design was reduced to 24 with a D-efficiency of 97.60 (main effects only). To further reduce the number of choice questions shown to respondents during the survey, the 24 choice questions were split in three blocks of 8 choice questions each. To avoid ordering effects, the order of the choice tasks was randomized. An example of a choice set is presented in Fig. 1.

<sup>1</sup> Participants are provided with more detailed information about the labels (see Appendix B)

**Table 1**  
Attributes and levels.

Attributes	Levels
Bio-based plastic packaging label	Present/Absent
Packaging disposal	Recycling label, Compostable label, No label
Organic label	Present/Absent
Price	0.99 €, 1.89 €, 2.79 €, 3.69 €

During the survey, participants were faced with 8 choice questions, each represented by two cherry tomatoes products and the opt-out option (no-purchase). Prior to the choice questions, respondents were also provided with an instruction about the DCE and asked to read a cheap talk script<sup>2</sup> (see Appendix A). In order to force respondents to carefully read both the instructions and the cheap talk, they were not able to continue with the questionnaire until 1 min had elapsed.

#### 3.2. Between-subject treatments

Before answering the DCE questions, participants were randomly assigned to one of seven treatment groups. These treatment groups were designed to explore if and how consumer WTP for bio-based plastic packaging increases when activating their pro-environmental values, beliefs, and social norms. The treatments are named as follows: *Control*, *Label Information*, *Control for Pictures*, *Nature Pictures*, *Reflection Questions*, *Environmental Information* and *Normative Information*. Table 2 summarizes the treatments, while Appendix B reports the specific information respondents received in each treatment.<sup>3</sup>

In the *Control* (hereafter CTRL), participants were asked to respond only to the DCE questions, while in the other treatments, participants were faced with information or asked to undertake diverse tasks prior to the DCE questions. To illustrate, in the *Label Information* treatment (hereafter LABEL), prior to the DCE questions, participants received information about the meaning of the bio-based, organic, recycling, and compostable labels. As the majority of German consumers are not familiar with bio-based labels (Rumm, 2016), we assume that an information about the label increases preferences for bio-based plastic packaging. The same set of label information was also used in the remaining treatments prior to the introduction of the other tasks. This allowed us to capture the net effects of the remaining behavioral treatments. For instance, in the *Nature Pictures* treatment (hereafter PICT), prior to the DCE questions, participants were primed with ten pictures of nature landscapes from the databases of the Nencki Affective Picture System (Marchewka et al., 2014) and were asked to rate their attractiveness to increase attention (Hahnel et al., 2014). The nature associations of pictures are assumed to prime consumers' pro-environmental values and preferences for bio-based plastic packaging. In order to make sure that the effect of the pictures can be ascribed to the pro-environmental content as opposed to the positive valence, an additional control group specifically for PIC was introduced (hereafter CTRL\_P).<sup>4</sup> In the *Reflection Questions* treatment (hereafter REFL), participants were

<sup>2</sup> This approach is based on the idea that explaining hypothetical bias and reminding of potential budget constraints motivate respondents to decide as if they were in a real buying situation Cummings and Taylor, 1999; van Loo et al., 2011.

<sup>3</sup> To encourage participants to read the provided information, specific time frames were determined before the button to advance appeared. Additionally, true-or-false questions were used to screen out inattentive participants. For example, four true-or-false questions were to test if respondents read the label information. If they gave incorrect answers, they were excluded from the survey.

<sup>4</sup> In CTRL\_P, participants received ten pictures with objects such as buildings, toys or cars from the Nencki database. A pre-study ( $N = 63$ ) confirmed that the pictures in PICT are significantly stronger associated with nature than in CTRL\_P, but do not significantly differ in terms of their perceived valence.



**Which of the following alternatives would you choose?**







<p><b>Alternative 1: Cherry Tomatoes</b></p>  <div style="display: flex; justify-content: center; align-items: center; gap: 10px;">   </div> <p><b>0,99 € / 250 g</b></p>	<p><b>Alternative 2: Cherry Tomatoes</b></p>  <div style="display: flex; justify-content: center; align-items: center; gap: 10px;">   </div> <p><b>1,89 € / 250 g</b></p>	<p><b>Alternative 3: No Purchase</b></p> <p>If these were the only two alternatives available I would not purchase either.</p>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 1. Example choice question.

**Table 2**  
Overview Treatments.

Treatments	Name	Description
Control	CTRL	DCE questions
Label Information	LABEL	Label info + DCE questions
Control for Pictures	CTRL_P	Label info + 10 neutral pictures + DCE questions
Nature Pictures	PICT	Label info + 10 nature pictures + DCE questions
Reflection Questions	REFL	Label info + Video + Reflection questions + DCE questions
Environmental Information	INFO	Label info + Video + Text summary + DCE questions
Normative Information	NORM	Label info + Normative information + DCE questions

provided with a video about the concept of the bio-economy made by the Federal Ministry for Education and Research (BMBF). In addition, they were asked to answer open reflection questions about the environmental consequences of fossil-based and bio-based plastics. The cognitive deliberation about the relationship between the consumers' own purchasing decisions and environmental consequences is assumed to activate respondents' ecological worldview. In the *Environmental Information* treatment (hereafter INFO), participants were also provided with the same Video as in REFL. In addition, participants received a short text about the fossil-based and bio-based plastic production. The information is hypothesized to prime participants' awareness of pro-environmental benefits of bio-based plastic. Finally, in the *Normative Information* treatment (hereafter NORM), participants received the information that the majority of Germans (in fact 77.5%) support bio-based plastic.<sup>5</sup> This information is assumed to activate participants' injunctive social norms<sup>6</sup> so that they want to conform with most Germans and feel an increased personal obligation to purchase bio-based packaged products.

#### 4. Data analysis

The DCE data was analyzed using discrete choice models; which are consistent with the random utility theory (McFadden, 1974). Accordingly, the utility that individual  $n$  derives from alternative  $j$  at choice occasion  $t$  can be expressed as follows:

$$U_{njt} = V_{njt} + \varepsilon_{njt} \quad (1)$$

<sup>5</sup> This statement is based on a study conducted by the technical university of Munich in 2016 (Rumm, 2016)

<sup>6</sup> Injunctive social norms are based on social approval of a certain activity (Cialdini et al., 1990)

where  $V_{njt}$  is the systematic component of the utility function determined by the selected attributes and  $\varepsilon_{njt}$  represents the random component. Depending on the underlying assumptions about individual preferences, different econometric models can be specified. For example, random parameter logit models are appropriate for a context in which preferences for product attributes are assumed to be heterogeneous as well as correlated with each other (Hensher et al., 2015). Following previous studies on consumer preferences for sustainable labels (Caputo et al., 2013; van Loo et al., 2015), this study uses a random parameter logit model with an error component (RPL-EC). As suggested by Scarpa et al. (2005), the utilities of the purchase options might correlate between each other but not with the no-purchase option. The RPL-EC model allows to account for this heteroscedasticity by adding a normally distributed random error component with zero mean in the estimation which is only associated with both the purchasing alternatives.

To test for treatment effects, the data from each treatment was used to estimate a RPL-EC model in preference space.<sup>7</sup> A total of seven models were estimated, each with the following indirect utility function:

$$U_{njt} = ASC + \alpha PRICE_{njt} + \beta_{BIO,n} BIO_{njt} + \beta_{ORG,n} ORG_{njt} + \beta_{COM,n} COM_{njt} + \beta_{REC,n} REC_{njt} + 1_j(\eta_{nt}) + \varepsilon_{njt} \quad (2)$$

where  $ASC$  is an alternative-specific constant representing the no-buy option;  $PRICE_{njt}$  represents the price levels for a package of 250 g of cherry tomatoes;  $BIO_{njt}$  and  $ORG_{njt}$  are dummy variables taking the value 1 if the product carries the corresponding label, and 0 otherwise (compare Fig. 1).  $COM_{njt}$  and  $REC_{njt}$  are dummy variables taking the value 1 if the packaging is compostable or recyclable respectively;  $1_j(\cdot)$

<sup>7</sup> Models in preference space specify the distribution of coefficients in the utility function to derive the distribution of WTP as defined by Train (2009).

is an indicator function that takes the value of 1 for the two tomatoes product profiles; and  $\eta_{nt}$  is the respondent-specific idiosyncratic error component associated with the experimentally designed product alternatives but not with the no-buy alternative; and  $\varepsilon_{njt}$  represents the random error term which follows a Type I Extreme Value distribution. In the model, the price coefficient ( $\alpha$ ) was assumed to be invariant in the population. On the other hand, the coefficients of the other attributes ( $\beta_{BIO,n}$ ,  $\beta_{ORG,n}$ ,  $\beta_{COMP,n}$ ,  $\beta_{REC,n}$ ) were considered to be random following a normal distribution. Using the results from the RPL-EC model, the marginal WTP values for each attribute were then calculated as the ratio between the coefficient of each non-monetary attribute and the price coefficient. To compare differences between marginal WTP estimates across treatments, we performed the combinational test suggested by Poe et al. (2005). The test was based on a distribution of 1000 WTP estimates<sup>8</sup> for each attribute across treatments and was generated using the parametric bootstrapping method suggested by Krinsky and Robb (1986).

Finally, to assess the robustness of our results to this econometric specification, we followed De-Magistris et al. (2013) and specified models in WTP space as they relax the assumption of a fixed price coefficient (Scarpa et al., 2008). In addition, models specified in WTP space have the advantage of directly estimating marginal WTP values. This offers a practicable comparison of WTP estimates across treatments through the specification of an extended utility function and the use of pooled data (De-Magistris et al., 2013; Caputo et al., 2016; Kim et al., 2018). Following this approach, we specified an extended utility function which includes a set of dummy variables identifying specific treatments, and pooled the data based on a comparison across treatments: CTRL vs. LABEL, CTRL vs. PICT, CTRL vs. REFL, CTRL vs. INFO, CTRL vs. NORM, and CTRL\_P vs. PICT, LABEL vs. REFL, LABEL vs. INFO, LABEL vs. NORM. A total of nine models were estimated, one for each treatment comparison. In each model, the extended utility function in WTP space was specified as follows:

$$U_{njt} = \theta_n [(-PRICE_{njt} + \omega_2 BIO_{njt} + \omega_3 ORG_{njt} + \theta\omega_4 COM_{njt} + \omega_5 REC_{njt} + ASC) + \delta_1 (BIO_{njt} \times TREAT) + \delta_2 (ORG_{njt} \times TREAT) + \delta_3 (COM_{njt} \times TREAT) + \delta_4 (REC_{njt} \times TREAT) + 1_j(\eta_{nt})] + \varepsilon_{njt} \quad (3)$$

where  $\theta_n$  is a random positive scalar representing the price/scale parameter;  $\omega$  are the marginal WTP estimates for the various attributes;  $TREAT$  is a dummy variable taking the value 1 for respondents in the given treatment group, and 0 otherwise; and  $\delta_i$  represent the differences in consumer WTP for each attribute across treatments. The other elements in (3) are specified as in (2). The significance and sign of  $\delta_i$  establish if the differences in marginal WTP estimated across treatments are statistically significant and their sign is as expected. In those models, the price coefficient is assumed to be random following a log-normal distribution. All the econometric models were estimated with NLogit 6 (Limdep) using 1000 Halton Draws.

## 5. Data and sample characteristics

Data for this study was collected via an online survey in Germany in May 2019. Participants were recruited by Qualtrics. They were screened to ensure they were over 18 years old, responsible for food purchases in their household, and have purchased cherry tomatoes within the last three months. In total, 1470 participants filled out the survey. However, 451 respondents were excluded<sup>9</sup> because they did not

pass the attention filters ( $n = 420$ ) or because they took more than 60 min to complete the survey ( $n = 31$ ). Thus, a total of 1019 respondents were employed for the analyses (CTRL = 149, LABEL = 146, CTRL\_P = 146, PICT = 146, REFL = 135, INFO = 147, NORM = 150). Table 3 reports the socio-demographic characteristics of the respondents across different treatment groups.

In terms of gender and age distribution, the overall sample is representative for the German population (Destatis, 2017). Looking at the education level, most respondents completed an apprenticeship which is in line with data of the German population (Destatis, 2018). Similarly, the overall distribution of the monthly household income is representative of the German population (Statista, 2019). Finally, the results of the chi-square tests suggest that the null hypothesis of equality between treatment groups cannot be rejected at the 5% significance level for these demographic variables.

The analysis of the consumption habits reveals a purchasing frequency of cherry tomatoes of 1–2 times per week (42.0%), every two weeks (29.7%), or once a month (16.5%). Only a few respondents purchase cherry tomatoes more than two times per week (10.9%). Moreover, they usually buy 250 g (48.2%) or 500 g (47.2%) of cherry tomatoes in discounters (40.5%) or supermarkets (51.3%). The majority of the respondents usually purchases cherry tomatoes with plastic packaging (77.2%), whereas only few respondents purchase cherry tomatoes with paper packaging (11.7%) or unpackaged cherry tomatoes (11.1%). Descriptive results for the consumption habits by treatment group are reported in Appendix C. The results of the chi-square tests suggest that the null hypothesis of equality between treatment groups cannot be rejected at the 5% significance level for these consumption habits, except for the choice of the point of sale.

## 6. Results

### 6.1. Label beliefs across treatments

After answering the DCE questions, participants were asked to report their beliefs about the innovativeness, healthiness, naturalness, environmental-friendliness, and affordability of cherry tomatoes with the bio-based label (Table 4).

The results of the non-parametric Kruskal-Wallis tests suggest that the differences in respondents' beliefs between treatment groups are statistically significant at the 5% level. Comparing the results descriptively, we found the highest ratings for the innovativeness, healthiness, naturalness, and environmental-friendliness of cherry tomatoes with the bio-based label in INFO. Moreover, respondents in CTRL had the highest ratings of the affordability of cherry tomatoes with bio-based packaging.

### 6.2. Results of the choice experiment across treatments

Table 5 presents the coefficient estimates from the RPL-EC model in preference space across treatments.<sup>10</sup>

The coefficient of the alternative specific constant (ASC) is significant and negative across all treatments, suggesting that respondents gain a higher utility from choosing cherry tomatoes than from choosing the no-buy option. The standard deviation of the error component associated with the purchase options has a significant estimate across all treatment groups, indicating that the utility variance is larger for purchase than for the no-purchase options. As expected, the price coefficient is also significant and of negative sign. The coefficients of the bio-based, organic, recyclable, and compostable label are statistically

<sup>8</sup> WTP estimates can be derived by taking the negative ratio of each attribute coefficient,  $\beta$ , and the price coefficient,  $\alpha$ .

<sup>9</sup> CTRL = 1, LABEL = 70, CTRL\_P = 30, PICT = 68, REFL = 89, INFO = 41, NORM = 152. Compared to the other treatment groups, more respondents dropped out of NORM. One potential reason for this phenomenon might be that one of the attention filter questions in NORM confused the respondents ("The text you just read was about cherry tomatoes" – True/False).

<sup>10</sup> In addition to the RPL-CE, we estimated various models including a Multinomial logit model and Random Parameter logit model. Based on the log-likelihood and AIC values, the RPL-EC model was selected as it outperformed all the other models in all treatment groups.

**Table 3**  
Sample Characteristics in percentages.

Variable	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>Gender</b>							
Female	44.3	52.1	46.6	51.4	54.1	56.5	53.3
Male	55.7	47.9	53.4	48.6	45.9	43.5	46.7
$X^2 = 6.48, p = .37, df = 6$							
<b>Age</b>							
18–34 years	28.9	28.1	28.1	26.0	20.7	23.1	28.0
35–49 years	19.5	22.6	15.8	21.2	28.9	27.9	31.3
50–65 years	27.5	31.5	30.1	31.5	25.9	29.3	27.4
Over 65 years	24.2	17.8	26.0	21.2	24.4	19.7	13.3
$X^2 = 24.43, p = .14, df = 18$							
<b>Education</b>							
Secondary School	20.1	20.5	18.5	24.7	10.4	21.1	11.3
High School	12.1	10.3	11.6	10.3	18.5	13.6	17.3
Apprenticeship	44.3	40.4	37.0	37.0	39.3	36.1	47.3
University	23.5	28.1	30.8	26.7	31.1	27.2	23.3
$X^2 = 53.50, p = .27, df = 48$							
<b>Household monthly income</b>							
Up to €1700	31.5	25.3	30.1	22.6	25.9	24.5	29.3
€1701–3600	38.9	41.1	38.4	35.6	42.2	38.8	42.7
Over €3601	29.5	33.6	31.5	41.8	31.9	36.7	28.0
$X^2 = 10.72, p = .55, df = 12$							
<b>No. of Observations</b>	149	146	146	146	135	147	150

significant and positive, indicating that participants gain a higher utility from cherry tomatoes labeled with the given attributes than from the unlabeled ones. The significant standard deviations of the random parameters reveal that preferences for the bio-based, organic, recyclable, and compostable label do indeed vary in the population. Following Train (2009, pp.149–150), we used the means and standard deviations of the coefficients reported in Table 5 to calculate the share of the sample that places positive values on each label (see Appendix D).

Overall, results indicate that the share of positive preferences for bio-based packaging increases when consumers are exposed to green nudges. To illustrate, bio-based packaging is preferred by 71% of respondents in the CTRL treatment and by 75%, 83%, 87%, and 89% in the PICT, NORM, REFL, and INFO treatments respectively. Moreover, the organic, compostable and recyclable also seem to be slightly preferred by consumers when they are exposed to the green nudges. However, given the differences in scales embedded in the RPL-EC models estimated for each treatment, the interpretation of coefficients is discouraged (Hensher and Greene, 2003). Moreover, although a high proportion of consumers prefers the bio-based label across the

treatment groups, it is still unknown whether consumers are also willing to pay a substantial price premium for this type of packaging, and whether the price premium differs across treatments. Hence, we discuss the results from the various treatments in the context of the marginal WTP estimates. Fig. 2 reports the marginal WTPs across the treatment groups, while Table 6 presents the estimated percentage price premium across treatments.

Overall, the marginal WTP estimates indicate that consumers are willing to pay a price premium for bio-based plastic packaging as well as organic, compostable, and recyclable labels. For example, in the CTRL treatment, on average, consumers are willing to pay a price premium of 22.8% for bio-based plastic packaging as well as 36.5% for the organic, 34.0% for the compostable and 30.2% for the recyclable label. As expected, results also indicate that the marginal WTP estimates for all product labels differ in magnitude across treatments. For example, the average price premium that consumers are willing to pay for bio-based packaging increases from 21.1% in CTRL to 25.0%, 30.4%, 33.9%, 50.5% and 51.5% in PICT, LABEL, REFL, NORM and INFO respectively. This is also clearly visible in Fig. 2, where WTP for bio-based packaging substantially lower in the CTRL treatment than in the INFO and NORM treatments. In order to test whether these differences between the marginal WTP estimates across treatment groups are statistically significant, we applied the combinational method of Poe et al. (2005), which was performed using 1000 bootstrapped marginal WTP estimates obtained from the Krinsky and Robb (1986) procedure. The results of the hypothesis tests are presented in Table 7.

This table is quite revealing in several ways. First, comparing WTP estimates of INFO and CTRL, we found significant differences for the bio-based label. By comparing INFO with BASIC, the difference in WTP estimates of the bio-based label remains significant, thereby suggesting that the effect is explained by the additional video and text information. Second, we also found a significant treatment effect of NORM on WTP for the bio-based label compared to CTRL. Similarly, as in INFO, the effect on WTP is robust for the bio-based label when comparing NORM with LABEL. Third, we found a significant treatment effect of REFL on WTP for the bio-based label when compared to CTRL. However, when comparing WTP values of REFL with LABEL, there is no statistically significant difference. Fourth, looking at PICT, we found no statistically significant differences in WTP estimates compared to both CTRL and CTRL\_P. Finally, results indicate that although WTP values for the bio-based label are higher in BASIC compared to CTRL, the differences are not statistically significant.

The results of the Poe et al. (2005) tests also reveal that the magnitude of WTP values of the other labels also changes across treatments. To illustrate, comparing INFO and CTRL, we found significant differences for the organic and recyclable label. Both effects on WTP remain

**Table 4**  
Beliefs about the bio-based label across Treatment Groups.

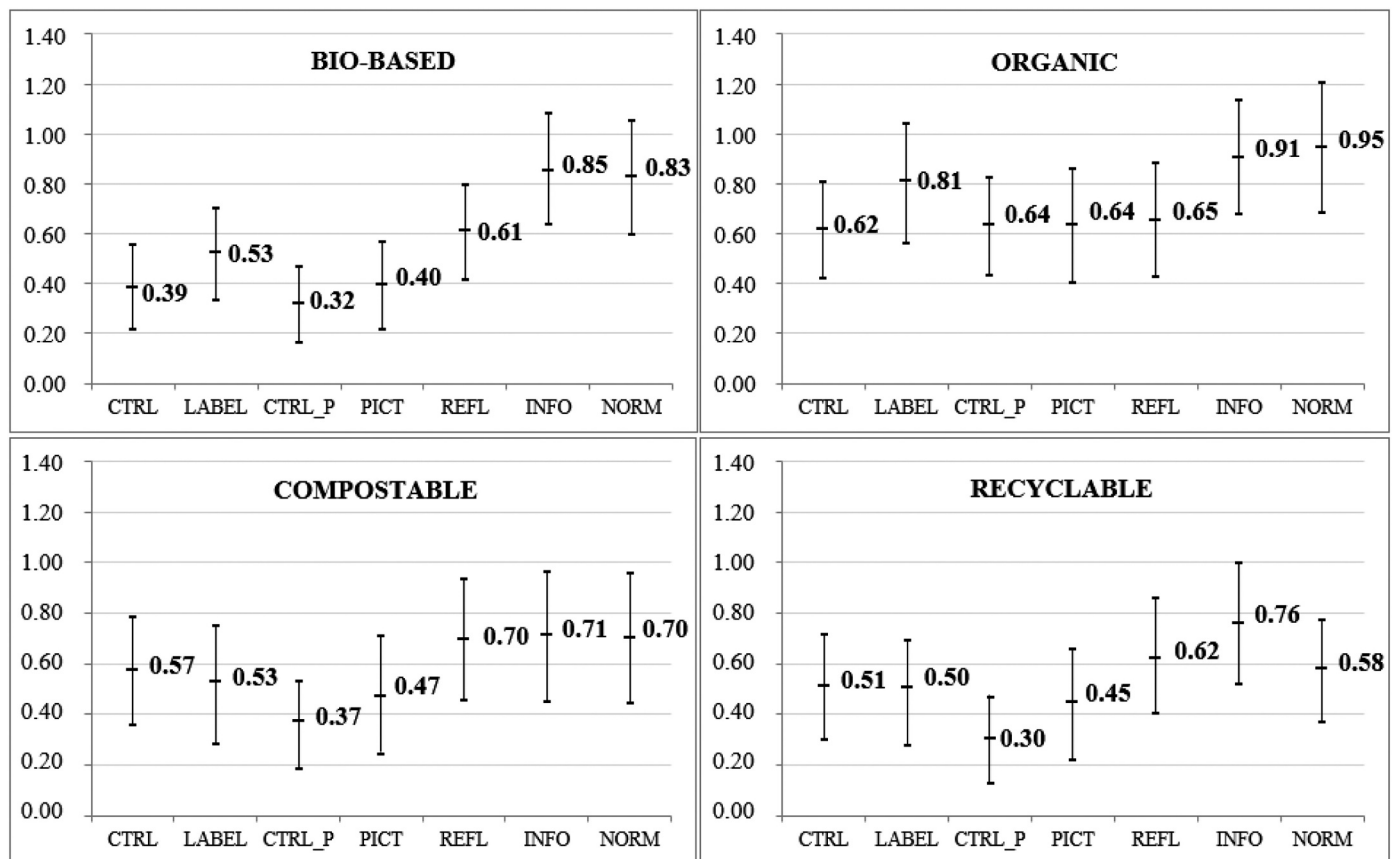
	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>Innovativeness</b>	3.76	3.95	3.76	3.78	4.04	<b>4.08</b>	4.06
$X^2 = 29.42, p = .00, df = 6$	[0.86]	[0.82]	[0.84]	[0.82]	[0.83]	[0.79]	[0.79]
<b>Healthiness</b>	3.43	3.42	3.38	3.26	3.45	<b>3.59</b>	3.41
$X^2 = 12.61, p = .02, df = 6$	[0.74]	[0.73]	[0.74]	[0.76]	[0.69]	[0.76]	[0.79]
<b>Naturalness</b>	3.36	3.51	3.55	3.36	3.67	<b>3.77</b>	3.60
$X^2 = 26.23, p = .00, df = 6$	[0.89]	[0.82]	[0.89]	[0.94]	[0.79]	[0.85]	[0.87]
<b>Environmentally-friendliness</b>	3.87	4.03	3.93	3.90	4.15	<b>4.20</b>	4.12
$X^2 = 23.63, p = .00, df = 6$	[0.87]	[0.77]	[0.88]	[0.79]	[0.70]	[0.77]	[0.82]
<b>Affordability</b>	<b>2.91</b>	2.85	2.78	2.78	2.71	2.88	2.60
$X^2 = 15.05, p = .02, df = 6$	[0.82]	[0.82]	[0.74]	[0.81]	[0.87]	[0.94]	[0.88]

**Note:** Numbers in parentheses are standard deviations. Numbers in bold are highest values for each label belief. Beliefs are measured on a scale from 1 = ‘do not agree at all’ to 5 = ‘absolutely agree’.

**Table 5**  
Estimates of RPL-EC Model across treatments.

	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>BIO-BASED</b>							
Mean	0.83*** (0.19)	0.90*** (0.17)	0.77*** (0.18)	0.68*** (0.16)	1.50*** (0.24)	1.35*** (0.18)	1.78*** (0.25)
St. dev.	1.49*** (0.22)	1.22*** (0.20)	1.23*** (0.23)	1.00*** (0.20)	1.33*** (0.27)	1.10*** (0.20)	1.84*** (0.26)
<b>ORGANIC</b>							
Mean	1.33*** (0.21)	1.40*** (0.21)	1.51*** (0.23)	1.09*** (0.20)	1.58*** (0.26)	1.44*** (0.19)	2.03*** (0.28)
St. dev.	1.87*** (0.29)	1.88*** (0.30)	2.04*** (0.32)	1.83*** (0.40)	2.22*** (0.33)	1.41*** (0.20)	2.37*** (0.28)
<b>COMPOSTABLE</b>							
Mean	1.24*** (0.23)	0.92*** (0.20)	0.88*** (0.21)	0.81*** (0.21)	1.71*** (0.29)	1.12*** (0.21)	1.51*** (0.28)
St. dev.	1.55*** (0.31)	1.49*** (0.25)	1.11*** (0.33)	1.47*** (0.30)	1.82*** (0.42)	1.38*** (0.31)	2.22*** (0.30)
<b>RECYCLABLE</b>							
Mean	1.10*** (0.22)	0.86*** (0.19)	0.73*** (0.22)	0.76*** (0.19)	1.52*** (0.27)	1.21*** (0.19)	1.24*** (0.22)
St. dev.	1.36*** (0.29)	1.04*** (0.26)	1.30*** (0.52)	1.09*** (0.24)	1.53*** (0.34)	0.92*** (0.21)	1.10*** (0.25)
<b>PRICE</b>							
Fixed coeff.	-2.19*** (0.14)	-1.66*** (0.10)	-2.40*** (0.15)	-1.66*** (0.11)	-2.42*** (0.18)	-1.61*** (0.10)	-2.27*** (0.15)
<b>NO-BUY</b>							
Fixed coeff.	-3.75*** (0.37)	-2.85*** (0.30)	-3.91*** (0.34)	-3.06*** (0.29)	-3.44*** (0.39)	-2.41*** (0.30)	-2.96*** (0.36)
<b>EC</b>							
St. dev.	2.51*** (0.36)	1.89*** (0.50)	1.70*** (0.54)	1.61*** (0.25)	2.13*** (0.36)	1.95*** (0.30)	2.46*** (0.47)
<i>Summary statistics</i>							
N	1192	1168	1168	1168	1080	1176	1200
Log-likelihood	-770.57	-838.60	-736.05	-845.96	-690.65	-823.23	-780.82
AIC/N	1.33	1.47	1.30	1.49	1.32	1.44	1.34

**Note:** Numbers in parentheses are standard errors. Single, double and triple asterisk (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level, respectively.



**Fig. 2.** Marginal WTP means and 95% confidence intervals by treatments.



**Table 6**  
Estimated percentage premium across treatments.

Treatments	N	BIOBA	ORG	COMP	RECY
		% premium	% premium	% premium	% premium
CTRL	1192	22.8	36.5	34.0	30.2
LABEL	1168	31.1	48.1	31.5	29.8
CTRL_P	1168	19.1	37.7	22.0	18.0
PICT	1168	23.4	37.6	28.0	26.4
REFL	1080	36.2	38.6	41.2	36.7
INFO	1176	50.6	53.7	42.2	44.8
NORM	1200	49.0	56.0	41.4	34.3

**Note:** % premium calculated according to the average price that the participants indicate to pay for cherry tomatoes in € per 250 g ( $M = 1.69$ ;  $SD = 0.57$ ,  $N = 1019$ ).

**Table 7**  
P-values for the treatment effects on marginal WTP values.

Treatment effects	BIOBA	ORG	COMP	RECY
WTP <sub>LABEL</sub> – WTP <sub>CTRL</sub>	0.135	0.110	0.604	0.510
WTP <sub>PICT</sub> – WTP <sub>CTRL</sub>	0.467	0.452	0.735	0.659
WTP <sub>REFL</sub> – WTP <sub>CTRL</sub>	0.044**	0.412	0.226	0.242
WTP <sub>INFO</sub> – WTP <sub>CTRL</sub>	0.000 ***	0.030 **	0.209	0.058 *
WTP <sub>NORM</sub> – WTP <sub>CTRL</sub>	0.001 ***	0.023 **	0.233	0.316
WTP <sub>PICT</sub> – WTP <sub>CTRL_P</sub>	0.271	0.502	0.251	0.163
WTP <sub>REFL</sub> – WTP <sub>LABEL</sub>	0.262	0.831	0.166	0.237
WTP <sub>INFO</sub> – WTP <sub>LABEL</sub>	0.011 **	0.293	0.154	0.056 *
WTP <sub>NORM</sub> – WTP <sub>LABEL</sub>	0.021**	0.230	0.172	0.310

**Note:** Single, double and triple asterisk (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level, respectively.

significant by comparing INFO and LABEL. For NORM, we found treatment effects on WTP for the organic label compared to CTRL. However, when comparing NORM with LABEL, the effect on WTP only remains significant for the bio-based and not for the organic label.

Table 8 reports the robustness test, i.e. the estimated parameters from the pooled sample in WTP space and the corresponding *p*-values of the dummy treatment variables as reported in Eq. (3).<sup>11</sup>

The results of the robustness test confirm the findings from the Poe et al. (2005) test for bio-based plastic packaging in seven out of nine treatment comparisons. In contrast to previous findings, no statistically significant effect was found for NORM compared to LABEL as well as for REFL compared to CTRL. Given both the results of the Poe et al. (2005) test and the robustness test, we could only find empirical support for the effectiveness of the INFO treatment.

### 6.3. Consumer cognitive styles and consumer WTP for bio-based packaging

To account for consumer differences in cognitive style, we additionally performed a sub-sample analysis by estimating separate models in preference space for two groups based on the median ( $med = 3.5$ ) of the “Need for cognition” (NFC) measure<sup>12</sup>: respondents low versus high in NFC.<sup>13</sup> The estimates from the segmented models

<sup>11</sup> The full set of results from the pooled models in WTP space are available upon request.

<sup>12</sup> The Cronbach's Alpha test of the NFC scale indicates an acceptable level of internal consistency ( $\alpha = 0.65$ ).

<sup>13</sup> We also tested the null hypothesis of preference equality between the below and above NFC median subsamples across treatments using a likelihood ratio test as shown in Louviere et al. (2010). Based on the results of the test the null hypothesis of preference equality is strongly rejected ( $\chi^2 = 1082.47$ ;  $p < .00$ ;  $df = 273$ ). To conserve space, estimates from these models are not reported in this article. These results are available from the authors upon request along with the estimates from the segmented models used to calculate the marginal WTPs reported in Figure 3.

were then used to calculate marginal WTP for the selected attributes; bio-based packaging, organic, compostable, and recyclable labels. Fig. 3 presents the marginal WTP means of these attributes for each sub-sample segmented by treatment and NFC level.

The figure shows that the magnitude of WTP values strongly differs across treatment groups and NFC levels. To illustrate, for the bio-based label, WTP values in CTRL, LABEL, and PICT are higher for respondents low in NFC than for those high in NFC; whereas the opposite is true for CTRL\_P, REFL, INFO and NORM. For the organic label, respondents high in NFC are willing to pay more compared to respondents low in NFC across all treatment groups, except for PICT where WTP values are similar. Similarly, respondents high in NFC are willing to pay more than respondents low in NFC for the compostable and for the recyclable label across all treatments, except in CTRL and CTRL\_P, where WTP values are higher or similar for respondents low in NFC. As the marginal WTP means in Fig. 3 are generated by the Krinsky and Robb (1986) procedure, the treatment effects conditional on the NFC level can be evaluated by comparing whether the confidence intervals overlap (see e.g. van Wezemael et al., 2014). In addition, we also applied the combinatorial method of Poe et al. (2005) as described earlier (see Appendix F). The findings generally provide evidence for an interaction effect between the nature of the green nudge and cognitive style of consumers. For intuitive decision-makers (low NFC), we found statistically significant treatment effects of LABEL and PICT on WTP for the bio-based label. For rational decision-makers (high NFC), the REFL, INFO and NORM treatment were found to have statistically significant effects on WTP for the bio-based label. The magnitude of WTP values of the other labels also changes across treatments and NFC level. For instance, in REFL and INFO, consumers high in NFC are willing to pay significantly more for the compostable label than in LABEL.

## 7. Discussion

The results provide evidence that the individual susceptibility of green nudges seems to depend on consumers' cognitive style in three different ways. First, only intuitive decision-makers seem to be influenced by the bio-based label information (LABEL), indicating that the provided information might need to be more detailed to convince consumers high in NFC. Similarly, nature pictures (PICT) only seem to affect intuitive decision-makers, but not consumers who base their decision on rational arguments. This result is partly in line with Hahnel et al. (2014), who found that nature pictures generally lower the price sensitivity for electric vehicles. However, in the food context, the effects of nature pictures seem to depend on individual differences such as demographics as shown by Bullock et al. (2017). Second, providing normative information (NORM) only triggers rational decision-makers to increase their WTP for bio-based plastic packaging. However, previous studies indicate that normative information about environmental issues generally mobilizes people to engage in the concordant behavior (Cialdini et al., 2006; Nolan et al., 2008). Further research thus needs to investigate whether rational decision-makers are generally more susceptible to normative information or whether this effect occurs because of the way this study presented the normative information. Moreover, rational decision-makers are also more prone to the strategy to reflect on the consequences of bio-based plastic packaging (REFL). This effect might occur because environmental consequences of plastic packaging are rather complex and, thus, more accessible for people who enjoy thinking about complex problems. Similarly, the INFO treatment only seems to be effective to increase WTP for bio-based plastic packaging of people high in NFC, indicating that the video and text information about the bio-economy are susceptible for rational decision-makers. This finding might explain why some prior studies find that relevant information triggers WTP for pro-environmental products (Francisco et al., 2015; Klaiman et al., 2016, 2017; Lusk, 2018) and others did not find evidence for the effect of information (Wuepper et al., 2019). One of the reasons for the effectiveness of information might be that it

**Table 8**  
Robustness Test in WTP Space (€/ 250 g).

	BIOBA	ORG	COMP	RECY
WTP <sub>LABEL</sub> <sup>a</sup>	<b>0.281</b> (0.207)	<b>0.372</b> (0.240)	- <b>0.046</b> (0.248)	- <b>0.191</b> (0.229)
p-value	0.175	0.122	0.854	0.403
WTP <sub>PICT</sub> <sup>a</sup>	<b>0.118</b> (0.204)	<b>0.118</b> (0.251)	<b>0.050</b> (0.244)	- <b>0.072</b> (0.241)
p-value	0.561	0.637	0.839	0.765
WTP <sub>REFL</sub> <sup>a</sup>	<b>0.365</b> (0.226)	- <b>0.129</b> (0.271)	<b>0.265</b> (0.267)	<b>0.237</b> (0.273)
p-value	0.107	0.635	0.321	0.386
WTP <sub>INFO</sub> <sup>a</sup>	<b>0.680***</b> (0.219)	<b>0.319</b> (0.221)	<b>0.102</b> (0.241)	<b>0.137</b> (0.241)
p-value	0.000	0.148	0.672	0.569
WTP <sub>NORM</sub> <sup>a</sup>	<b>0.525**</b> (0.231)	<b>0.278</b> (0.271)	- <b>0.046</b> (0.276)	- <b>0.331</b> (0.247)
p-value	0.023	0.304	0.869	0.180
WTP <sub>PICT</sub> <sup>b</sup>	<b>0.152</b> (0.201)	<b>0.070</b> (0.245)	<b>0.311</b> (0.239)	<b>0.250</b> (0.244)
p-value	0.450	0.776	0.193	0.304
WTP <sub>REFL</sub> <sup>c</sup>	<b>0.038</b> (0.196)	- <b>0.488*</b> (0.254)	<b>0.260</b> (0.264)	<b>0.387</b> (0.244)
p-value	0.845	0.055	0.326	0.113
WTP <sub>INFO</sub> <sup>c</sup>	<b>0.357*</b> (0.190)	- <b>0.063</b> (0.210)	<b>0.143</b> (0.223)	<b>0.302</b> (0.209)
p-value	0.06	0.765	0.523	0.148
WTP <sub>NORM</sub> <sup>c</sup>	<b>0.177</b> (0.080)	- <b>0.186</b> (0.247)	- <b>0.051</b> (0.245)	- <b>0.101</b> (0.232)
p-value	0.400	0.452	0.837	0.664

**Note:** a = pooled with CTRL; b = pooled with CTRL<sub>P</sub>; c = pooled with LABEL. Numbers in parentheses are standard errors. Single, double and triple asterisk (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% level, respectively.

All the parameters are printed in bold. We did this for clarity reasons and not to indicate significance.

activates the belief that these products are environmentally friendly. Indeed, our results indicate that respondents in INFO rate the bio-based label as more environmentally friendly than respondents in CTRL and LABEL.

Moreover, the magnitude of WTP values of the other labels also changes across treatments and NFC level. For instance, results indicate that label information might only affect rational decision-makers to prefer well-known labels. This is in line with findings from [Kaminski and Caputo \(2018\)](#) suggesting that basic label information has a stronger effect on consumers' WTP for already established sustainability labels such as the organic label than on a novel label certifying labor conditions on dairy farms.

Overall, our findings generally show evidence for an interaction effect between the green nudging strategy and cognitive style of consumers. The results can be explained by the meta-analysis from [Phillips et al. \(2016\)](#) who found that the effect of cognitive styles on decision-making depends on the specific task. Without considering respondents' degree of need for cognition, our results would have indicated that neither the activation of values (PICT) nor worldview (REFL) is an effective strategy to increase WTP for bio-based plastic packaging. Nevertheless, taking NFC into account, our study reveals that the strongest effects are generated when the task matches the characteristics of the thinking style.

## 8. Conclusion and limitations

This study explores the effects of green nudges on consumer WTP for bio-based plastic packaging by conducting a DCE with seven different treatment groups. Overall, results indicate that the strongest effects are generated when the nudging strategy matches the characteristic of consumers' cognitive style. For example, providing nature pictures only seems to increase WTP for bio-based packaging when consumers base their decision on their emotions and intuition. On the other hand, the strategies that provide environmental or normative information and activate the reflection about environmental consequences of plastics are most effective for consumers who enjoy cognitive deliberation. These findings have two important theoretical

implications for the behavioral economics and environmental psychology literature. First, this is the first study which compares the effectiveness of green nudges which differ according to the internal motivation that they aim to activate. Our findings indicate that green nudges are generally most effective when they are based on the activation of beliefs (INFO) and social norms (NORM). This is in line with the VBN theory assuming that variables in the end of the chain have stronger impacts on behavior ([Stern et al., 1999](#)) - or hypothetical WTP which this research uses as a proxy for behavior. Second, our results provide evidence that the effectiveness of green nudges depends on consumers' cognitive styles. This is in line with the theoretical assumption that behavior is influenced by the interaction of external and internal factors ([Guagnano et al., 1995](#)). However, in order to develop a profound theory about the interaction of nudging strategies and cognitive styles, more evidence is still needed.

In addition to these theoretical conclusions, this study has three major practical implications for the food industry and policy-makers. First, our findings show that consumers are willing to pay a price premium for bio-based plastic packaging. According to the calculations by [van den Oever et al. \(2017\)](#), this premium covers the additional costs for bio-based plastic packaging compared to the conventional alternative. Hence, the food industry could adopt bio-based plastic packaging without needing to reduce their usual profit margin. However, it is important that the packaging is labeled accordingly because bio-based and fossil-plastic packaging are not distinguishable by the consumers ([European Bioplastics, 2020](#)). Second, policy-makers can make use of the green nudges presented in this paper in order to boost consumer preferences for bio-based plastic packaging, and potentially also for other bio-based products. Even though consumers are already exposed to several stimuli when making purchase decisions, we recommend the implementation of changes in the choice architecture to activate consumers' pro-environmental values, beliefs and norms. For example, pro-environmental product attributes and labels need to be made more salient for the consumer. Moreover, packaging designs could integrate nature pictures and products can be positioned in a context that evokes associations with nature such as organic grocery stores. In addition, flyers could deliver additional information or provide reflection

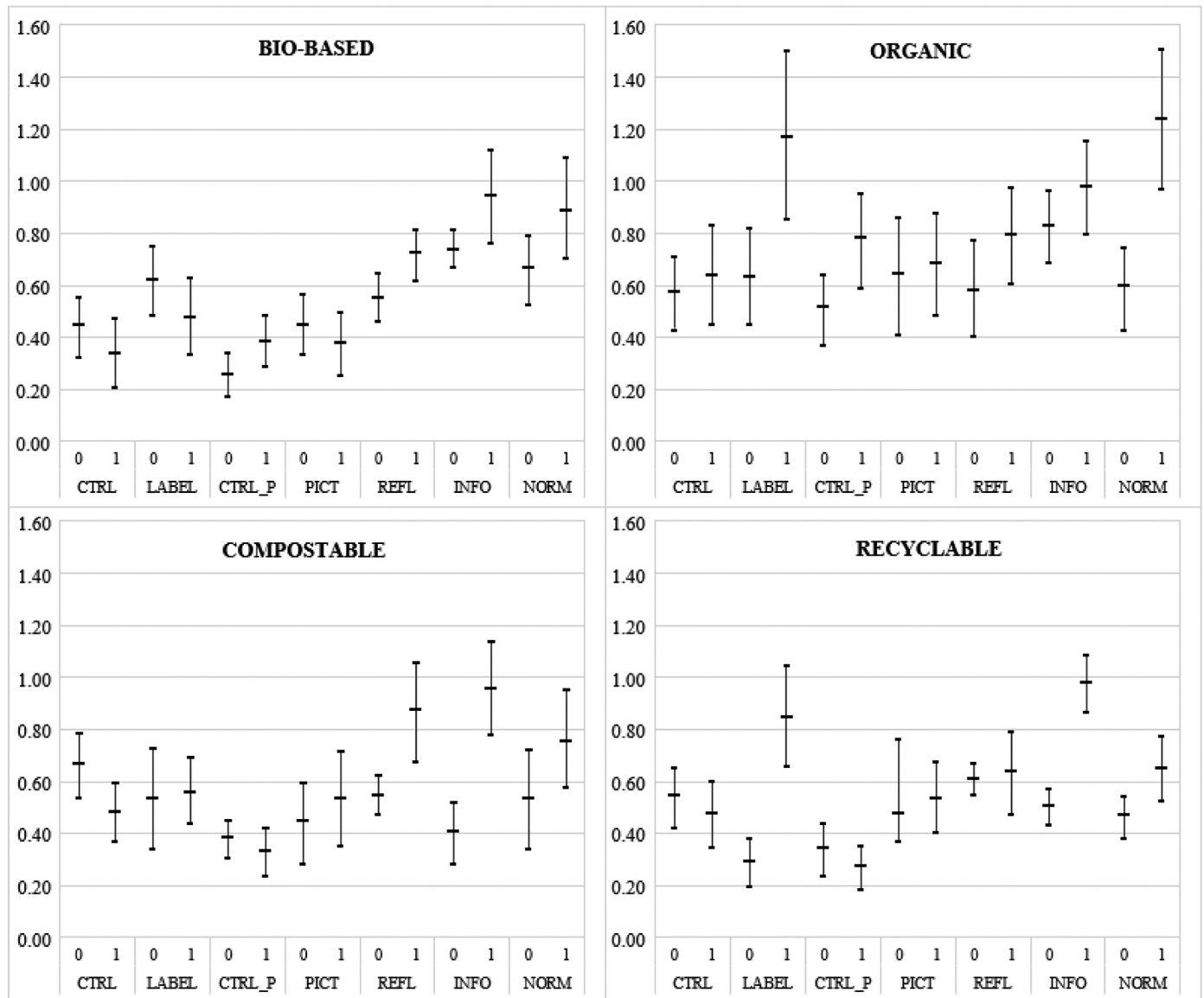


Fig. 3. Marginal WTP means and 95% confidence intervals by treatments and NFC level.  
Note: 0 = low NFC, 1 = high NFC.

questions about environmental consequences to activate an ecological worldview. Since normative information was found to be very effective, companies could benefit from providing information about the amount of people who support the idea of bio-based packaging. Moreover, it might be advantageous to join forces with social media influencers to provide pro-environmental opinions and practices. Third, marketers of food companies as well as policymakers need to take different cognitive styles of consumers into account when developing green nudges to increase demand for pro-environmental products. In the future, marketers are recommended to choose the strategy in line with the specific target group. For example, activating reflection about environmental issues might only be a successful strategy to convince people who base their decisions on their cognitive deliberation.

The limitations of our study give rise to some implications for

further research. Since our data was collected in Germany considering the case of bio-based plastic packaging for cherry tomatoes, there is further evidence needed to test the effectiveness of the chosen green nudges in other areas. More importantly, since this study only conducted a hypothetical choice experiment, future studies need to validate our results with real market data. Moreover, it is not clear whether providing environmental information and normative information only shortly activate beliefs and norms or even change them in the long run. In addition, it is unclear whether presenting the information and labels repeatedly would lead to a lower or stronger effect. Therefore, longitudinal studies need to be conducted in terms of the durability and wear-out effects. Moreover, this study uses a control condition with neutral pictures for the value activation treatment. Neutral conditions are not considered for the belief and norm activation treatments as

these are not expected to cause positive valence that could bias the results. However, future research needs to include control conditions with a neutral video and text to also test for differences in the effects. Moreover, future studies also need to explore the effects of more subtle nudging strategies such as making green products as the default option or positioning products in supermarkets at the eye level (Schubert, 2017). In addition, further research also need to consider how prior pro-environmental beliefs affect the success of the green nudges. For example, past studies already showed that people are more susceptible to nature pictures if they have strong pro-environmental values (Hahnel et al., 2014) and that people are more likely to adopt information which conform prior beliefs (McFadden and Lusk, 2015; Vainio et al., 2018). These assumptions could be tested by assessing consumer beliefs before and after the treatments. Similarly, studies are needed to look deeper into the causal effect of cognitive styles on consumer willingness to reflect environmental issues. For example, qualitative interviews with people low and high in NFC could facilitate the comparison of the ideas generated in the reflection process, and also assess the activation of an ecological worldview. In general, insights of this study might also be

applicable to other choice contexts such as managers' decisions to invest in pro-environmental innovations. Thus, we hope that our findings motivate other researchers to explore the relationship between cognitive styles and the susceptibility towards nudging strategies.

### 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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## Appendix A. Choice experiment instruction and cheap talk script

'Imagine you are shopping at your local grocery store. In what follows, we will ask you 8 different choice questions. Each choice question is represented by two options of packaged cherry tomatoes and a "no purchase" option. The tomatoes in both options are exactly the same except for the following attributes: price charged (0.99 €, 1.89 €, 2.79 €, 3.69 €), organically produced tomatoes (yes, no) and the type of packaging used, i.e. bio-based packaging (yes, no) and recyclable (yes, no) or compostable (yes, no). Any other characteristics of tomatoes that are not reported in the product profiles are identical across the two options. In both packages, there are 250 g of tomatoes.

When responding to each choice question, please try to think the same way you would if you really had to pay for the product and take it home. So, imagine you are at the retailer of your choice and that you are looking for 250 g of cherry tomatoes. When making your selection, consider whether you would actually be willing to pay the listed price, meaning that you would no longer have that amount available for purchases. Keeping this in minds, for each of the following choice questions, please choose ONLY one option of the packaged tomatoes you would prefer to purchase at the listed prices. Alternatively, you may choose NOT TO PURCHASE any product.'

## Appendix B. Provided information in treatment groups

### B.1. LABEL

Consumers are exposed to a variety of labels and claims when shopping for food products. The following is a selection of such labels and claims. Please carefully read the information below which will help you in completing the questions that follow about tomato purchase decisions. Afterwards, we will check with your understanding of the text.



The Bio-Siegel marks organically produced products. The use of synthetic chemical fertilizers, and pesticides as well as preservatives is permitted.



This bio-based plastic label certifies packaging which is based on renewable resources. Plastic packaging with this label is produced on the basis of plant-based biomass (e.g. maize, grass, algae).



The recycling symbol certifies packaging which can be recycled. After disposal, plastic packaging with this label can be shredded, melted and reused to produce other products.



The Seedling label certifies packaging which is industrially compostable. Plastic packaging with this label is fully biodegradable in industrial composting plants under controlled conditions.



## B.2. CTRL\_P

## CTRL\_P



How do you rate the attractiveness of this picture?

Not attractive at all

Not attractive

Moderately attractive

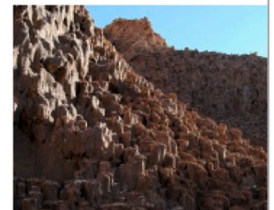
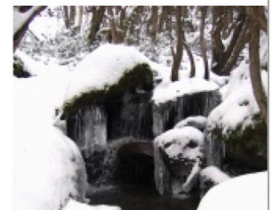
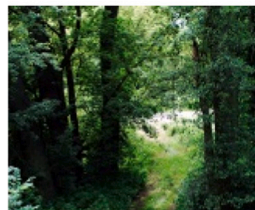
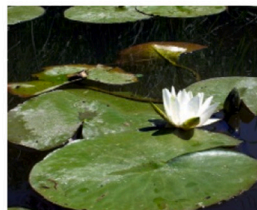
Attractive

Extremely attractive

☐
☐
☐
☐
☐

## B.3. PICT

## PICT



How do you rate the attractiveness of this picture?

Not attractive at all

Not attractive

Moderately attractive

Attractive

Extremely attractive

☐
☐
☐
☐
☐



## B.4. REFL

**Video script:**

'We dependent on fossil fuels - and not only when it comes to energy. Many everyday products such as plastics, paints and textiles are based on fossil oil. The problem is that oil production is harmful for the climate and fossil fuels are becoming scarce. In contrast to that, bio-based materials are renewable and much more environmentally friendly. Therefore, scientists are looking for new ways to make better use of plants, animals, micro-organisms and even biological waste. They are developing new products with innovative properties for a wide variety of industries. This knowledge-based economic concept is called bio-economy. This means that companies use materials from renewable resources or rely on bio-based production processes, for instance by producing fuel with the help of microorganisms. The advantage is that if the bio-economy prevails, we can reduce greenhouse gas emissions and contribute to supplying the growing world population with food and preserve resources. The long-term goal of the bio-economy is a circular economy in which materials are used several times and produce as little waste as possible. Innovative bio-based products can already be found in our everyday lives: for example, clothes made of coffee grounds, computer screens made of sugar or fuel made of straw remains. As the bio-economy combines economic growth with sustainability, it is becoming increasingly important in everyday life and in politics in Germany, Europe and the world.'

(Link: <https://www.bmbf.de/de/media-video-11043.html>)

**Reflection questions:**

'What does it mean for plastic?

Take 1 min and 30 s and consider the consequences of plastic production for plants and animals as well as for the environment as a whole. Note that the button to advance is set to appear based on a timer to encourage your thoughtful deliberation.'

'Which consequences do you see for the environment following high amounts of fossil oil used for fossil-based plastic production?'

'Which consequences do you see for the environment if not fossil oil but plant biomass is used to produce plastic?'

## B.5. INFO

**Video** (same as in WVIEW)

**Text:**

'What does this mean for plastic?

Conventional plastics are manufactured on the basis of petroleum. During this process, high amounts of CO<sub>2</sub> emissions are released. CO<sub>2</sub> is a greenhouse gas which prevents the heat on earth from escaping to space which is why the earth is continuously getting warmer.

Plastics can also be manufactured on the basis of plant biomass. Plants take the same amount of carbon oxide from the air as will be released during their later rotting. Their CO<sub>2</sub> balance is, thus, balanced. Thus, substituting fossil oil with plant biomass could lead to a reduction of CO<sub>2</sub> emissions in the manufacturing process of plastics.'

## B.6. NORM

**Text:**

**'German consumers state bio-based plastic is important**

According to the study conducted by the technical university of Munich (TUM) in 2016, German consumers highly appreciate bio-based plastics. In fact, 77,5% of 1191 questioned consumers state that bio-based plastics based are either important or very important to them. Moreover, the majority of participants in that study agrees that - compared to conventional petroleum-based plastics - bio-based plastics can reduce the dependency of fossil fuels and, in turn, reduce CO<sub>2</sub> emissions.

You find more information about the study [here](#).'

(Link: <https://d-nb.info/1125627026/34>)

**Appendix C. Consumption habits by Treatment groups**

Variable	Total	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>How often did you buy cherry tomatoes during the past three months?</b>								
> 2 times per week	10.9	14.1	13.0	11.6	12.3	6.7	11.6	6.7
1-2 times per week	42.0	33.6	38.4	34.9	45.2	43.7	47.6	50.7
Every 2 weeks	29.7	31.5	28.1	34.2	28.8	33.3	23.1	29.3
Once a month	16.5	18.8	20.5	19.2	12.3	14.8	16.3	13.3
Other	0.9	2.0	-	-	1.4	1.5	1.4	-
$\chi^2 = 32.78, p = .11, df = 24$								
<b>How many grams of cherry tomatoes do you usually buy?</b>								
250 g	48.2	38.9	48.6	55.5	45.9	49.6	48.3	50.7
500 g	47.2	53.0	46.6	39.0	48.6	46.7	49.0	47.3
Other	4.6	8.1	4.8	5.5	5.5	3.7	2.7	2.0
$\chi^2 = 15.90, p = .20, df = 12$								
<b>Where do you usually buy cherry tomatoes?</b>								
Discounter	40.5	48.3	35.6	41.1	43.2	40.7	37.4	37.3
Supermarket	51.3	45.6	50.7	54.8	47.3	53.3	49.7	58.0
Other	8.1	6.0	13.7	4.1	9.6	5.9	12.9	4.7
$\chi^2 = 24.14, p = .02, df = 12$								
<b>How are the cherry tomatoes you buy usually packaged?</b>								
Plastic	77.2	77.9	76.7	78.1	75.3	75.6	74.1	82.7
Paper	11.7	12.8	11.0	4.8	13.7	14.8	14.3	10.7

<i>unpackaged</i>	11.1	9.4	12.3	17.1	11.0	9.6	11.6	6.7
$\chi^2 = 17.99, p = .12, df = 12$								
<b>N</b>	<b>1019</b>	149	146	146	146	135	147	150

#### Appendix D. Share of negative and positive valuations of the labels

	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>BIO-BASED</b>							
Negative Value	0.29	0.23	0.27	0.25	0.13	0.11	0.17
Positive Value	0.71	0.77	0.73	0.75	0.87	0.89	0.83
<b>ORGANIC</b>							
Negative Value	0.24	0.23	0.23	0.28	0.24	0.15	0.20
Positive Value	0.76	0.77	0.77	0.72	0.76	0.85	0.80
<b>COMPOSTABLE</b>							
Negative Value	0.21	0.27	0.21	0.29	0.17	0.21	0.25
Positive Value	0.79	0.73	0.79	0.71	0.83	0.79	0.75
<b>RECYCLABLE</b>							
Negative Value	0.21	0.20	0.29	0.24	0.16	0.09	0.13
Positive Value	0.79	0.80	0.71	0.76	0.84	0.91	0.87

#### Appendix E. Share of negative and positive valuations of the labels

	CTRL	LABEL	CTRL_P	PICT	REFL	INFO	NORM
<b>BIO-BASED</b>							
Negative Value	0.29	0.23	0.27	0.25	0.13	0.11	0.17
Positive Value	0.71	0.77	0.73	0.75	0.87	0.89	0.83
<b>ORGANIC</b>							
Negative Value	0.24	0.23	0.23	0.28	0.24	0.15	0.20
Positive Value	0.76	0.77	0.77	0.72	0.76	0.85	0.80
<b>COMPOSTABLE</b>							
Negative Value	0.21	0.27	0.21	0.29	0.17	0.21	0.25
Positive Value	0.79	0.73	0.79	0.71	0.83	0.79	0.75
<b>RECYCLABLE</b>							
Negative Value	0.21	0.20	0.29	0.24	0.16	0.09	0.13
Positive Value	0.79	0.80	0.71	0.76	0.84	0.91	0.87

#### Appendix F. Treatment effects on marginal WTP values (€/250 g) by NFC level

	NFC	BIOBA	p-value	ORG	p-value	COMP	p-value	RECY	p-value
WTP <sub>CTRL</sub>	low	0.422		0.575		0.650		0.520	
	high	0.514		1.000		0.711		0.733	
p-value	(high-low)	0.344		<b>0.071</b>		0.407		0.224	
WTP <sub>LABEL</sub>	low	0.654	<b>0.097</b> <sup>a</sup>	0.668	0.322 <sup>a</sup>	0.556	0.655 <sup>a</sup>	0.301	0.859 <sup>a</sup>
	high	0.472	0.563 <sup>a</sup>	1.156	0.330 <sup>a</sup>	0.563	0.716 <sup>a</sup>	0.834	0.381 <sup>a</sup>
p-value	(high-low)	0.810		<b>0.048</b>		0.488		<b>0.016</b>	
WTP <sub>PICT</sub>	low	0.505	<b>0.087</b> <sup>b</sup>	0.737	0.145 <sup>b</sup>	0.489	0.298 <sup>b</sup>	0.4220	0.321 <sup>b</sup>
	high	0.363	0.396 <sup>b</sup>	0.650	0.508 <sup>b</sup>	0.5094	0.111 <sup>b</sup>	0.493	<b>0.063</b> <sup>b</sup>
p-value	(high-low)	0.751		0.633		0.468		0.389	
WTP <sub>REFL</sub>	low	0.505	0.793 <sup>c</sup>	0.518	0.763 <sup>c</sup>	0.504	0.585 <sup>c</sup>	0.542	0.110 <sup>c</sup>
	high	0.780	<b>0.075</b> <sup>c</sup>	0.853	0.841 <sup>c</sup>	0.946	<b>0.069</b> <sup>c</sup>	0.651	0.748 <sup>c</sup>
p-value	(high-low)	<b>0.075</b>		<b>0.069</b>		<b>0.030</b>		0.322	
WTP <sub>INFO</sub>	low	0.614	0.590 <sup>c</sup>	0.699	0.442 <sup>c</sup>	0.334	0.822 <sup>c</sup>	0.431	0.251 <sup>c</sup>
	high	1.022	<b>0.011</b> <sup>c</sup>	1.054	0.629 <sup>c</sup>	1.028	<b>0.035</b> <sup>c</sup>	1.050	0.211 <sup>c</sup>
p-value	(high-low)	<b>0.031</b>		<b>0.061</b>		<b>0.002</b>		<b>0.003</b>	
WTP <sub>NORM</sub>	low	0.735	0.340 <sup>c</sup>	0.640	0.552 <sup>c</sup>	0.617	0.408 <sup>c</sup>	0.524	0.135 <sup>c</sup>
	high	0.877	<b>0.047</b> <sup>c</sup>	1.252	0.397 <sup>c</sup>	0.732	0.244 <sup>c</sup>	0.648	0.766 <sup>c</sup>
p-value	(high-low)	0.277		<b>0.016</b>		0.330		0.283	

**Note:** a = The null hypothesis is  $\beta_{\text{NFC, CTRL, j}} = \beta_{\text{NFC, LABEL, j}}$ , where NFC indicates the NFC level, and j denotes each attribute; b = The null hypothesis is  $\beta_{\text{NFC, CTRL, P, j}} = \beta_{\text{NFC, PICT, j}}$ , where NFC indicates the NFC level, and j denotes each attribute; c = The null hypothesis is  $\beta_{\text{NFC, LABEL, j}} = \beta_{\text{NFC, i, j}}$ , where NFC indicates the NFC level, i = REFL, INFO, NORM, and j denotes each attribute.

Bold p-values indicate statistical significance below the 10 % level

#### References

- Destatis, 2017. Datenreport 2018. Ein Sozialbericht für die Bundesrepublik Deutschland. <https://www.destatis.de/DE/Service/Statistik-Campus/Datenreport/Downloads/datenreport-2018.html>, Accessed date: 25 May 2019.
- Baum, C., Weigelt, R., 2019. How where i shop influences what i buy: the importance of the retail format in sustainable tomato consumption. In: Chai, A., Baum, C. (Eds.), *Demand, Complexity, and Long-Run Economic Evolution*. Springer International Publishing.
- European Bioplastics, 2020. Frequently Asked Questions on Bioplastics. [https://docs.european-bioplastics.org/publications/EUBP\\_FAQ\\_on\\_bioplastics.pdf](https://docs.european-bioplastics.org/publications/EUBP_FAQ_on_bioplastics.pdf).

- Bless, H., Wänke, M., Bohner, G., Fellhauer, F., Schwarz, R., 1994. Need for cognition: Eine Skala zur Erfassung von Engagement und Freude bei Denkaufgaben [Presentation and validation of a German version of the Need for Cognition Scale]. 25. Zeitschrift für Sozialpsychologie, pp. 147–154.
- Bos, H., Meesters, K., Conijn, S., Corré, W., Patel, M., 2010. Sustainability aspects of biobased applications. <http://edepot.wur.nl/170079>.
- Bullock, G., Johnson, C., Southwell, B., 2017. Activating values to stimulate organic food purchases: can advertisements increase pro-environmental intentions? *J. Consum. Mark.* 34 (5), 427–441. <https://doi.org/10.1108/JCM-12-2015-1643>.
- Cacioppo, J.T., Petty, R.E., 1982. The need for cognition. *J. Pers. Soc. Psychol.* 42 (1), 116–131. <https://doi.org/10.1037/0022-3514.42.1.116>.
- Cacioppo, J.T., Petty, R.E., 1984. The elaboration likelihood model of persuasion. *Adv. Consum. Res.* 11, 673–675.
- Cacioppo, J.T., Petty, R.E., Feinstein, J.A., Jarvis, W.B.G., 1996. Dispositional differences in cognitive motivation: the life and times of individuals varying in need for cognition. *Psychol. Bull.* 119 (2), 197–253. <https://doi.org/10.1037/0033-2909.119.2.197>.
- Caputo, V., Nayga, R.M., Scarpa, R., 2013. Food miles or carbon emissions? Exploring labelling preference for food transport footprint with a stated choice study. *Aust. J. Agric. Resour. Econ.* 57 (4), 465–482. <https://doi.org/10.1111/1467-8489.12014>.
- Caputo, V., Scarpa, R., Nayga, R.M., 2016. Cue versus independent food attributes: the effect of adding attributes in choice experiments. *European Review of Agriculture Economics* 39 (2), 229. <https://doi.org/10.1093/erae/jbw022>.
- Carnevale, J.J., Inbar, Y., Lerner, J.S., 2011. Individual differences in need for cognition and decision-making competence among leaders. *Personal. Individ. Differ.* 51 (3), 274–278. <https://doi.org/10.1016/j.paid.2010.07.002>.
- Carus, M., Eder, A., Beckmann, J., 2014. GreenPremium prices along the value chain of biobased products. *Ind. Biotechnol.* 10 (2), 83–88. <https://doi.org/10.1089/ind.2014.1512>.
- Cialdini, R.B., Trost, M.R., 1998. Social influence: social norms, conformity and compliance. In: Gilbert, D.T., Fiske, S.T., Lindzey, G. (Eds.), *The Handbook of Social Psychology*. McGraw-Hill, New York, pp. 151–192.
- Cialdini, R.B., Reno, R.R., Kallgren, C.A., 1990. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *J. Pers. Soc. Psychol.* 58 (6), 1015–1026. <https://doi.org/10.1037/0022-3514.58.6.1015>.
- Cialdini, R.B., Demaine, L.J., Sagarin, B.J., Barrett, D.W., Rhoads, K., Winter, P.L., 2006. Managing social norms for persuasive impact. *Soc. Influ.* 1 (1), 3–15. <https://doi.org/10.1080/15534510500181459>.
- Cox, M., Elen, J., Steegen, an, 2019. The use of causal diagrams to Foster Systems thinking in geography education: results of an intervention study. *J. Geogr.* 118 (6), 238–251. <https://doi.org/10.1080/00221341.2019.1608460>.
- Cummings, R.G., Taylor, L.O., 1999. Unbiased value estimates for environmental goods: a cheap talk Design for the Contingent Valuation Method. *Am. Econ. Rev.* 89 (3), 649–665. <https://doi.org/10.1257/aer.89.3.649>.
- Cutter, C.N., 2006. Opportunities for bio-based packaging technologies to improve the quality and safety of fresh and further processed muscle foods. *Meat Sci.* 74 (1), 131–142. <https://doi.org/10.1016/j.meatsci.2006.04.023>.
- De-Magistris, T., Gracia, A., Nayga, R.M., 2013. On the use of honesty priming tasks to mitigate hypothetical Bias in choice experiments. *Am. J. Agric. Econ.* 95 (5), 1136–1154. <https://doi.org/10.1093/ajae/aat052>.
- Destatis, 2018. Bevölkerung nach Bildungsabschluss in Deutschland. <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Bildungsstand/Tabellen/bildungsabschluss.html>.
- European Commission, 2018. A European Strategy for Plastics in a Circular Economy. [https://eur-lex.europa.eu/resource.html?uri=cellar:2df5d1d2-fac7-11e7-b8f5-01aa75ed71a1.0001.02/DOC\\_1&format=PDF](https://eur-lex.europa.eu/resource.html?uri=cellar:2df5d1d2-fac7-11e7-b8f5-01aa75ed71a1.0001.02/DOC_1&format=PDF).
- Eurostat, 2019. Packaging Waste Statistics. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging\\_waste\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics).
- Francisco, A.J., Bruce, A.S., Crespi, J.M., Lusk, J.L., McFadden, B., Bruce, J.M., Aupperle, R.L., Lim, S.-L., 2015. Are consumers as constrained as hens are confined? Brain activations and Behavioral choices after informational influence. *Journal of Agricultural & Food Industrial Organization* 13 (1), 485. <https://doi.org/10.1515/jafio-2015-0022>.
- German Environment Agency, 2018. Aufkommen und Verwertung von Verpackungsabfällen in Deutschland im Jahr 2016. [https://www.umweltbundesamt.de/sites/default/files/medien/2546/publikationen/aufkommen\\_und\\_verwertung\\_von\\_verpackungsabfaellen\\_in\\_deutschland\\_im\\_jahr\\_2016\\_final.pdf](https://www.umweltbundesamt.de/sites/default/files/medien/2546/publikationen/aufkommen_und_verwertung_von_verpackungsabfaellen_in_deutschland_im_jahr_2016_final.pdf).
- Goldstein, N.J., Cialdini, R.B., Griskevicius, V., 2008. A room with a viewpoint: using social norms to motivate environmental conservation in hotels. *J. Consum. Res.* 35 (3), 472–482. <https://doi.org/10.1086/586910>.
- Guagnano, G.A., Stern, P.C., Dietz, T., 1995. Influences on attitude-behavior relationships. *Environ. Behav.* 27 (5), 699–718. <https://doi.org/10.1177/0013916595275005>.
- Hafner, B.R., Elmes, D., Read, D., White, M.P., 2019. Exploring the role of normative, financial and environmental information in promoting uptake of energy efficient technologies. *J. Environ. Psychol.* 63, 26–35. <https://doi.org/10.1016/j.jenvp.2019.03.004>.
- Hahnel, U.J.J., Ortmann, C., Korcay, L., Spada, H., 2014. What is green worth to you?: activating environmental values lowers price sensitivity towards electric vehicles. *J. Environ. Psychol.* 40, 306–319. <https://doi.org/10.1016/j.jenvp.2014.08.002>.
- Hensher, D.A., Greene, W.H., 2003. The mixed logit model: the state of practice. *Transportation* 30 (2), 133–176. <https://doi.org/10.1023/A:1022558715350>.
- Hensher, D.A., Rose, J.M., Greene, W.H., 2015. *Applied Choice Analysis*. Cambridge University Press, Cambridge.
- Herbes, C., Beuthner, C., Ramme, I., 2018. Consumer attitudes towards biobased packaging - a cross-cultural comparative study. *J. Clean. Prod.* 194, 203–218. <https://doi.org/10.1016/j.jclepro.2018.05.106>.
- Hmelo-Silver, C.E., Jordan, R., Eberbach, C., Sinha, S., 2017. Systems learning with a conceptual representation: a quasi-experimental study. *Instr. Sci.* 45 (1), 53–72. <https://doi.org/10.1007/s11251-016-9392-y>.
- Hovland, C.I., Janis, I.L., Kelley, H.H., 1953. *Communications and Persuasion: Psychological Studies in Opinion Change*. Yale University Press, New Haven, CT.
- Kahneman, D., 2003. Maps of bounded rationality: psychology for Behavioral economics. *Am. Econ. Rev.* 93 (5), 1449–1475. <https://doi.org/10.1257/00028280322655392>.
- Kainz, U.W., 2016. Consumers' Willingness to Pay for Durable Biobased Plastic Products: Findings from an Experimental Auction. <https://mediatum.ub.tum.de/?id=1293618>.
- Kaminski, D.M., Caputo, V., 2018. Milk Produced Under Certified Labor Conditions: Are U.S. Consumers Willing to Pay for It and Does Prior Information Impact Their Behavior? Annual Meeting of the Agricultural and Applied Economics Association. (August 5–7, Washington, D.C.).
- Kim, S.-W., Lusk, J., Brorsen, B., 2018. “Look at me, I’m buying organic”: the effects of social pressure on organic food purchases. *J. Agric. Resour. Econ.* 43 (3), 276500.
- Klaiman, K., Ortega, D.L., Garnache, C., 2016. Consumer preferences and demand for packaging material and recyclability. *Resour. Conserv. Recycl.* 115, 1–8. <https://doi.org/10.1016/j.resconrec.2016.08.021>.
- Klaiman, K., Ortega, D.L., Garnache, C., 2017. Perceived barriers to food packaging recycling: evidence from a choice experiment of US consumers. *Food Control* 73, 291–299. <https://doi.org/10.1016/j.foodcont.2016.08.017>.
- Kollmuss, A., Agyeman, J., 2010. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res.* 8 (3), 239–260. <https://doi.org/10.1080/13504620220145401>.
- Koutsimanis, G., Getter, K., Behe, B., Harte, J., Almenar, E., 2012. Influences of packaging attributes on consumer purchase decisions for fresh produce. *Appetite* 59 (2), 270–280. <https://doi.org/10.1016/j.appet.2012.05.012>.
- Krinsky, I., Robb, A.L., 1986. On approximating the statistical properties of elasticities. *Rev. Econ. Stat.* 68 (4), 715. <https://doi.org/10.2307/1924536>.
- van Loo, E.J., Caputo, V., Nayga, R.M., Meullenet, J.-F., Ricke, S.C., 2011. Consumers' willingness to pay for organic chicken breast: evidence from choice experiment. *Food Qual. Prefer.* 22 (7), 603–613. <https://doi.org/10.1016/j.foodqual.2011.02.003>.
- van Loo, E.J., Caputo, V., Nayga, R.M., Seo, H.-S., Zhang, B., Verbeke, W., 2015. Sustainability labels on coffee: consumer preferences, willingness-to-pay and visual attention to attributes. *Ecol. Econ.* 118, 215–225. <https://doi.org/10.1016/j.ecolecon.2015.07.011>.
- Louviere, J.J., Hensher, D.A., Swait, J.D., Adamowicz, W., 2010. *Stated Choice Methods*. Cambridge University Press.
- Lusk, J.L., 2018. Consumer preferences for and beliefs about slow growth chicken. *Poult. Sci.* 97 (12), 4159–4166. <https://doi.org/10.3382/ps/pey301>.
- Mandel, D.R., Kapler, I.V., 2018. Cognitive style and frame susceptibility in decision-making. *Front. Psychol.* 9 (1461). <https://doi.org/10.3389/fpsyg.2018.01461>.
- Marchewka, A., Zurawski, L., Jednoróg, K., Grabowska, A., 2014. The Nencki affective picture system (NAPS): introduction to a novel, standardized, wide-range, high-quality, realistic picture database. *Behav. Res. Methods* 46 (2), 596–610. <https://doi.org/10.3758/s13428-013-0379-1>.
- McFadden, D., 1974. Conditional logit Analysis of qualitative choice behavior. In: Zarembka, P. (Ed.), *Frontiers in Econometrics*. Academic Press, New York, pp. 105–142.
- McFadden, B.R., Lusk, J.L., 2015. Cognitive biases in the assimilation of scientific information on global warming and genetically modified food. *Food Policy* 54, 35–43. <https://doi.org/10.1016/j.foodpol.2015.04.010>.
- Nolan, J.M., Schultz, P.W., Cialdini, R.B., Goldstein, N.J., Griskevicius, V., 2008. Normative social influence is underdetected. *Personality & Social Psychology Bulletin* 34 (7), 913–923. <https://doi.org/10.1177/0146167208316691>.
- Nordlund, A.M., Garvill, J., 2002. Value structures behind Proenvironmental behavior. *Environ. Behav.* 34 (6), 740–756. <https://doi.org/10.1177/001391602237244>.
- van den Oever, M., Molenveld, K., van der Zee, M., Bos, H., 2017. Bio-Based and Biodegradable Plastics: Facts and Figures: Facts and Figures. 1722 Wageningen Food & Biobased Research <https://doi.org/10.18174/408350>.
- Olson, J.C., Reynolds, T.J., 1983. Understanding consumers' cognitive structures: Implications for advertising strategy. In: Percy, L., Woodside, A. (Eds.), *Advertising and Consumer Psychology*. vol. 1 Lexington Books, Lexington, MA.
- Pan, Y., Farmahini-Parahani, M., O'Hearn, P., Xiao, H., Ocampo, H., 2016. An overview of bio-based polymers for packaging materials. *Journal of Bioresources and Bioproducts* 1 (3), 106–113.
- Parks, C.D., Sanna, L.J., Berel, S.R., 2001. Actions of similar others as inducements to cooperate in social dilemmas. *Personality & Social Psychology Bulletin* 27 (3), 345–354. <https://doi.org/10.1177/0146167201273008>.
- Peelman, N., Ragaert, P., de Meulenaer, B., Adons, D., Peeters, R., Cardon, L., van Impe, F., Devlieghere, F., 2013. Application of bioplastics for food packaging. *Trends Food Sci. Technol.* 32 (2), 128–141. <https://doi.org/10.1016/j.tifs.2013.06.003>.
- Phillips, W.J., Fletcher, J.M., Marks, A.D.G., Hine, D.W., 2016. Thinking styles and decision making: a meta-analysis. *Psychol. Bull.* 142 (3), 260–290. <https://doi.org/10.1037/bul0000027>.
- Poe, G.L., Giraud, K.L., Loomis, J.B., 2005. Computational methods for measuring the difference of empirical distributions. *Am. J. Agric. Econ.* 87 (2), 353–365. <https://doi.org/10.1111/j.1467-8276.2005.00727.x>.
- Rumm, S., 2016. Verbrauchereinschätzungen zu Biokunststoffen: eine Analyse vor dem Hintergrund des heuristisch-systematic model. <https://mediatum.ub.tum.de/1306582> (Accessed 18 October 2018).
- Scarpa, R., Ferrini, S., Willis, K., 2005. Performance of error component models for status-quo effects in choice experiments. In: Scarpa, R., Alberini, A. (Eds.), *Applications of Simulation Methods in Environmental and Resource Economics*. vol. 6. Springer,

- Berlin/Heidelberg, pp. 247–273.
- Scarpa, R., Thiene, M., Train, K., 2008. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. *Am. J. Agric. Econ.* 90 (4), 994–1010. <https://doi.org/10.1111/j.1467-8276.2008.01155.x>.
- Schubert, C., 2017. Green nudges: do they work? Are they ethical? *Ecol. Econ.* 132, 329–342. <https://doi.org/10.1016/j.ecolecon.2016.11.009>.
- Schultz, P.W., 1999. Changing behavior with normative feedback interventions: a field experiment on Curbside recycling. *Basic Appl. Soc. Psychol.* 21 (1), 25–36. [https://doi.org/10.1207/s15324834basp2101\\_3](https://doi.org/10.1207/s15324834basp2101_3).
- Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., Griskevicius, V., 2007. The constructive, destructive, and reconstructive power of social norms. *Psychol. Sci.* 18 (5), 429–434. <https://doi.org/10.1111/j.1467-9280.2007.01917.x>.
- Schwartz, S.H., 1977. Normative influences on altruism. In: *Advances in Experimental Social Psychology*. vol. 10. Elsevier, pp. 221–279.
- Simon, H.A., 1979. Information processing models of cognition. *Annu. Rev. Psychol.* 30, 363–396. <https://doi.org/10.1146/annurev.ps.30.020179.002051>.
- Smith, S.M., Levin, I.P., 1996. Need for Cognition and Choice Framing Effects. *Journal of Behavioral Decision Making*. 9 (4), pp. 283–290. [https://doi.org/10.1002/\(SICI\)1099-0771\(199612\)9:4<283::AID-BDM241>3.0.CO;2-7](https://doi.org/10.1002/(SICI)1099-0771(199612)9:4<283::AID-BDM241>3.0.CO;2-7).
- Statista, 2018. Pro-Kopf-Konsum von Gemüse in Deutschland nach Art. <https://de.statista.com/statistik/daten/studie/290802/umfrage/pro-kopf-konsum-von-tomaten-in-deutschland/>.
- Statista, 2019. Distribution of Private Households: Based on Monthly Household Net Income in Germany in 2018. <https://www.statista.com/statistics/750827/private-household-income-distribution-in-germany/>.
- Steenis, N.D., van Herpen, E., van der Lans, Ivo A., Ligthart, T.N., van Trijp, H.C.M., 2017. Consumer response to packaging design: the role of packaging materials and graphics in sustainability perceptions and product evaluations. *J. Clean. Prod.* 162, 286–298. <https://doi.org/10.1016/j.jclepro.2017.06.036>.
- Steg, L., de Groot, J., 2010. Explaining prosocial intentions: testing causal relationships in the norm activation model. *Br. J. Social Psychol.* 49 (Pt 4), 725–743. <https://doi.org/10.1348/014466609X477745>.
- Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. *J. Environ. Psychol.* 29 (3), 309–317. <https://doi.org/10.1016/j.jenvp.2008.10.004>.
- Stern, P.C., Kalof, L., Dietz, T., Guagnano, G.A., 1995. Values, beliefs, and Proenvironmental action: attitude formation toward emergent attitude objects. *J. Appl. Soc. Psychol.* 25 (18), 1611–1636. <https://doi.org/10.1111/j.1559-1816.1995.tb02636.x>.
- Stern, P.C., Dietz, T., Abel, T., Guagnano, G., Kalof, L., 1999. A value-belief-norm theory of support for social movements: the case of environmentalism. *Hum. Ecol. Rev.* 6 (2), 81–97.
- Street, D.J., Burgess, L., Louviere, J.J., 2005. Quick and easy choice sets: constructing optimal and nearly optimal stated choice experiments. *Int. J. Res. Mark.* 22 (4), 459–470. <https://doi.org/10.1016/j.ijresmar.2005.09.003>.
- Thaler, R.H., Sunstein, C.R., 2009. *Nudge: Improving Decisions about Health, Wealth and Happiness*. Penguin Books, London.
- Train, K.E., 2009. *Discrete Choice Methods with Simulation*, 2nd ed. Cambridge University Press.
- Tversky, A., Kahneman, D., 1992. Advances in prospect theory: cumulative representation of uncertainty. *J. Risk Uncertain.* 5 (4), 297–323. <https://doi.org/10.1007/BF00122574>.
- Vainio, A., Irz, X., Hartikainen, H., 2018. How effective are messages and their characteristics in changing behavioural intentions to substitute plant-based foods for red meat? The mediating role of prior beliefs. *Appetite* 125, 217–224. <https://doi.org/10.1016/j.appet.2018.02.002>.
- Venkatachalam, L., 2008. Behavioral economics for environmental policy. *Ecol. Econ.* 67 (4), 640–645. <https://doi.org/10.1016/j.ecolecon.2008.01.018>.
- Verplanken, B., Holland, R.W., 2002. Motivated decision making: effects of activation and self-centrality of values on choices and behavior. *J. Pers. Soc. Psychol.* 82 (3), 434–447. <https://doi.org/10.1037//0022-3514.82.3.434>.
- van Wezemael, L., Caputo, V., Nayga, R.M., Chrysoschoidis, G., Verbeke, W., 2014. European consumer preferences for beef with nutrition and health claims: a multi-country investigation using discrete choice experiments. *Food Policy* 44, 167–176. <https://doi.org/10.1016/j.foodpol.2013.11.006>.
- Wuepper, D., Wree, P., Ardali, G., 2019. Does information change German consumers' attitudes about genetically modified food? *European Review of Agriculture Economics* 46 (1), 53–78. <https://doi.org/10.1093/erae/jby018>.
- Yue, C., Hall, C.R., Behe, B.K., Campbell, B.L., Dennis, J.H., Lopez, R.G., 2010. Are consumers willing to pay more for biodegradable containers than for plastic ones? Evidence from hypothetical conjoint analysis and nonhypothetical experimental auctions. *J. Agric. Appl. Econ.* 42, 757–772.