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Making the carbon basket count:

Goal setting promotes sustainable consumption in a simulated online supermarket

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Abstract

We compared the effectiveness of basket goal-setting to product information strategies on sustainable consumption in a simulated online supermarket. Experiment 1 found a significant effect of basket goal setting techniques with carbon basket feedback in either numerical or graphical form on the carbon content of baskets purchased but no effect of numerical product information alone or in combination with basket CO2 information. Experiment 2 also found that basket goal setting was effective, but found no additional effect of introducing five-colour coding of the carbon footprints of either products or baskets. Experiment 3 replicated the effects of goal setting and found that repeated visits to the online supermarket led to improved learning about product carbon footprint in the basket goal setting condition. Our results suggest that goal setting techniques with feedback can reduce the carbon footprint of online shopping baskets and facilitate learning about product carbon footprint.

Keywords: Sustainable consumption; Goal-setting; Decision-aiding; Carbon labels; Groceries

1. Introduction

Greenhouse gas emission is an important problem to which economic agents contribute by their consumption choices (Stern, 2008). Food is one of the major causes of these emissions, and contributes to about 17% of EU household emissions (Ivanova et al., 2017). According to Hertwich and Peters (2009), about half of the non-carbon dioxide greenhouse gases such as methane are caused from food production. Given that dietary choices can have a significant impact on the greenhouse gases which have been implicated in global warming, interest is growing in how consumers can be encouraged to reduce their carbon footprint when grocery shopping (e.g., Panzone, Ulph, Zizzo, Hilton, & Clear, 2018).

We investigate how goal setting theory can be applied to promote sustainable consumption in an online supermarket setting. Goal setting theory focuses on the relation between consciously held performance goals and task performance level, and defines a goal as "the object or aim of an action, for example, to attain a specific standard of proficiency, usually within a specified time limit" (Locke & Latham, 2002, p. 705). In this view, goals can impact performance by four mechanisms: they 1) direct attention to goal-related activities; 2) activate energy and challenging goals lead to greater effort; 3) influence persistence; and 4) impact action by instigating people to use their knowledge and task-relevant strategies. Below, we review how goal setting techniques have been used to boost sustainable consumption, before drawing on goal setting theory to formulate specific hypotheses on how carbon basket goal setting techniques can influence sustainable consumer behaviour and learning in a grocery shopping context. Our results have managerial and policy implications as they show how the use of goal-setting techniques can be incorporated in online grocery stores to boost sustainable consumption, and evaluate their effectiveness with respect to more conventional product information strategies.

1.2. Using goal setting techniques to promote sustainable consumption

Goal setting theory is based on the premise that conscious behaviour is purposeful and regulated by goals of individuals (Latham & Locke, 1991), and that there is a crucial relation between performance and goals (Lunenburg, 2011). Goals have been used successfully to encourage many sustainable consumption behaviours, including household energy conservation (Abrahamse, Steg, Vlek, & Rothengatter, 2007; Becker, 1978; Katzev & Johnson, 1983) or preferences for loose rather than packaged grocery products (Tate, Stewart, & Daly, 2014).Various factors have been shown to moderate goal effectiveness. For example, it has been shown that difficult goals lead to greater achievement, but goals which are fixed at a too high a level may discourage and demoralize individuals (Locke, 1996). Goals are more likely to be effective motivators if they are accepted as legitimate, feasible, stated in exact terms, and provide precise feedback allowing the agent to evaluate his/her progress to that goal (Locke & Latham, 2002). In order to legitimate the ideal that consumers should reduce their carbon footprint in the goal setting conditions, in our studies we communicated an injunctive norm (cf., Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007) that participants should do so in order to reduce harm to the planet. We expected this to be a motivating injunction for our target population, given that most French consumers consider environmental responsibility to be a legitimate concern (Céci-Renaud & Khamsing, 2012).

Feedback is of crucial importance to the success of goal setting strategies, and being precise about what to achieve can diminish variance in performance and thus improve goal attainment. We expected that the most intelligible form of feedback in the context of an online shopping visit would be about the carbon footprint of the shopping *basket* (see below for details). We used aspiration levels (March & Shapira, 1992) in the form of target levels of CO2 reduction in basket carbon footprint. This would allow consumers to regulate their behaviour to approach and in some cases attain the set sustainability goal in a way that is consistent with their need to maintain a positive self-image (Ulph, Panzone, & Hilton, 2017). As belief in the possibility of reaching the goal enhances one's commitment to attaining the goal, we gave our participants an easier intermediate carbon reduction goal than the one that would be required to be fully sustainable (see below). Our first and principal aim was to establish whether sustainability goals set according to these principles did in fact influence consumer behaviour in a realistic experimental online supermarket.

However, we had a second major aim, which was to compare the impact of our basket goal-setting techniques with more conventional informational strategies which give consumers product feedback about sustainable consumption. In comparing basket goal-setting techniques to product information strategies, it is important to note their similarities and differences. We suggest that basket goal-setting may be said to involve both a *motivational* (setting a basket goal) and an *informational* (giving feedback about progress to that goal) component. In contrast, product information strategies do not involve explicit goal setting (e.g., to attain a given sustainability goal), but they do give information relevant to the agent's performance with respect to sustainability considerations, often in precise, numerical form about product carbon footprint (e.g., Perino, Panzone, & Swanson, 2014). However, there are two important considerations here. The first is that providing product carbon footprint information may make environmental concerns salient and so *implicitly* activate sustainability goals in a way consistent with Cialdini, Reno and Kallgren's (1990) norm activation model. Consequently, it is important to compare our basket goal setting conditions (with basket-level carbon footprint goals and basket and/or product feedback) with product information (or "feedback only") conditions conveying basket or product footprint alone in order to assess the impact of setting goals.

The second consideration is that informational strategies may only affect consumer behaviour under certain conditions that facilitate product information uptake and use such as by making carbon footprint information accessible and understandable (McGuire, 1976). To this end, we begin by reviewing research on the effectiveness of product information strategies on sustainable consumption in real or realistic grocery supermarket settings. We then present a framework that highlights the role of task complexity in product information acquisition and use that allows understanding of when product carbon labels are likely to be effective. We then show how a basket-level representation of carbon footprint may provide more intelligible feedback about one's progress to a sustainability goal and so facilitate consumption informed by sustainability considerations.

1.2.2. Do product carbon labels influence sustainable food consumption in realistic supermarket settings? Contextual effects in the construction of consumer preferences

Most information-based strategies for boosting sustainable consumption such as eco-labels have focused on *product* information. Where relevant market data is available, results suggest that eco-labels often (but not always) have a positive effect. For example, using econometric methods, Bjørner, Hansen and Russell (2004) report that eco-labels have been found to affect actual purchase of some consumer goods, such as detergents, dolphin-safe tuna and seafood, toilet paper, recycled toilet paper, paper towels, organic cotton in clothes and green electricity. Harris (2007) reports that the Green Tick eco-label was followed by substantially increased sales of seven household cleaning products in Australia. In contrast, eco-labels have had no effect on purchases of unbleached toilet paper and use of environmentally friendly dyes in clothes (Bjørner et al., 2004; see also Nimon & Beghin, 1999; Teisl, Roe, & Hicks, 2002).

Advances in product life cycle analysis has led to the development of a specific kind of eco-label to help inform consumers' choices, namely carbon labels (Sharp & Wheeler, 2013). The underlying assumption is that these labels will provide the information about a product's carbon footprint that is necessary for concerned consumers to make an informed choice. This information may be displayed in symbolic, numerical or colour coded form, or a hybrid of these. In the grocery domain, numerical CO2 information was displayed from 2008 using the *Carbon Trust* carbon footprint symbol on selected goods in Tesco supermarkets in the UK. French supermarket Leclerc put numerical CO2 information on their products as well as the CO2 content of the basket onto clients' receipts. Colour coding products' carbon footprint has been used in French Casino supermarkets and in RAISIO in Finland (Schaefer & Blanke, 2014).

In theory, carbon labels provide relevant information and so should have an impact on consumer choices. To obtain information about quality or price attributes, consumers can conduct a search before purchasing products or they can obtain information about some attributes by having experience with regard to these products after purchase (Nelson, 1970). Sustainability traits of food may be considered as credence attributes (Bonroy & Constantatos, 2008; Darby & Karni, 1973), which cannot be directly detected by consumers before purchase and similarly cannot be experienced after purchase. Therefore, the aim of sustainability labels is to aid consumers with their food choice since they can be used as a means to communicate sustainability features of products (Van Loo et al., 2015). As a result, consumers may be able to make informed choices with the use of these product labels (Cohen & Vandenbergh, 2012).

In practice, attempts to influence actual consumer behaviour through product CO2 labels have not always been successful. We suggest that this is because information acquisition and evaluation and its expression in a decision may depend on local factors in the choice context, described by Payne et al. (1993) as task effects. Task effects refer to the factors related to decision problems' general structural characteristics such as response mode, number of alternatives and attributes, information display mode and context effects related to the factors concerning the value of the objects in a decision task. These may moderate the impact of information provision through a carbon label on decision-making in an online shop, such as the number of categories of product available, the number of options available within each category, and the use of between- or within-subject comparisons. For example, they may make carbon labels more or less salient and/or difficult to use in the decision-making process. We highlight such aspects in Table 1, where we refer to all labels that give information about product carbon footprint (whether in symbolic, numerical, colour coded or hybrid form) as product CO2 labels. We only include studies which evaluate the effect of these labels on actual purchase behaviour, either in the context of a field study (where carbon labels were introduced in a real-life setting such as a supermarket, and their effect on consumer choice observed), or an incentive-compatible experiment where consumers were given money by the experimenter and asked to use it to buy goods in an experimental shop. We comment on these papers below.

A large field study using loyalty card data did not report any effect of Carbon Trust labels used by Tesco, the UK's largest retailer, in encouraging sustainable consumption (Hornibrook, May, & Fearne, 2015). These labels contain numerical information printed on the background of a black footprint (see Figure 1). However, their study makes it difficult to draw definitive conclusions as Tesco initially only put carbon information on four product categories: light bulbs; washing detergent; orange juice and potatoes (three more categories were added later: milk; toilet tissue and kitchen towels). Furthermore, no results are reported in their study concerning whether carbon labels actually affected the overall carbon content of consumer baskets. However, it seems likely that these labels had disappointing results, as Tesco withdrew carbon labels from their products in 2012 (Lucas & Clark, 2012). One problem may be that consumers did not pay attention to the numerical information contained in it (Beattie, McGuire, & Sale, 2010). Hornibrook et al. also noted that focus group data suggested that lack of awareness and understanding of carbon labels, a finding that is unsurprising given that many people have considerable difficulty in using numerical information in decision-making unless the information is presented in user-friendly formats (e.g., Cokely, Galesic, Schulz, Ghazal, & Garcia-Retamero, 2012; Reyna, Nelson, Han, & Dieckmann, 2009; Sedlmeier & Hilton, 2012).

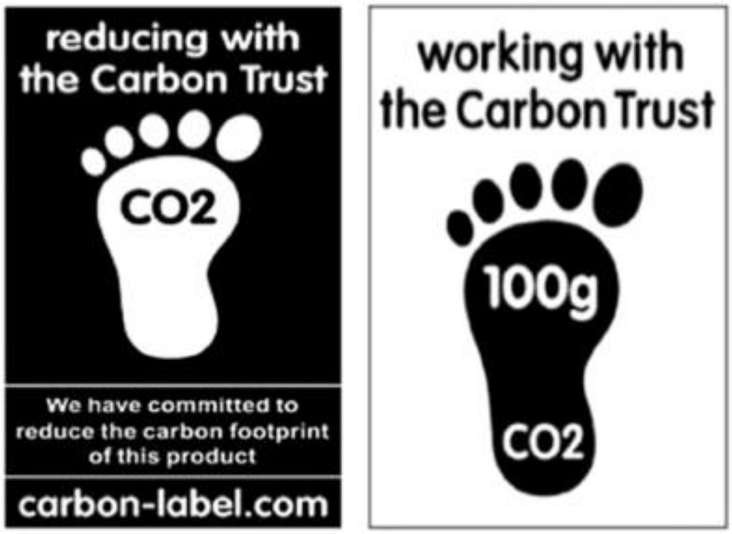

Figure 1. Carbon Labels Used in UK (from Liu, Wang, & Su, 2016, p.73)

Carbon Trust labels have been shown to be effective in settings where they are made salient and the numerical information they give is easily interpretable in the context of presentation. Thus, Perino et al. (2014) used the Carbon Trust labels in a field experiment where they: a) presented participants with a restricted range of products (cola, milk, meat and butter/margarine) on a computer screen upon their entry to the shop, b) presented a restricted range of options for each product type (between 3 and 12), and c) used a within-subject design whereby consumers were required to make the choices from each category without CO2 information before doing so again with CO2 labels present. This within-subject experimental set up may have made the carbon labels highly salient and simplified the normal choice set as well as creating demand effects. While Carbon Trust labels were effective in shifting consumption to lower carbon products in this study, visitors to real supermarkets do not undergo such a computer-based choice procedure before entering the supermarket proper. In particular, the choice architecture used may not be representative of those used in online shopping interfaces which use a menu-based approach whereby products are displayed together in larger super-ordinate categories or « shelves » such that particular items such as milk, butter, margarine etc. will be displayed along with other "dairy" items such as yoghurts, milk-based desserts and vegetal-based desserts.

Spaargaren, Van Koppen, Janssen, Hendriksen and Kolfschoten (2013) explored the effect of colour schemes in a restaurant setting using a similar product CO2 label and found that a carbon label similar to the Carbon Trust label that shows only the numerical information printed in white against the black background (see Figure 2) was not successful in reducing carbon consumption in a university cafeteria. A small but significant shift happened when they adapted these product CO2 labels using an intra-categorical colour scheme, but it is important to note that other interventions that were introduced at the same time, notably a sensibilisation campaign, could explain this effect.

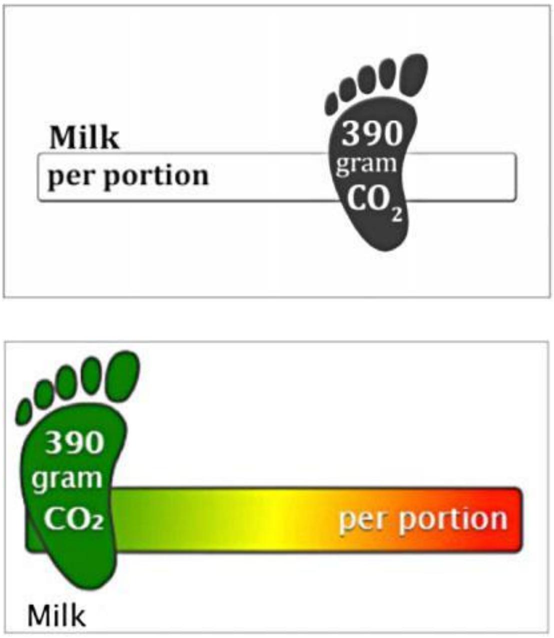

Figure 2. Black and White and Coloured Numerical Product CO2 Labels (Spaargaren et al., 2013, p.438-439)

Vanclay et al. (2011) tested a colour-coded product CO2 label in a real-life grocery store in Australia and found that a significant number of participants changed their behaviour by buying 4% more products with the green label (indicating lower

CO2) and 6% less products with the black label (indicating higher CO2) (see Figure 3). However, this study only displayed labels on a restricted range of products (spreadable butter, bottled water, canned tomatoes, milk and non-perishable pet foods). Importantly, as well as displaying numerical information, these labels also displayed qualitative information coded (higher, medium, lower CO2) using a modified traffic light approach (black = higher, amber = medium, green = lower) within categories of products. This format may have facilitated intra-categorical comparisons: for example, Vanclay et al. find that their carbon labels are especially effective when the low-carbon option is also the cheapest in a product category. While the experiment appears to have high external validity, having been conducted in a real life supermarket setting, there are internal validity concerns as the authors note there was considerable media interest in the experiment that may have contributed to the intervention's effectiveness.

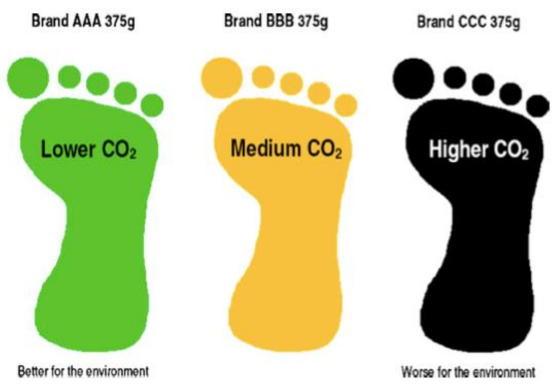

Figure 3. Colour Schemed Labels (Vanclay et al., 2011, p. 155)

In a student union restaurant at Chalmers University of Technology, Sweden. Brunner, Kurz, Bryngelsson and Hedenus (2018) investigated a variant of a Carbon Trust containing a colour-coded bar whose length depended on the carbon emission along with a numerical value indicating carbon content with a Carbon Trust footprint symbol (see Figure 4) for each of the 7 meals in the restaurant’s menu. Information concerning the relation between climate change and food, numerical carbon footprint and the consumers' role was also given on the restaurant's web site, next to the menus with posters and on tables. Brunner et al. found that while sales of green labelled meat dishes increased by 11.5%, red-labelled ones decreased by 4.9% (a marginally significant change). While the yellow label diminished the sales of fish dishes, it increased vegetarian meals. Green labels did not have an impact either on vegetarian or fish dishes.

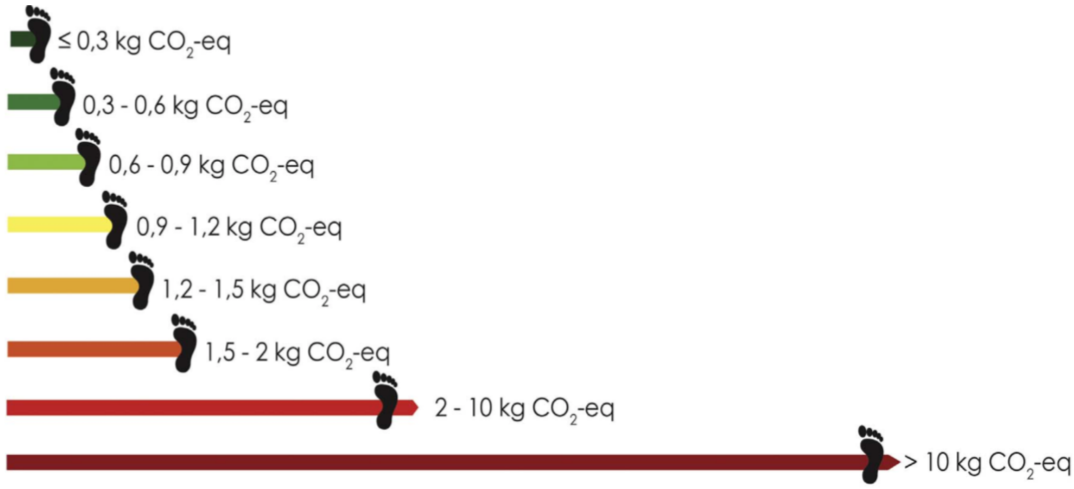

Figure 4. Colour-coded label used in Student Union Restaurant in Sweden (Brunner et al., 2018, p. 660)

Finally, other studies have investigated the effectiveness of product CO2 labels that do not use the Carbon Trust footprint or its variants. For example, Elofsson, Bengtsson, Matsdotter and Arntyr (2016) tested the effect of displaying a climate certification label indicating a commitment from producers to diminish carbon emissions from production in 17 retail stores in Sweden. Compared to a control condition where consumers saw a shelf label announcing the brand of milk sold, consumers who saw a modified shelf label with information that the milk was climate certified bought around 6-8 % more milk. In another study, Vlaeminck, Jiang and Vranken's (2014) survey showed that a gradated colour scheme label (red being not eco-friendly and green being very eco-friendly) together with an overall eco-friendliness score combining environmental impact information concerning carbon, land use or water use (see Figure 5) was selected as the most effective in communicating the eco-friendliness of a product. This was preferred to five other labels giving information about products' sustainability in: three numerical raw formats (three different environmental labels in numeric form giving information about either overall sustainability of product or information about environmental impact of the product or a combination of these two); a colour coded form that did not mention the overall sustainability score; and a label that combines the numerical and colour coded form. They then conducted a study using the preferred label in an incentive-compatible experimental market and found that it led to more sustainable food consumption. However, again, in this study, the product range is restricted and rendered highly salient in the experimental supermarket (a vegetable stand, a fruit stand and a protein stand).

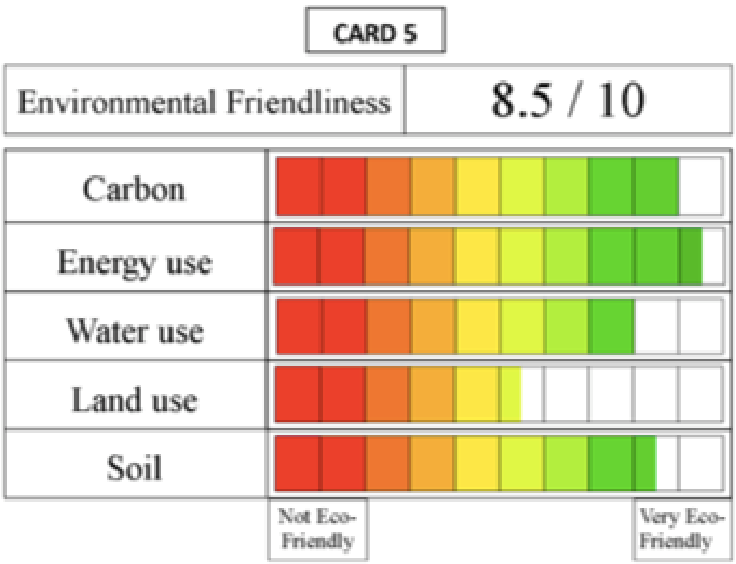

Figure 5. Label selected as the most effective in communicating the eco-friendliness of a product (Vlaeminck et al., 2014, p.182)

Muller, Lacroix and Ruffieux (2019) investigated the effectiveness of a product CO2 label presented in a kilometric format showing the CO2 emission in terms of kilometers driven by car, and two colour coded labels, a single traffic lights and a multiple traffic lights labels (see Figure 6) communicating the sustainability of the product in the form of coloured pastilles (green being the most, orange being the medium and red being the least sustainable) in an experimental laboratory store. In this store, participants reviewed options and made their choices on a computer screen, before collecting the chosen items from the store. While a single traffic lights label signals information only about one criterion, CO2 emission, a multiple traffic lights label signals information about three criteria (CO2 emission, the marine eutrophication and air acidification). The results show that the multiple traffic lights label led to a greater CO2 reduction in shopping baskets and the kilometric format lead to the least CO2 reduction.

Figure 6. Kilometric Environmental Label (label on the left), Single Traffic Lights Environmental Label (label in the middle), Multiple Traffic Lights Environmental Label (label on the right) (Muller et al., 2019).

In sum, product-focused carbon labels have been shown to be effective in influencing sustainable consumption some field and experimental studies but not others. Consequently, we have proposed a framework in which incidental, contextual factors influence the construction of consumer preferences (for reviews see Hilton, 1997; Payne et al., 1993). For example, presentational format appears to matter: numerical representations of product carbon information are less easily processed than visual representations, leading to lower information uptake. In addition, it seems likely that the complexity of the screen display (e.g., number of categories available, number of options displayed within a category) may lead to information overload, affecting product information uptake. These conclusions suggest that presenting carbon footprint information in an online shopping environment is likely to be successful when its acquisition and use is rendered intelligible and easy. With these considerations in mind, we now review the potential advantages of a basket level approach to presenting goal and carbon footprint (feedback) information in the context of a realistic online supermarket display with a hierarchical organization wherein several categories of product are available, with numerous options available within each category.

Reducing task complexity: The basket-level approach to giving carbon footprint feedback

A major moderator of the effectiveness of goal-setting techniques is task complexity: the more complex the task, the more the impact of the goal depends on the ability to find the appropriate strategy for the task (Locke & Latham, 2002). In particular, the design of feedback is of crucial importance so that relevant information is presented in a form that is clear and intuitively accessible to the consumer. Grocery shopping is increasingly conducted online, which gives an opportunity not only to give feedback about the carbon footprint of each *product* but also the overall carbon footprint of the shopping *basket*. Mental representations of shopping baskets may be thought of as an ad hoc category (Barsalou, 1985) of “things to buy at the supermarket” that constitute a mental unit that is meaningful, routinized and cognitively undemanding for consumers, and which is recruited in their decision making process. We test the effectiveness of numerical feedback about basket carbon footprint, but also introduce a visual representation of the carbon footprint of the shopping basket in the form of a "carbon basket thermometer" that is updated by each product that is placed in the basket. In this experimental condition, consumers are not only able to assess the numerical carbon impact of each product they place in the basket but also to verify how well they are doing in attaining the sustainability goal marked in the form of a desired level on the carbon thermometer. In this way, online representations of basket CO2 footprint may help consumers construct dynamic "mental accounts" (Thaler, 1985) that facilitate "carbon budgeting" (Capstick & Lewis, 2010; Grönborg, 2019) by enabling consumers to make basket-level compensations between high carbon footprint products and low ones. In particular, as inter-categorical comparisons in decision-making are likely to require greater cognitive effort than intra-categorical choice processes (Abelson & Levi, 1985; Payne et al., 1993), we assume that basket level representations may facilitate greater recognition of inter-categorical differences in product carbon footprint and hence reduction of basket carbon footprint through inter-categorical substitutions (e.g., vegetable for meat products).

As the presentation format of information has an impact on the choice of information processing strategy (Bettman & Kakkar, 1977), we tested different feedback formats such as numerical format, bi-colour graphical and multi-colour graphical forms. While numerical feedback can be shown effective in changing behaviour in the sustainability context (e.g., Perino et al., 2014), graphical presentation of information can be even more effective. Garcia-Retamero and Cokely

(2013) emphasized the importance of properly-designed visual aids in communicating risk information. For instance, Garcia-Retamero and Galesic (2010) demonstrated that numerical information coupled with visual aids such as icon arrays and bar graphs, improved medical decision-making. Similarly, Garcia-Retamero and Hoffrage (2013) showed that information presented in a numerical format accompanied with visual aids lead to better diagnostic inferences compared to the case when information was presented only in a numerical format. Another study conducted by Walker, Stange, Dixon, Koehler and Fugelsang (2019) showed that gambling related judgments were improved when payback percentage was presented in a graphic format instead of a numerical one.

By orienting consumers to buy sustainable baskets, we expect the cognitive dynamics of consumer behaviour to be modified in a number of potentially important ways. First, the basket format allows consumers to compare the environmental impact of different food categories and recognize that certain food categories (e.g., meat and dairy) have much higher carbon footprints than others (e.g., fruit and vegetables). In addition, giving consumers precise feedback about the environmental impact of each item that they put into their basket may enable learning and hence the acquisition of accurate mental representations of product carbon footprint that may guide future choices. Second, repeated experience of action-outcome pairings where high CO2 products placed into the basket lead the carbon basket thermometer to rise substantially in contrast to low CO2 products may be expected to induce a form of instrumental (action-outcome) learning (Dickinson, 1980). As such learning is automatic it may be assumed to make the task less difficult, and indeed research has shown that this kind of experiential learning often leads to more adaptive decision-making than information communicated in narrative form (Hertwig, Hogarth, & Lejarraga, 2018).

1.4. Overview of our protocol and empirical studies

With the above considerations in mind, we designed an experimental online shop where the consumer can clearly see and explore six different product shelves (fruits and vegetables, meats and fish, dairy products and eggs, frozen foods, sweet goods, and savoury goods) in a way that is familiar from online shopping interfaces familiar in France, using a variant of a the earlier *GreenShop* platform (Demarque, Charalambides, Hilton, & Waroquier, 2015), which used in a high-fidelity simulation of online grocery shopping. The new platform, which we refer to as *GreenShop 2* offered a selection of 112 food and drink items chosen from the French supermarket chain *Casino*'s catalogue of products. Numerical carbon footprint information was presented about both product and consumer basket carbon footprint in some experimental conditions, based on estimates produced by Tesco (Product Carbon Footprint Summary, 2012) and information available from the French ADEME website.

The *GreenShop2* platform presented numerical and graphical representations of basket carbon footprint in different conditions designed to facilitate processing of carbon footprint information in a way that enables participants to make not only intra-categorical but also inter-categorical product comparisons concerning the carbon content of products. We expected that this online feedback about basket carbon footprint may enable consumers to learn that large reductions of carbon footprint can be obtained by substituting products from low (e.g., fruits & vegetables) carbon footprint shelves for products from high carbon footprint shelves (e.g., meat, dairy products). In addition, this format may facilitate substitutions *within* shelves (e.g., dairy products) of low for high carbon products (e.g., vegetal for milk desserts), resulting in baskets with a lower carbon content.

In the goal setting conditions participants could also see an ideal level of carbon footprint reduction displayed in a numerical or graphical form (numerical, graphical, graphical with traffic light colours, etc.). We developed a realistic carbon footprint reduction goal based on data from a pilot experiment involving 21 students from the University of Toulouse-II (Jean Jaurès) conducted in January 2014, whose control condition enabled us to calculate the mean carbon footprint of a 25€ shopping basket for our target sample (M = 3.11 kg CO2 per kg of product, SD = .70). Given the Grenelle Environment Forum's conclusions that carbon emissions should be reduced by 75% by 2050, we supposed that a 25% decrease in this footprint would be a fitting first step towards this goal, as well as being attainable and hence motivating for our participants. Thus, in experimental conditions where a goal was set, the sustainable "threshold" corresponded to a mean shopping basket carbon footprint of 2.33 kg CO2 per kg of product.

Experiment 1 provided an initial test of the effectiveness of basket goal setting techniques compared to control and to product information strategies. In order to replicate our key results, we then conducted two further experimental studies. These tested whether a modified design of the basket goal setting graphical interface would influence shopping behaviour (Experiment 2) and whether repeated visits to the shop in the graphical interface condition would influence shopping behaviour and learning about product carbon footprint (Experiment 3).The experimental conditions used in each experiment are set out in Table 2.

2. Experiment 1

In Experiment 1 we tested the following hypotheses: 1. Both goal setting conditions with carbon basket feedback (*numerical goal setting* (1a) and *graphical thermometer goal setting* (1b)) will lead to shopping baskets with lower carbon footprint compared to a control condition; 2. Numerical product feedback (*product numerical footprint* condition, (2a)) and the *numerical product & basket footprint* condition (2b) will lead to lower basket footprint compared to control; Both goal setting conditions with carbon basket feedback (*numerical goal setting* (3a) and *graphical thermometer goal setting* (3b)) will lead to shopping baskets with lower carbon footprint compared to the numerical product feedback alone (*product numerical footprint* condition) condition; 4. Both goal setting conditions with carbon basket feedback (*numerical goal setting* (4a) and *graphical thermometer goal setting* (4b)) will lead to shopping baskets with lower carbon footprint compared to numerical basket and product feedback alone (*numerical product & basket footprint* condition); 5. Visual presentation of the goal and basket feedback (*graphical thermometer goal setting*) will be more effective than numerical presentation of goal and basket feedback (*numerical goal setting*).

2.1. Method

2.1.1. Participants

One hundred and eighty-four students were recruited on the campus of the University of Toulouse II (Jean Jaurès) in February 2014. This initial sample was reduced to 176 participants because under-age participants (less than 18 years old) and outliers[1] were identified and eliminated. Thus, our final sample consisted of 115 women and 61 men, between the ages of 18 and 50 (*M* = 21.89, *SD* = 4.59). Their average level of education was 1.85 years of higher education post-Baccalauréat (*SD* = 1.72).

2.1.2. Materials and procedure

In all three experiments, the procedure required that each participant be seated in front of a laptop computer in order to generate their weekly shopping order on our platform. To accelerate the recruitment process, 8 laptop computers were set up in an experimental room of the University of Toulouse-II (Jean Jaurès). Participants were seated a few metres apart and randomly assigned to separate experimental conditions. Immediately preceding their shopping spree, they were informed that they disposed of a 25€ budget and that they had 1 chance out of 5 of winning the basket of products they selected, and were informed that they could not leave the shop until they had spent a minimum of 20 euros. This procedure enabled us to ensure that the experimental design was incentive-compatible and encourage the expression of participants' true preferences.

Once they had finished their shopping, participants proceeded to respond to a series of questions, generated by the *GreenShop 2* interface. They began by filling in an adapted version of the short Environmental Attitudes Inventory (EAI-S, Milfont & Duckitt, 2010), then they responded to questions regarding their purchasing habits/criteria, familiarity with online shopping and socio-demographic information. Finally, they rolled a dice to determine whether they had won the shopping basket of selected products (5 "you win"; 6 "roll the dice again"). The "winners" were informed

[1] Eight participants were excluded: those under the age of 18 and those with z-scores > 3.29.

they would be able to pick up their shopping basket in a downtown Casino grocery store within the following weeks.

2.1.3. Measures

Adapted version of the EAI-S (Milfont & Duckitt, 2010). The EAI assesses two dimensions of people's beliefs about the environment and the elements affecting its quality: Preservation (e.g., "Whenever possible, I try to save natural resources") and Utilization (e.g., "It is all right for humans to use nature as a resource for economic purposes"). We used a short version of this questionnaire with 12 questions.

Purchasing criteria/habits. The importance of 7 distinct purchasing criteria was assessed on a Likert-type scale ranging from 1: "not at all important" to 7: "extremely important": quality, price, value for money, number of calories, nutritional value, production mode, environmental impact. Purchasing habits were also gauged. Specifically, participants were required to indicate how frequently (1: "never", 7: "very often") they purchased their goods from: 1) hypermarkets, 2) supermarkets, 3) minimarkets, 4) hard discount stores, 5) convenience stores, 6) organic shops, 7) associations for the maintenance of peasant farming[2], 8) producers, 9) food markets.

Familiarity with online shopping. Participants were also required to indicate their level of familiarity with this type of online shopping (1: "never", 7: "very frequently") by answering the following question: "How often do you shop online in similar stores to this one?"

Socio-demographics. In order to assess whether any socio-demographic factors might have an impact on their consumption patterns, participants were finally asked to specify their revenue, level and field of education, political orientation, age, gender

[2] The association for the maintenance of peasant farming, known as *Association pour le maintien d'une agriculture paysanne (AMAP)* in France, enables consumers to annually pre-order their produce directly from farmers.

and knowledge of French (1: much less good level than my mother tongue, 4: mother tongue).

Experimental conditions

Participants were randomly assigned to 1 of the 5 experimental conditions:

Control (*n* = 36). This condition simply informed participants of the fact that they would be able to do their shopping using our virtual platform (cf. Appendix A). The following message was systematically displayed on the landing page: “This shop sells daily usage products. Use the tabs to gain access to the different shop shelves and proceed with your shopping.”

Product numerical footprint (*n* = 37). This condition provided participants with the same information as in the control condition, but additionally displayed carbon footprint information for every product in the shop (cf. Appendix B). This information was presented as the amount of CO2 (kg) produced per kg of product (kg CO2/kg) and it was displayed on the bottom right corner of the product display. It was obtained by either by referring directly to Casino’s own estimate for the product or (if this information was not available), by referring to Tesco’s Product Carbon Footprint Summary (August 2012) or Greenext’s listing of the carbon footprint of the 34 most purchased food products in France (http://www.wedodata.fr/greencode.php)[3]. To make sure that participants would take notice of this information and be able to interpret it, the following explanatory message was displayed on the landing page (in addition to the message used in the *control* condition): “For each product, the carbon footprint is displayed (kg of CO2 emitted for each kg of produce). The greater the carbon footprint, the greater the

[3] The Environmental Working Group’s “Meat eater’s guide to climate change” was also used.

product's contribution to climate change (during production, transport and distribution)."

Numerical product & basket footprint (*n* = 34). This condition provided participants with the same information as in the *control* and *product numerical footprint* conditions, but additionally displayed the total carbon footprint per kg of weight of the participant's shopping basket (cf. Appendix C). The texts used in the *control* and *product numerical footprint* conditions were displayed and an additional sentence was added: "The mean carbon footprint of your shopping basket will also be shown."

Numerical goal setting (*n* = 35). This condition provided participants with the same information as in the *control* and *numerical product & basket footprint* conditions, while specifying the ideal maximum amount of carbon emissions their shopping basket should aim to have in an inset at the bottom right hand corner of the screen. This amount (2.33 kg CO2/kg) was indicated numerically in red font, under the figure indicating the current total carbon emissions per kg of the basket. Again, the landing page texts used in the previously listed conditions were displayed and a complementary explanation was added: "With a view to limiting climate change, the objective which has been validated by the Grenelle Environment Forum (*Grenelle de l'Environnement)* is to achieve a 75% reduction of carbon emissions by the year 2050. Reducing CO2 emissions by 25% would be an intermediary objective. For this reason, a threshold representing a 25% reduction of the mean carbon footprint of a shopping basket will be displayed."

Graphical thermometer goal setting (*n* = 34). This condition provided participants with the same information and explanatory texts as in the *numerical goal setting*. It also displayed the ideal maximum carbon footprint their shopping basket should have in graphical form. The graph plotted a fixed, red line representing the maximum carbon emissions threshold (2.33 kgCO2/kg) and a mobile bi-coloured bar (green when under the sustainable threshold and red when above the sustainable threshold) representing the current amount of carbon emissions produced by the participant's shopping basket (fluctuating with each added product). If carbon footprint of basket respected the sustainable threshold, the green bar stayed under the red line showing the current carbon footprint of basket. If the carbon footprint of shopping basket exceeded the sustainable threshold, a red bar went up from the red line to the current level of carbon footprint of basket (cf. Appendix D).

2.2. Results

2.2.1. Descriptive statistics and preliminary analyses

Overall, participants bought on average 16.59 products (*SD* = 4.92) with their 25 euros budget. Across conditions, the mean carbon footprint for the shopping baskets was 2.98 kg CO2 per kg of product (*SD* = .82), slightly lower than that observed in the pilot study (*M* = 3.11 kg, *SD* = .70). The mean total carbon footprint of the baskets was 16.38 kg (*SD* = 3.45; see Table 3 for more details). Participants rated three of the shopping criteria as most important: value-for-money (*M* = 5.90, *SD* = 1.24), price (*M* = 5.73, *SD* = 1.23) and quality (*M* = 5.13, *SD* = 1.36). The criteria rated as least important were: number of calories (*M* = 2.80, *SD* = 1.84) and nutritional value (*M* = 3.76, *SD* = 1.79). Experimental condition only had a significant effect on the rated importance of the number of calories ($F(4, 171) = 3.52$, $p < .01$, $\eta^2p = .08$) with this criterion being rated significantly higher in the product CO2 condition (*M* = 3.41, *SD* = 2.01) than in the basket CO2 condition (*M* = 1.91, *SD* = 1.22). In terms of shopping habits, our participants mostly carried out their shopping in supermarkets (*M* = 4.44, *SD* = 1.94), hypermarkets (*M* = 4.09, *SD* = 1.98) and least often in organic shops (*M* = 2.15, *SD* = 1.71) or associations for the maintenance of peasant farming (*M* = 1.65, *SD* = 1.47). Participants indicated little familiarity with doing online shopping, saying they did not shop often in shops comparable to ours (*M* = 1.42, *SD* = 1.16).

More than half of the participants' (66.5%) field of education/activity is human and social sciences followed by letters and languages (16.5%), art, music, audio-visual and cinema (6.8%), and medical and paramedical (2.8%). Regarding political orientation, 34.1 % indicated belonging to a left-wing party (Front de Gauche, Parti Socialiste, Parti Radical de Gauche), 5.7 % to an environmental party (Europe Ecologie Les Verts), 0.6 % to a regional party (Union Democratique Bretonne) and 7.8% to a right-wing party (Union pour un Mouvement Populaire, Mouvement Démocrate), with the remainder preferring not to respond.

We also conducted further analyses to determine the relationship between level of education, gender, income, age and sustainable shopping behaviour. Calculations of Cronbach's α to check reliability of EAI-S revealed for the preservation dimension, α = .37 and for the utilisation dimension, α = .32. We did not investigate the impact of environmental attitude further since this variable had low internal reliability. Education level explained a significant proportion of variance in CO2 per kg of basket, $R^2 = .03$, $F(1, 174) = 5.44$, $p < .05$. There was a significant mean difference of CO2 per kg of basket between male (*M* = 3.17, *SD* = .95) and female (*M* = 2.88, *SD* = .72) participants (*t*(97.99, *corrected for inequality of variances*) = 2.04, p < .05, *two tailed)*. Regarding income, 55 participants chose not to indicate their level of income. Results from the remaining participants showed that self-reported income did not explain a significant proportion of variance in CO2 per kg of basket (R^2 = .01, $F(1, 119) = .83$, $p = .36$). Lastly, age, did not explain a significant proportion of variance in CO_2 per kg of basket (R^2 = .01, $F(1, 174) = 1.8$, $p = .18$).

2.2.2. Assessing the impact of goal setting and feedback

As our goal setting interventions oriented participants to achieve targets stated in kilograms of CO2 per kg weight of products we use this indicator as our target measure of mean basket CO2 footprint, although we also report the absolute mean kilograms of CO2 for each basket (see Table 3). In order to test the effect of the different experimental conditions, we first ran an ANOVA which revealed a significant effect of experimental condition on the mean shopping basket carbon footprint ($F(4, 171) = 2.89$, $p < .05$, $\eta^2 p = .06$).

We then conducted planned comparisons in order to test Hypotheses 1a and 1b. The results confirmed both hypotheses concerning the effectiveness of the goal setting manipulations by indicating that compared to the control condition ($M = 3.26$, $SD = .84$) the *numerical goal setting* condition led to a basket with a significantly lower carbon footprint ($M = 2.75$, $SD = .67$, $t(69) = 2.80$, $p < .005$, *one-tailed*) as did the *graphical thermometer goal setting* condition ($M = 2.77$, $SD = .93$, $t(68) = 2.29$, $p < .05$, *one-tailed*).

However, product information did not have a significant effect on basket carbon footprint, thus disconfirming Hypotheses 2a and 2b. Thus, basket carbon footprint in *control* condition ($M = 3.26$, $SD = .84$) was not significantly lower than that of *product numerical footprint* condition ($M = 2.95$, $SD = .73$; $t(71) = 1.65$, $p = .052$, *one-tailed*) or the *numerical product & basket footprint* condition ($M = 3.18$, $SD = .8$; $t(68) = .41$, $p = .34$, *one-tailed*). These results indicate that informational strategies presenting numerical CO_2 product or carbon feedback alone were not effective.

Hypotheses 3a and 3b that the goal setting conditions would lead to lower basket carbon footprint than the *product numerical footprint* condition were not confirmed, although the absolute values of mean carbon footprints were in the expected direction. Participants assigned to *product numerical footprint* condition ($M = 2.95$; $SD = .73$) had non-significantly higher carbon footprint per kg of basket compared to *numerical goal setting* condition ($M = 2.75$, $SD = .67$; $t(70) = 1.22$, $p = .11$, *one-tailed*) and *graphical thermometer goal setting* condition ($M = 2.77$, $SD = .93$; $t(69) = .91$, $p = .18$, *one-tailed*).

Hypothesis 4a and 4b were confirmed: Results showed that participants assigned to *numerical product & basket footprint* condition ($M = 3.18$, $SD = .8$) had significantly higher carbon footprint per kg of basket than those assigned to *numerical goal setting* condition ($M = 2.75$, $SD = .67$; $t(67) = 2.39$, $p < .05$, *one tailed*) and to the *graphical thermometer goal setting* condition ($M = 2.77$, $SD = .93$; $t(66) = 1.91$, $p < .05$, *one tailed*). These results indicate that in the goal-setting condition it is important to set a basket goal as well as to give basket-level feedback.

Hypothesis 5 was not confirmed, so indicating that both kinds of basket-level feedback (numerical and graphical) with goal setting were equally effective: mean basket CO_2 in the *numerical goal setting* condition ($M = 2.75$, $SD = .67$) was not significantly different than the mean basket CO_2 in *graphical thermometer goal setting* condition ($M = 2.77$, $SD = .93$; $t(67) = -.1$, $p = .46$, *one tailed*).

2.3. Discussion

The first experiment shows that sustainable basket goal setting conditions had the predicted impact on the carbon footprint of the basket, regardless of the form of presentation (graphic or numerical). However, this result was not obtained when numerical product and basket feedback was displayed without a goal. This shows the importance of goal-feedback *pairings*: participants change their purchase choices when they have feedback about the footprint of their basket and when they can evaluate this feedback with respect to a goal in the form of an ideal level of carbon footprint, but do not do so when presented with feedback alone. A perhaps surprising result in view of the greater difficulty people have in using quantitative information conveyed in numerical rather than graphical form (e.g., Cokely et al., 2012) is that we found no difference between numerical and graphical goal feedback in our experiment. One reason for this may be that the numerical basket level representation we used simplified the use of information, as consumers only had to evaluate two items of information (the basket aspiration level and the current CO2 level of the basket) at any given moment. The basket goal and feedback information were presented next to each other on the screen, making them easy to compare. In this respect, it may be significant to note that cases where product numerical information had an impact on judgment and behaviour were also found in studies where visual displays made it easy to compare relative CO2 footprint between a small range of options (Perino et al.,2014; Thogersen & Nielsen, 2016). Such local task effects may explain why numerical representations of carbon footprint at the basket level with goal setting succeeded in influencing purchasing behaviour whereas numerical information at the product level did not.

Although both goal setting conditions led to baskets with lower carbon footprint than the product numerical footprint condition, these differences were not significant. In addition, neither the *product numerical footprint* nor the *numerical basket & product footprint* conditions differed significantly from control, despite being prefaced by an explanation explaining the purpose of this information. One might have expected that displaying these attributes of each option might have activated pro-environmental norms (Cialdini et al., 1990) or served as “signposts” (Ungemach, Camilleri, Johnson, Larrick, & Weber, 2017) that would suffice to orient consumers towards choosing more socially desirable, sustainable options, yet we did not observe this in our experiment. We therefore explored ways of making product numerical footprint more salient through colour coding in the next experiment, as this has been shown to enhance sustainable consumption in other contexts. We also included a numerical carbon footprint condition to enable comparisons with the colour coded condition, as well as with the numerical goal setting condition.

3. Experiment 2

In the second experiment, we sought to replicate the main results obtained in the first study concerning sustainable goal setting and feedback techniques but also extend them by incorporating colour-coded labels for both product and basket footprint information. In particular, we investigated if a 5-colour carbon-coding scheme would enhance the impact of numerical product footprint information and the graphical basket level representation. For products, this was achieved by colouring the borders of the cell in which each product was displayed, and for baskets this was achieved by colouring the zones of the thermometer (Multi-coloured thermometer goal setting, where the zone between 0 and 2.33 kg CO2 footprint per kg of basket was coloured green, between 2.33 kg Co2 per kg and 4.66 kg CO2 per kg of basket coloured yellow, between 4,66 kg Co2 per kg and 6.99 kg CO2 per kg of basket coloured amber, between 6.99 kg CO2 per kg and 9.32 kg CO2 per kg of basket coloured vermilion and more than 9.32 kg Co2 per kg of basket coloured as red). The same principle was used for colouring products.

We tested the following hypotheses in Experiment 2, some of which were replications of comparisons made in Experiment 1 (e.g. Hypothesis 1a) and others involved new comparisons (e.g., Hypothesis 1c): 1.The first hypotheses tested whether our old and new goal setting manipulations were effective compared to control. Specifically, participants assigned to *numerical goal setting* condition (replication of test 1a) and *multi-coloured thermometer goal setting* condition (new Hypothesis 1c) will have shopping baskets with lower carbon footprint than participants assigned to the control condition. 2. We also tested the second set of hypotheses about whether product information alone will lead to reduction in basket carbon footprint: Numerical product feedback (*product numerical footprint* condition, replication of test 2a) and the *colour coded product numerical footprint* condition (new Hypothesis 2c) will lead to lower basket footprint compared to control. 3. We also tested whether the two goal setting conditions were more effective than the corresponding product information strategies. Thus we hypothesized that participants assigned to the *numerical goal setting* condition (old Hypothesis 3a) will have baskets with lower carbon footprint than those assigned to the *product numerical footprint* condition and that the *multi-coloured thermometer goal setting* condition (new Hypothesis 3c) will have baskets with lower carbon footprint than those assigned to the *colour-coded product numerical footprint* condition. 4. We also tested whether participants assigned to the *multi-coloured thermometer goal setting* condition will have shopping baskets with lower carbon footprint than participants assigned to the *numerical goal setting* condition (Hypothesis 5b). 5. Finally, we tested whether participants assigned to *colour-coded product numerical footprint* condition have significantly lower carbon footprint compared to those assigned to *product numerical footprint* condition to see if colour coding (i.e. a visual representation of carbon footprint information) enhanced the impact of numerical carbon information (new Hypothesis 6).

3.1. Method

3.1.1. Participants

Two hundred participants were initially recruited on the campus of the University of Toulouse-2 (Jean Jaurès) in April 2014. Three outliers were excluded[4], leaving a final sample of 196 participants: 137 women and 59 men, aged between 18 and 40 (*M* = 21.64, *SD* = 3.70), with an average level of 1.85 years of higher education post-Baccalauréat (*SD* = 1.64).

3.1.2. Materials and procedure

The same procedure was used as in Experiment 1. One small modification was made in how basket footprint was displayed: it was no longer displayed on the bottom right corner of the screen, but rather on the top right corner instead. This was to explore whether this change would increase the salience of the basket-level information. Each participant was randomly assigned to 1 of the following 5 experimental conditions (cf. Table 2 for a summary of conditions):

Control (*n* = 39). The same condition as in Study 1.

Product numerical footprint (*n* = 38). The same condition as in Study 1.

Colour coded product numerical footprint (*n* = 40). This condition displayed the carbon footprint of each product, highlighted with a specific colour coding (cf.

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[4] Two participants were excluded because they had total carbon emissions z-scores > 3.29 and one participant was excluded because he had ordered 25kg of potatoes. We also excluded one participant who was under-aged (17 years old).

Appendix E). This colour coding ranged from light green (weak carbon footprint) to dark red (highest carbon footprint).

Numerical goal setting (*n* = 39). The same condition as the *numerical goal setting* condition used in Study 1.

Multi-coloured thermometer goal setting (*n* = 40). This condition displayed the same information as the *numerical goal setting* condition with added colour coding. The colours were used to highlight the carbon footprint of each product, as in the *colour coded product numerical footprint* condition and they were also used to signal the level of emissions of the shopping basket. If the carbon footprint of the shopping basket respected the sustainable level, the cursor stayed in the sustainable green zone showing the current carbon footprint of the basket (cf. Appendix F). If carbon footprint of the shopping basket exceeded the sustainable level, the cursor went up from the green zone to one of the yellow/amber/vermilion/red non-sustainable zones. The explanatory text displayed on the landing page was therefore adapted to include an additional description of the colour coding: "With a view to limiting climate change, the objective which has been validated by the Grenelle Environment Forum (*Grenelle de l'Environnement)* is to achieve a 75% reduction of carbon emissions by the year 2050. Reducing CO2 emissions by 25% would be an intermediary objective. For this reason, a "carbon thermometer" which will help you evaluate the mean total carbon footprint of your basket, will be displayed. If your emissions are in the green zone, then this objective is respected, since the upper limit of the green zone corresponds to a 25% reduction of the carbon footprint of a shopping basket."

3.2. Results

3.2.1. Descriptive statistics and correlations with stated choice criteria

Participants purchased on average 17.57 products (*SD* = 6.32). The mean amount of carbon emissions for a basketful of products was 2.98 kg per kg of product (*SD* = .98) and the mean of total amount of carbon footprint of shopping baskets was 15.94 (*SD* = 4.07; see Table 4 for the means). Participants reported their most important criteria for selecting items when shopping were: value-for-money (*M* = 5.87, *SD* = 1.12), price (*M* = 5.59, *SD* = 1.17) and quality (*M* = 5.34, *SD* = 1.2). The least important criterion that was mentioned was the number of calories (*M* = 3.12, *SD* = 1.77). There was no significant effect of experimental condition on the rated importance of any of the choice criteria. Regarding purchasing habits, participants most often went shopping in supermarkets (*M* = 4.21, *SD* = 1.85) and hypermarkets (*M* = 4.05, *SD* = 1.94). They reported being less inclined to purchase their food from associations for the maintenance of peasant farming (*M* = 1.60, *SD* = 1.36), in organic shops (*M* = 2.35, *SD* = 1.8) or directly from the producers (*M* = 2.16, *SD* = 1.63). Thus, participants in Study 1 & 2 appear to report matching consumption patterns.

We checked Cronbach's α to verify reliability of EAI-S: for the preservation dimension, α = .43 and for utilisation dimension, α = .34. Since the reliability analysis showed low internal consistency, we did not conduct further analysis with this variable.

Participants indicated they did not often shop online in shops similar to ours (*M* = 1.59, *SD* = 1.26). Moreover, almost more than half of the participants indicated that their field of study/activity is human and social sciences (54.6%) followed by language and letters (30.1%) and art, music, audio-visual and cinema (4.6%). Concerning political opinion, 39.9% indicated belonging to a left-wing party (Partie Socialiste, Parti Radical de Gauche, Front de Gauche) , 11.2 % to a right-wing party (L'Union pour un mouvement populaire, Union des Démocrates et Indépendants, Front National/Rassemblement Bleu Marine, Mouvement Démocrate, Parti Chrétien-Démocrate) 5.6 % to an environmental party (Europe Ecologie Les Verts) with the remainder preferring not to answer.

We conducted an analysis to see the relationship between the impact of level of education, gender, income, age and the sustainability of shopping baskets. Education level did not explain a significant proportion of variance in CO2 per kg of basket (R^2 = .01, F(1, 194) = 1.05, p = .31). There was no significant mean difference between male (M = 3.19, SD = 1.08) and female (M = 2.89, SD = .93) participants (t(194) = 1.97, p = .05, *two-tailed*). Regarding income, 76 participants chose not to indicate their level of income. Results from the remaining participants showed that self-reported income did not significantly explain a significant proportion of variance in CO2 per kg of basket (R^2 = 0, F(1, 118) = .18, p = .67). Lastly, age did not explain a significant variance in CO2 per kg of basket (R^2 = 0, F(1, 194) = .37, p = .54).

3.2.2. Assessing the impact of goal setting and feedback

In order to measure the impact of providing different types of carbon information on the mean total carbon footprints per kg of participants' shopping baskets, a one-way ANOVA was conducted. No significant overall differences were found (F(4, 191) = 1.44, p = .22, ηp^2 = .03). However, focused comparisons again revealed differences in the expected direction. Unlike in Experiment 1, Hypothesis 1a was not confirmed as participants had a non-significantly lower basket carbon footprint in the *numerical goal setting* condition than the *control* condition (M = 3.19, SD = .88 vs. M = 2.88, SD = .87, t(76) = 1.53, p = .065, *one-tailed*). Hypothesis 1c was confirmed as participants had a significantly lower basket carbon footprint in the *multi-coloured thermometer goal setting* conditions (M = 2.75, SD = .97, t(77) = 2.11, p < .05, *one-tailed*) compared to control.

As the previous experiment we found no effect of product information alone. Thus the mean carbon content of shopping baskets in the *product numerical footprint* ((2a), $M = 2.94$, $SD = 1$; $t(75) = 1.13$, $p = .13$, *one-tailed*) condition and the *colour coded product numerical footprint* condition ((2c), $M = 3.16$, $SD = 1.14$; $t(77) = .13$, $p = .45$, *one tailed*) were not significantly different than *control* ($M = 3.19$, $SD = .88$) condition disconfirming Hypotheses 2a and 2c.

Hypotheses 3a was not supported whereas Hypothesis 3c was. Thus, participants assigned to *product numerical footprint* ($M = 2.94$, $SD = 1$) did not have significantly higher carbon footprint per kg of basked compared to those assigned to *numerical goal setting* condition (3a, $M = 2.88$, $SD = .87$; $t(75) = .28$, $p = .39$, *one-tailed*). However, Hypothesis 3c was confirmed as participants assigned to the *colour coded product numerical footprint* condition ($M = 3.16$, $SD = 1.14$) had significantly higher carbon footprint than participants assigned to the *multi-coloured thermometer goal setting* condition ($M = 2.75$, $SD = .97$, $t(78) = 1.74$, $p < .05$, *one-tailed*).

Hypothesis 5b is not supported by the results, as both goal setting manipulations appeared to be equally effective. No difference was found between the *numerical goal setting* condition ($M = 2.88$, $SD = .87$) and the *multi-coloured thermometer goal setting* ($M = 2.75$, $SD = .97$) condition ($t(77) = .66$, $p = .26$, *one tailed*).

Finally, Hypothesis 6 was not confirmed. Participants did not have significantly lower carbon footprints in the *colour-coded product numerical footprint* ($M = 3.16$, $SD = 1.14$) condition than in the *product numerical footprint* ($M = 2.94$, $SD = 1$; $t(76) = -.88$, $p = .19$, *one-tailed*). Therefore, colour coding carbon footprint information did not increase the impact of carbon footprint information alone condition.

3.2.3 Meta-analysis of the effects of the numerical goal-setting and numerical product information conditions

As the *numerical goal setting* condition was compared to a *control* condition in both Experiments 1 and 2, we conducted a meta-analysis of this contrast to have a better estimation of the significance of the results and of the effect size. We computed a meta-analytical Cohen's *d* (Cumming, 2012) with 95% confidence intervals (CIs) around it (Algina & Keselman, 2003). Across studies we found a significant goal setting effect, $t(147) = 2.98$, $p < .005$, with a Cohen's $d = .49$, 95% CI [0.13, 0.66], indicating a small to medium effect size. Although the effect observed in Experiment 2 was not conventionally significant, amalgamating it with that observed in Experiment 1 increases confidence that the numerical goal setting condition has a significant effect.

Similarly, we compared *product numerical footprint* condition to the *control* condition and to the *numerical goal setting* condition in Experiments 1 and 2. This revealed that over the two experiments the *product numerical footprint* condition did lead to significantly lower basket carbon footprint compared to the *control* condition $t(148) = 1.92$, $p = .028$, *one-tailed* with a Cohen's $d = .32$, 95% CI [- .01, .55]. However, over the two experiments a non-significant difference was found between the *product numerical footprint* condition and *numerical goal setting* condition, $t(147) = .94$, $p = .18$, *one-tailed* with a Cohen's $d = .15$, 95% CI [- .14, .4].

3.3. Discussion

The results of Experiment 2 reinforced the finding of the first study by showing a similar pattern of results in the *numerical goal setting* on purchases, that when combined across experiments was highly significant. In addition, there was a significant effect of the *multi-coloured thermometer goal setting* condition. The difference between the *numerical goal setting* condition and the *multi-coloured thermometer goal setting* condition was non-significant, indicating that both goal setting manipulations were equally effective.

An important null result was that there was no effect of colour coded product information compared to control and to product numerical information. Our failure to replicate earlier studies that found an effect of coloured carbon labels may be explained by the specific form of colour coding used in our experiments, whereby five colours (red, vermilion, amber, yellow, green) were used to colour the borders of the square in which each product was presented, whereas other studies that did find this effect used coloured pastilles (Muller et al., 2019), coloured versions of the Carbon Trust footprint (Thogersen & Nielsen, 2016; Vanclay et al., 2011) or a gradated colour label (Vlaeminck et al., 2014).

However, a meta-analysis of our results over Experiments 1 and 2 indicated that presenting numerical product carbon information along with an explanation of its meaning is sufficient to induce more sustainable consumption in our online supermarket setting. However, taken in conjunction with results of Experiment 1, the results of Experiment 2 reinforce our earlier findings concerning the effectiveness of goal setting, by showing that the combination of a basket goal with an injunctive norm and precise feedback consistently leads to purchase of lower CO2 baskets, regardless of whether basket CO2 feedback is presented in numerical or coloured graphical form. Importantly, the *multi-coloured thermometer goal setting* condition was significantly more effective than the colour coded product information in reducing basket carbon footprint, indicating that the presence of a goal in the goal setting manipulation contributed independently of product feedback to this effect. Finally, a comparison of the contrasts between the numerical goal setting and control conditions in Experiments 1 and 2 suggested that there was no advantage to be gained by placing the basket feedback information in the top right-hand corner of the screen.

4. Experiment 3

Research has indicated that consumers have a poor understanding of the carbon footprint of different grocery products (Camilleri, Larrick, Hossain, & Patino-Echeverri, 2019; Panzone, Lemke, & Petersen, 2016; Sale, 2012). In the third experiment, we wanted to investigate whether repeated visits to a shop where graphical feedback was given about basket carbon footprint would result in more accurate representations of product carbon footprint through associative learning (Dickinson, 1980; Hertwig et al., 2018). We began by replicating the test of Hypothesis 1c that the multicoloured thermometer goal-setting condition would lead to baskets with lower carbon footprint than control. We also tested two new hypotheses. Specifically, we hypothesized that being more frequently exposed to the *multi-coloured thermometer goal setting* condition would: 7a) lead to lower CO2 baskets being purchased over visits and 7b) enhance the accuracy of consumers' product carbon footprint knowledge over visits. In order to test these hypotheses, we added a repeated-visit condition where participants made 3 visits to the *GreenShop 2*. Product carbon footprint knowledge was measured with a post-experimental survey. As in the previous study, we also expect the *multi-coloured thermometer goal setting* condition to lead to a reduction in the mean total carbon emission of the baskets.

4.1. Method

4.1.1. Participants

One hundred and thirty-two participants were initially recruited through the Toulouse School of Economics subject pool in March 2018. One participant who claimed to speak French much less than his/her mother tongue was excluded from the data, which leaves a final sample of 131 participants composed of 61 men and 70 women aged between 18 and 32 (M = 20.83, SD = 1.90)[5] with an average level of 2.50 years of higher education post-Baccalauréat (SD = 1.11). We used a 2 x 2 design crossing experimental condition (Goal setting vs. control) with the number of visits (1 vs. 3). This resulted in four experimental conditions: *Control with one visit* (n = 29), *control with three-visits* (n = 34), *multi-coloured thermometer goal setting* (n = 35), *multi-coloured thermometer goal setting with three-visits* (n = 33).

4.1.2. Procedure

Upon arrival at the Toulouse School of Economics experimental laboratory participants were randomly assigned to sit in front of one of a suite of laptop computers, separated from each other by a board, which prevented them from seeing how others are responding. Participants were assigned to the experimental conditions and after having read the instructions, they immediately proceeded to their shopping visit. As in the previous experiments, participants were informed that they disposed of a 25€ budget and that they had to spend minimum of 20 euros to be able to leave the shopping platform. They were also told that the unspent part of the budget would not be returned to them.

Participants could make either one or three visits. This was clarified in the beginning of the experiment. Participants who did three visits saw a page saying,

[5] One participant who wrote “100” as age was excluded.

“You are going to do your visit once again. Imagine that your last visit is about one week ago.” between the visits. As in the previous experiments, participants were informed that they had 1 chance out of 5 of winning the basket of products they selected. After having finished the experiment, participants who did one visit rolled a dice to determine whether they would receive the basket they ordered and participants who did three visits rolled the dice three times, once for each basket selected to determine whether they would receive the basket or baskets they ordered. This procedure enabled us to augment the ecological validity of the experimental design and encourage the expression of participants’ true preferences on all visits. After finishing their shopping, participants proceeded to answer the same series of questions as in the first two studies, but also responded to a carbon footprint knowledge questionnaire, which was presented prior to the final socio-demographic questions.

4.1.3. Measures

As in Studies 1 and 2, we administered an adapted version of the EAI-S (Milfont & Duckitt, 2010), asked questions about purchasing criteria and habits, familiarity with online shopping and socio-demographics.

Participants were required to estimate the carbon footprint of 36 products selected from the food catalogue of *GreenShop 2* as high, medium or low (see Appendix G for an example of an item). A default response category “I do not know” was also provided to the participants. For each of the 6 categories (fruits and vegetables, meats and fish, dairy products and eggs, frozen foods, sweet goods, and savoury goods), representative products were included in the questionnaire. Products coming from other countries were not included in order to eliminate possible use of the food-mile heuristic (Sale, 2012). Similarly, organic products were excluded from the questionnaire. The order of the products was randomly generated and an informative paragraph about carbon footprint was displayed before starting the questionnaire. An error score was calculated such that lower scores showed that participants' answers were closer to the correct answers and thus more accurate.

4.2. Results

4.2.1. Descriptive statistics and preliminary analyses

Participants purchased on average 17.64 products (*SD* = 5.01) in the one-visit conditions and in the three-visits conditions, they purchased on average 17.93 products in the first visit (*SD* = 7.27), 17.22 products in the second visit (*SD* = 6.51) and 18.54 products in the third visit (*SD* = 7.10). The most important criteria for selecting the items while shopping reported by the participants were: value-for-money (*M* = 6.14, *SD* = .99), quality (*M* = 5.56, *SD* = 1.11) and price (*M* = 5.51, *SD* = 1.24) and the least important was number of calories (*M* = 3.20, *SD* = 1.77). Concerning purchasing habits, participants reported that they most often went shopping in supermarkets (*M* = 4.79, *SD* = 1.92), hypermarkets (*M* = 3.75, *SD* = 2.02) and minimarkets (*M* = 3.48, *SD* = 2.02) and least often from associations for the maintenance of peasant farming (*M* = 1.64, *SD* = 1.51), directly from the producers (*M* = 1.75, *SD* = 1.33) or from organic shops (*M* = 2.18, *SD* = 1.66). An ANOVA revealed no effect of goal setting condition or interaction thereof on number of visits on choice criteria for grocery shopping (i.e., quality, price, value for money, number of calories, nutritional values, production mode and environmental impact). The mean amount of carbon emissions per kg of products in the single visit conditions was 3.35 kg (*SD* = 1.27) and the total mean CO_2 emission was 15.88 kg (*SD* = 3.65). The mean amount of carbon emission per basket of products in the 3 visits conditions were 3.26 kg (*SD* = .97), 3.35 kg (*SD* = 1.31) and 3.28 kg (*SD* = 1.02) respectively and the mean total carbon footprint were 16.80 kg (*SD* = 4.41), 15.95 kg (*SD* = 4.21) and 16.50 kg (*SD* = 4.37) respectively (see Figure 7 & Figure 8).

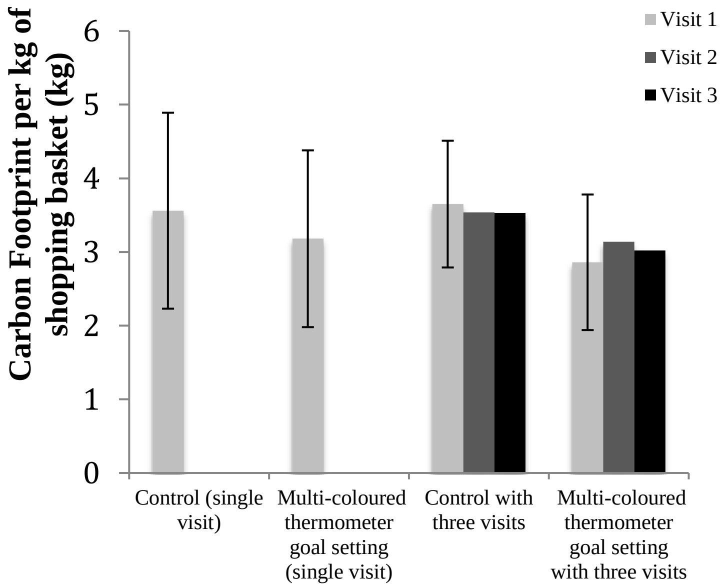

Figure 7. Experiment 3: Mean of carbon emission per kg of shopping basket for each experimental condition.

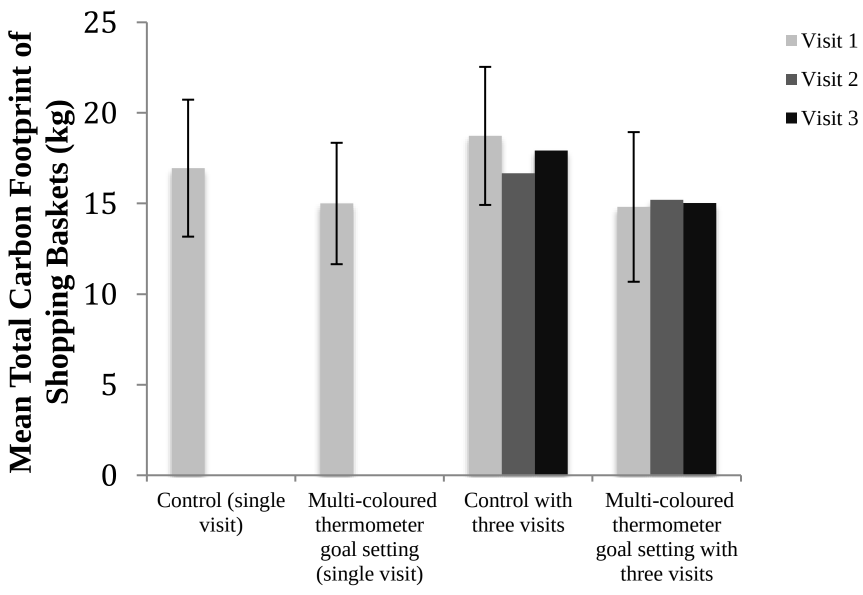

Figure 8. Experiment 3: Mean of total carbon footprint emission of shopping baskets in kg for each experimental condition.

Among participants who did 3 visits to the shop, carbon footprint of first basket and that of the second basket was moderately correlated ($r(65) = .49$, $p < .01$), similarly a moderate positive correlation was found between carbon footprint of first and third shopping baskets ($r(65) = .54$, $p < .01$). Finally, a moderate positive correlation was found between shopping baskets of the second and third visits ($r(65) = .68$, $p < .01$).

We checked Cronbach's α to conduct a reliability analysis for EAI-S: for preservation, α = .45 and for utilisation, α = .4. Since results showed low reliability, we did not conduct further analysis with this variable. Participants indicated not shopping online frequently in the shops comparable to ours ($M = 1.69$, $SD = 1.43$). Moreover, 45.8% of the participants indicated that economics is their field of study/activity. For 23.7% of participants this was business, finance and management, 7.6% law and justice and 7.6% mathematics and statistics. Regarding political opinion, 26 % indicated belonging to a left-wing party (Parti Socialiste, France Insoumise), 6.9 % to a right-wing party (Les Républicains, Debout la France) 3.8 % to an environmental party (Europe Ecologie Les Verts) and 29% to a centre party (La République en marche !) with the remainder preferring not to respond.

Moreover, we investigated the relationship between level of education, gender, income, age and the sustainability of baskets built during the first visit. Education level did not explain a significant proportion of variance in CO2 per kg of basket ($R^2 = .01$, $F(1, 129) = 1.13$, $p = .29$). Concerning gender, as in the first experiment, baskets purchased during the first visit by female participants ($M = 3.06$, *SD* = .90) had a significantly lower carbon footprint than baskets purchased during the first visit by male participants (*M* = 3.59, *SD* = 1.28, *t*(106.24, *corrected for inequality of variances*) = 2.70, *p* < .01, *two-tailed*). Regarding income, 56 participants chose to not to indicate their income level[6]. Results showed that income did not explain a significant proportion of variance in CO_2 per kg of basket (R^2 = .01, *F*(1, 71) = .7, *p* = .41). Regarding age[7], age did not explain a significant variance in CO_2 per kg of basket (R^2 =0, *F*(1, 128) = 0, *p* = .97).

4.2.2. Assessing the impact of goal setting and number of visits on carbon footprint of baskets

In order to measure the impact of goal setting and the number of visits on the mean total carbon emission of the baskets, a mixed ANOVA was conducted among participants who were assigned to *multi-coloured thermometer goal setting with three-visits* and *control with three-visits* conditions. As expected, and replicating the pattern of Experiment 2, Hypothesis 1c was confirmed as baskets in the *multi-coloured thermometer goal setting* conditions had significantly lower carbon footprint than those on the control conditions over the three visits (*F*(1, 65) = 6.83, *p* < .05, η_p^2 = .10). However, Hypothesis 7a that repeated visits in the *multi-coloured thermometer goal setting* condition would lead to lower basket carbon footprint was not supported as there was no significant effect of number of visits on the carbon footprint of the baskets (*F*(2, 130) = .26, *p* = .77, η_p^2 = .00) and no significant interaction effect of number of visits and exposure to *multi-coloured thermometer goal setting* (*F*(2, 130) = 1.28, *p* = .28, η_p^2 = .02).

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[6] One participant who wrote “100000000000000” as their income and one participant who wrote “étudiant” as income were also excluded.
[7] One participant who wrote “100” as age was excluded.

Similarly, when taking into account baskets built during the first visit, the results of two-way ANOVA showed a significant main impact of goal setting on the carbon content of the shopping baskets ($F(1,127) = 9.46$, $p < .05$, $\eta_p^2 = .07$). Number of visits ($F(1,127) = .36$, $p = .55$, $\eta_p^2 = .00$) and the interaction of number of visits and goal setting ($F(1, 127) = 1.22$, $p = .27$, $\eta_p^2 = .01$) did not have a significant main effect on the carbon content of shopping baskets. These results replicate the finding that *multi-coloured thermometer goal setting* condition lead to baskets with lower CO2 footprint (supporting Hypothesis 1c), but fail to support Hypothesis 7a that repeated visits to the shop will lead to further reductions in basket CO2 footprint.

4.2.3. Assessing the impact of goal setting and the number of visits on carbon footprint knowledge.

Independent two-way ANOVA confirmed Hypothesis 7b that showed that being exposed to *multi-coloured thermometer goal setting* ($F(1, 127) = 41.41$, $p < .001$, $\eta_p^2 = .25$) would improve the accuracy of carbon footprint knowledge[8]. As predicted, the interaction of *multi-coloured thermometer goal setting* and number of visits on the accuracy of carbon footprint knowledge was statistically significant ($F(1,127) = 9.46$, $p < .01$, $\eta_p^2 = .07$) (see Figure 9), and focused *t*-tests confirmed Hypothesis 7b by showing that there was significantly greater accuracy of product CO2 knowledge in the *multi-coloured thermometer goal setting* ($M = 1.27$, $SD = .32$) condition than in the *control* condition ($M = 1.44$, $SD = .23$, t(60.98, *corrected for inequality of variances*) = 2.53, $p < .01$, *one tailed*). Moreover, accuracy was significantly higher in the three-visit compared to the one-visit *multi-coloured*

[8] Given the fact that the option “I don’t know” is not used often by the participants ($M = 2.00$, $SD = 5.08$), while computing the carbon footprint knowledge score, we considered these responses as if the participants chose “medium” as an estimation for these products.

thermometer goal setting condition (*M* = 1.27, *SD* = .32 vs. *M* = .96, *SD* = .27; *t*(66) = 4.29, *p* < .001, *one tailed*); but not in the corresponding control conditions (*M* = 1.45, *SD* = .34 vs. *M* = 1.44, *SD* = .23; *t*(61) = - .12, *p* = .45, *one tailed*). These results support Hypothesis 7b that the goal setting condition with graphical feedback enables participants to learn about product carbon footprint, and that repeated exposure leads to greater accuracy.

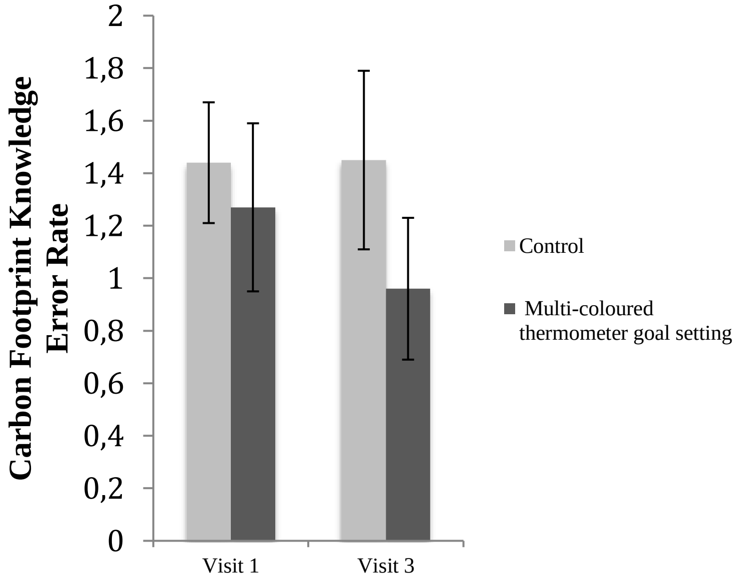

Figure 9. Experiment 3: Carbon Footprint Knowledge Error Score for each Experimental Condition[9].

4.2.4. Meta-analysis of the effect of the multi-coloured goal setting condition.

As the *multi-coloured goal setting* condition was compared to a control condition in both Experiments 2 and 3, we conducted a meta-analysis of this contrast. It revealed a significant effect, *t*(208) = 3.67, *p* < .001, with a Cohen's *d* = .51, 95% CI [0.24, 0.81], indicating a medium effect size. This result gave further support to Hypothesis 1c that participants in the *multi-coloured thermometer goal setting*

[9] Lower error rates indicates increased learning.

condition will have shopping baskets with lower carbon footprint than those assigned to the *control* condition.

4.3. Discussion

The results of Experiment 3 replicate those of Experiment 2 with respect to the effect of the goal setting condition on basket CO2. Thus, participants bought baskets with significantly less carbon footprint when they were exposed to *multi-coloured thermometer goal setting* in both the first and third visits. In addition, a new result was that the goal setting condition led to the acquisition of more accurate knowledge about product carbon footprint, and that three visits led to further learning compared to when only one visit was made. This suggests that our basket "carbon thermometer" offers an alternative approach to facilitating learning about grocery carbon footprint to product-based approaches (Camilleri et al., 2019). Although this learning did not result in further decreases in the carbon footprint of the basket purchased compared to control in our experiment, it is possible that acquiring more accurate representations of grocery carbon footprint would lead to more informed consumer choices by our participants on future occasions.

5. General discussion and conclusions

Using a high fidelity incentive-compatible simulation of an online supermarket, we found over three experiments that our basket goal setting & feedback manipulations had a significant effect on consumer behaviour. These effects emerged whether the feedback was numerical or graphical in form and whether the graphical feedback used two colours or five (Experiments 1 & 2), and whether the consumer made one or three visits to the online experimental supermarket using the five-colour carbon thermometer (Experiment 3). Experiment 3 also showed that the coloured graphical feedback enabled participants to learn about product carbon footprint, and that their representations of carbon footprint became more accurate with increased visits to the online experimental supermarket.

The basket-level representations of carbon footprint have the advantage of enabling comparisons of the carbon footprint of products within and across product categories, as well as enabling consumers to compensate high-carbon products with low carbon ones from different product categories and shelves. They also enable consumers to regulate their carbon footprint with respect to set goals, with clear feedback about their position with respect to that goal. Our results are in line with earlier results on household energy use which showed that goal setting techniques led both to lower consumption of energy as well as increased knowledge about energy conservation (Abrahamse et al., 2007). Although acquiring more accurate representations of product carbon footprint did not translate into purchasing reduced carbon footprint baskets in Experiment 3, it is of course possible that such learning will help motivated consumers select more sustainable baskets in a longer term perspective. It would be instructive to examine the relationship between using basket-level representations of carbon footprint and learning about product carbon footprint in real-life contexts, such as online supermarket or educational settings.

Our research also suggests that choice architecture – in the form of numerical or graphical feedback about the carbon status of the shopping basket with respect to the aspiration level – can help consumers form a mental representation of their carbon budget (Capstick & Lewis, 2010; Marek, Raux, & Engelmann, 2018) that will guide consumer behaviour in a realistic online grocery shopping setting. Our results thus contribute to research that suggests that techniques that facilitate the construction of mental accounts that are relevant to decision-making can encourage choices of more sustainable options, such as public over private transportation. In addition, the basket level representations have the incidental effect of leading to formation of more accurate representations of product carbon footprint.

In contrast, other methods of promoting sustainable consumption had less effect on sustainable consumption in our realistic online supermarket setting. Thus, combining over Experiments 1 and 2 numerical carbon footprint information had a significant effect on sustainable consumption in our studies. In Experiment 2, colour coded numerical product information did not have a significant effect compared to control, and significantly less effect than the colour coded goal setting condition. It is important to note that previous studies that have demonstrated an effect of numerical product information on supermarket shopping (e.g., Perino et al., 2014) did so in highly structured decision environments where the numerical information was made salient in a within-subject design and the number of options available at any given time restricted to between 3 and 12 within the same category. In related vein, presenting (non-incentivized) experimental participants with "greenhouse gas rating" rather than "fuel economy" information succeeded in directing their choices towards more sustainable options in a structured series of pairwise car comparisons (Ungemach et al., 2017).

The success of our numerical goal-setting condition may be due to choice architecture features that similarly simplified information processing demands, namely that the two numbers relating the actual and ideal basket carbon footprints were situated next to each other in the screen corner, so making it easy to compare them and regulate behaviour accordingly. However, it may be that presenting numerical product information presented in the more complex environment of real-life supermarket displays will fail to influence consumer behaviour without decision support, as suggested by the experience of supermarket chains such as Tesco in the

UK which have experimented with numerical carbon labels only to later withdraw them. Further research using eye-tracking techniques (e.g., Babakhani, Lee, & Dolnicar, 2020; Graham, Orquin, & Visschers, 2012) may be able to elucidate whether participants actually scanned the numerical information, and manipulation checks performed to see whether they acquired the information presented.

Interestingly, and against expectations based on previous research (e.g., Crosetto, Muller, & Ruffieux, 2016; Crosetto, Lacroix, Muller, & Ruffieux, 2019) our colour coding of the borders had no effect on sustainable consumption. However, Muller et al. (2019) found a significant effect of a product coding scheme using coloured pastilles in a shopping environment that bears many similarities to our own, wherein consumers first chose products from a computer screen structured in shelves before going on to collect their chosen basket from an experimental shop. It therefore seems possible that the particular scheme we used (coloured borders for product displays) in the present studies is an ineffective way of representing carbon footprint information in an online shopping environment.

6. Limitations and future directions

Our studies have some limitations. To begin with, regarding the moderators of goal-performance relationship, we only tested feedback together with the sustainable goal we set in our experiments. Future studies can investigate the impact of other moderators such as goal commitment in reducing basket carbon footprint. When one feels committed to the goal, relationship between goal and performance can be straightened and hence might display sustainable behaviour. Moreover, we found no effects of the kind of feedback used (numerical vs. graphical; bi-coloured vs multi-coloured) on sustainable consumption but it is possible that other ways of representing feedback about carbon footprint may be easier for participants to use, so further increasing the impact of goal setting techniques. This can be tested in future studies in the sustainable online grocery setting. Additionally, in our experiments, we did not randomize the screen position of the basket level carbon footprint information and product carbon footprint labels on the online shopping platform to eliminate location effects.

It is also possible that manipulation checks would enable us to learn more about why participants did not use numerical product CO2 information, e.g. because they did not perceive and remember it, or because they failed to interpret it in terms of high vs. low carbon footprint. Future studies can integrate different manipulation checks to better interpret results. Questions may also be posed about the external validity of the results. For example, it may be that repeated visits in the space of several minutes (asking them to imagine that there has been a week between each visit) may facilitate learning about product CO2 footprint, but a more realistic test may be to bring participants back at week-long intervals for their repeated visits. More generally, given the promising nature of our results using a realistic experimental online setting, future studies can test this approach in real-life online supermarkets. Such tests will determine the effectiveness of the goal setting approach in real life online grocery stores and whether they can be used as a tool to decrease consumers' carbon footprint emissions.

In sum, our study introduces an innovative basket-level representation of carbon footprint and might have useful theoretical and practical implications. Goal setting techniques are effective in inducing sustainable consumption in a realistic online grocery shopping environment, and succeeds where numerical product and basket level carbon information alone fails. Our studies also failed to find any significant effect of colour coding on sustainable consumption at either the product level or at the basket level. The use of a basket-level representation of carbon footprint suggests that “mental accounts” can be constructed on the fly in decision-making that enable consumers to manage their carbon budget, for example by compensating high carbon footprint options with low ones. This form of representing carbon footprint information can be a self-explanatory and intelligible system of communication of carbon footprint information, which will enable consumers to regulate their behaviour in a more sustainable way. Future research should be able to calibrate these techniques in a way that is likely to render them fully effective as a decision aid in online supermarket shopping, for example by systematically modifying the placement of basket carbon footprint information on the screen.

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Table 1:

Summary of studies on the effect of carbon labels on sustainable consumption in realistic settings

Author/Date	Study Type	Outcome Measurement & population	Type of carbon label used	Relevant results	Possible confounds and imitations
Hornibrook, May, & Fearne (2015)	Field study with supermarket retail data	Purchase of labelled goods (light bulbs; washing detergent; orange juice and potatoes (later: milk; toilet tissue and kitchen towels)) by UK consumers in Tesco supermarkets	Carbon Trust label	No effect of Carbon Trust label on purchase decision reported.	No information about carbon content of shopping baskets was provided.
Elofsson, Bengtsson, Matsdotter, & Arntyr (2016)	Field study	Labelled milk purchase by Swedish consumers	Swedish Climate Certification of Food (CCF) (non-numerical) carbon certification label	CCF increased certified milk demand by 6-8 %.	
Vanclay et al. (2011)	Field study	Purchase of dirty vs. clean products within 5 categories (spreadable butter, bottled water, canned tomatoes, milk, non-perishable pet foods) by Australian consumers	Colour coded Carbon Trust label	4% more products with the green label (lower CO2) and 6% less products with the black label (higher CO2) were chosen.	Media announcements could account for impact.
Spaargaren, Van Koppen, Janssen, Hendriksen & Kolfschoten (2013)	Field study	Meals purchased in University of Groningen cafeteria	A variation of Carbon Trust label and a colour coded Carbon Trust label	While the variation of Carbon Trust label did not reduce carbon consumption, a colour coded version of this label worked.	A sensibilization campaign was conducted with the labels, which could account for impact.
Brunner, Kurz, Bryngelsson, & Hedenus (2018)	Field study	Meals purchased in Chalmers University of Technology student cafeteria, Gothenburg	Coloured traffic lights label (from green to dark red) containing a bar whose length depended on the carbon emission along with a numerical value indicating carbon content with a Carbon Trust footprint symbol	Sales of green labelled meat dishes increased by 11.5%, red-labelled ones decreased by 4.9% (a marginally significant change)	Meals offered during the control and label stage were not identical.
Perino, Panzone, & Swanson (2014)	Field experiment	Purchase of dirty vs. clean products within 4 categories (cola, milk, meat, butter/ margarine) by UK consumers in Sainsbury's supermarkets	Carbon trust label	Labelling treatment successful in switching behaviour towards cleaner options.	A within-subject design may have increased the salience of the CO2 label.
Vlaeminck, Jiang and Vranken's (2014)	Field experiment	Choice of products (vegetables, fruit and protein) placed on stands in a Belgium supermarket	Colour coded environmental label	Labels lead to more sustainable product choice	Experimental set-up may have increased label salience.
Muller, Lacroix, & Ruffieux (2019)	Incentive compatible laboratory experiment	Purchase of wide range of groceries by French consumer panel	Kilometric format showing the CO2 emission in terms of kilometers driven by car, and two colour coded labels, a single traffic lights and a multiple traffic lights labels	Multiple traffic lights carbon labels and single traffic light label reduced basket carbon footprint more than symbolic (car journey) label.	A within-subject design may have increased the salience of the CO2 labels.

Table 2:

Brief Explanation of Each Experimental Condition

Experimental Conditions	Price of products	Product footprint	Basket footprint	Numeric threshold	Colour coding	Landing page text
Control [Expts. 1,2,3]	X					"This shop sells daily usage products. Use the tabs to gain access to the different shop shelves and proceed with your shopping."
Product numerical footprint [Expts. 1, 2]	X	X				"This shop sells daily usage products. Use the tabs to gain access to the different shop shelves and proceed with your shopping. For each product, the carbon footprint is displayed (kg of CO2 emitted for each kg of produce). The greater the carbon footprint, the greater the product's contribution to climate change (during production, transport and distribution)."
Numerical Product & basket Footprint [Expt. 1]	X	X	X			"This shop sells daily usage products. Use the tabs to gain access to the different shop shelves and proceed with your shopping. For each product, the carbon footprint is displayed (kg of CO2 emitted for each kg of produce). The greater the carbon footprint, the greater the product's contribution to climate change (during production, transport and distribution). The mean carbon footprint of your shopping basket will also be shown."
Numerical goal setting [Expts. 1,2]	X	X	X	X		"This shop sells daily usage products. Use the tabs to gain access to the different shop shelves and proceed with your shopping. For each product, the carbon footprint is displayed (kg of CO2 emitted for each kg of produce). The greater the carbon footprint, the greater the product's contribution to climate change (during production, transport and distribution). The mean carbon footprint of your shopping basket will also be shown. With a view to limiting climate change, the objective which has been validated by the Grenelle Enviro"nment Forum (*Grenelle de l'Environnement)* is to achieve a 75% reduction of carbon emissions by the year 2050. Reducing CO2 emissions by 25% would be an intermediary objective. For this reason, a threshold representing a 25% reduction of the mean carbon footprint of a shopping basket will be displayed."
Graphical thermometer goal setting [Expt. 1]	X	X	X	X		id Numerical goal setting
Colour coded product numerical footprint [Expt 2]	X	X			X	id. Product numerical footprint condition
Multi-coloured thermometer goal setting [Expt. 2, 3]	X	X	X	X	X	"With a view to limiting climate change, the objective which has been validated by the Grenelle Environment Forum (Grenelle de l'Environnement) is to achieve a 75% reduction of carbon emissions by the year 2050. Reducing CO2 emissions by 25% would be an intermediary objective. For this reason, a "carbon thermometer" which will help you evaluate the mean total carbon footprint of your basket, will be displayed. If your emissions are in the green zone, then this objective is respected, since the upper limit of the green zone corresponds to a 25% reduction of the carbon footprint of a shopping basket."

Table 3

Experiment 1: Mean Carbon Emissions per kg of Basket and Mean of Total Carbon Emission of Basket in kg for Each Experimental Condition

Experimental Conditions	M*	SD	M**	SD	N
Control	3.26	.84	17.67	3.01	36
Product numerical footprint	2.95	.73	15.95	3.19	37
Numerical product & basket footprint	3.18	.80	17.37	3.50	34
Numerical goal setting	2.75	.67	15.64	3.12	35
Graphical thermometer goal setting	2.77	.93	15.24	3.90	34

*Mean carbon footprint per kg of basket in kg

** Mean total carbon footprint of basket in kg

Table 4

Experiment 2: Mean Carbon Emissions per kg of Basket and Mean Total Carbon Emission of Basket for each Experimental Condition

Experimental Conditions	M*	SD	M**	SD	N
Control	3.19	.88	16.78	4.33	39
Product numerical footprint	2.94	1	16.42	4.25	38
Colour coded product numerical footprint	3.16	1.14	16.10	3.57	40
Numerical goal setting	2.88	.87	15.02	3.78	39
Multi-coloured thermometer goal setting	2.75	.97	15.41	4.32	40

* Mean carbon footprint per kg of basket in kg

** Mean total carbon footprint of basket in kg

Table 5

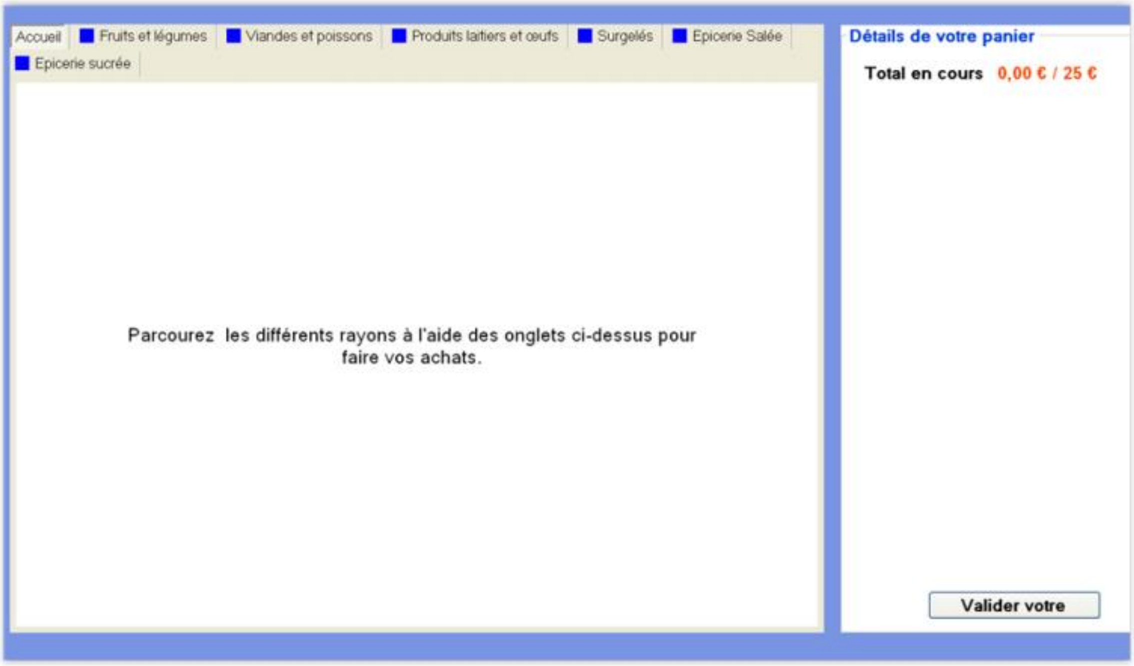
Overview of results of the three experiments

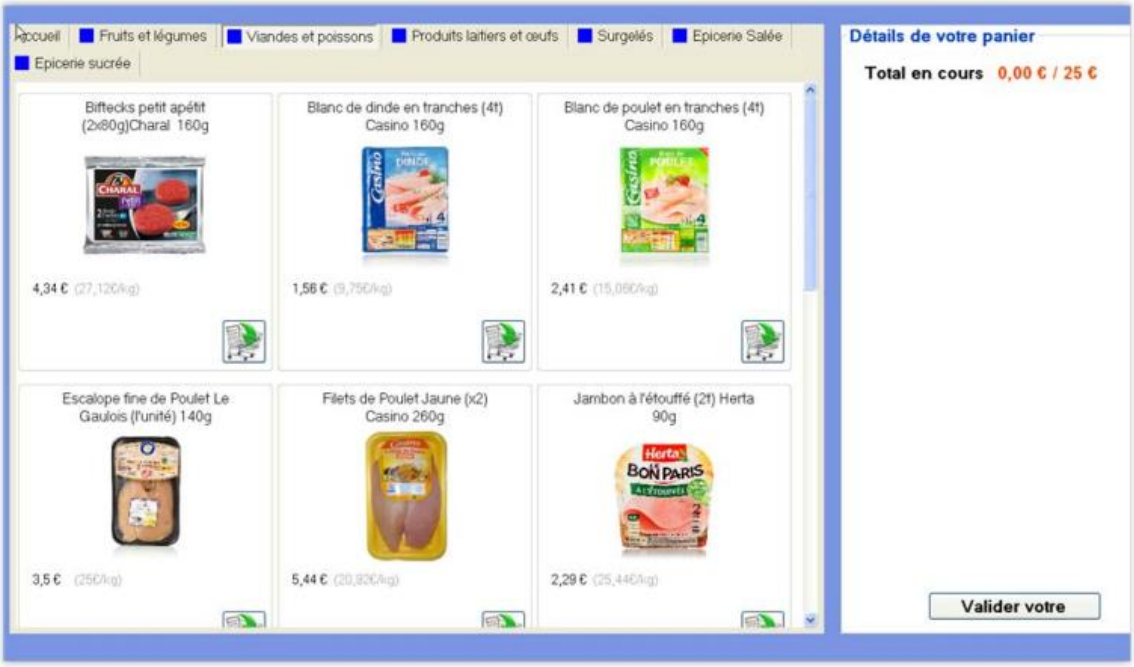
Principal hypotheses & ***specific contrasts*** **tested**	Expt 1.	Expt. 2.	Expt.1 & Expt 2. (Meta-analysis)	Expt. 3.	Expt. 2. & Expt. 3 (Meta-analysis)
Goal setting will lead to lower carbon footprint baskets compared to control					
1a. Numerical goal setting vs. control	Supported	Not supported	Supported		
1b. Graphical thermometer goal setting vs. control	Supported				
1c. Multi-coloured thermometer goal setting vs. control		Supported		Supported	Supported
Feedback only will lead to lower carbon footprint baskets compared to control					
2a. Product numerical footprint only vs. control	Not supported	Not supported	Supported		
2b. Numerical product & basket footprint vs. control	Not supported				
2c. Colour coded product numerical footprint vs. control.		Not supported			
3. **Goal setting will lead to lower carbon footprint baskets compared to product feedback.**					
3a. *Numerical goal setting vs. product numerical footprint*	Not supported	Not supported	Not supported		
3b. Graphical thermometer goal setting vs. product numerical footprint	Not supported				
3c. Multi-coloured thermometer goal setting vs. colour coded product numerical footprint		Supported			
4. **Goal setting conditions will lead to lower basket carbon footprint compared to numerical basket and product feedback alone**					
4a. *Numerical goal setting vs. numerical product & basket footprint.*	Supported				
4b. Graphical thermometer goal setting vs. numerical product & basket footprint.	Supported				

5. Graphical thermometer goal setting will lead to lower basket carbon footprint than numerical goal setting. *5a. Graphical thermometer goal setting* vs. *numerical goal setting*. 5b. *Multi-coloured thermometer goal setting* vs. *numerical goal setting*	 Not supported	 Not supported			
6. Colour-coded product numerical footprint **will lead to lower basket carbon footprint compared to** ***product numerical footprint***		Not supported			
7a. Multiple visits to shop will decrease basket footprint over visits. **7b. Multiple visits to shop will increase product carbon knowledge over visits**				Not supported Supported	

Appendix A

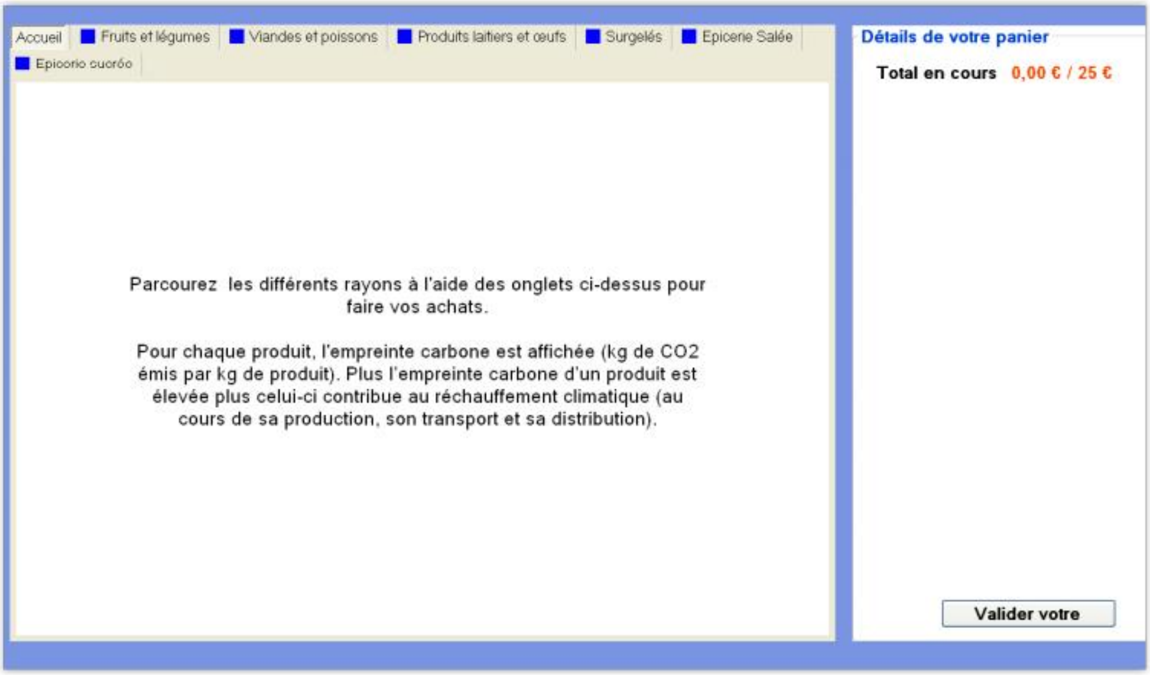
Control Condition

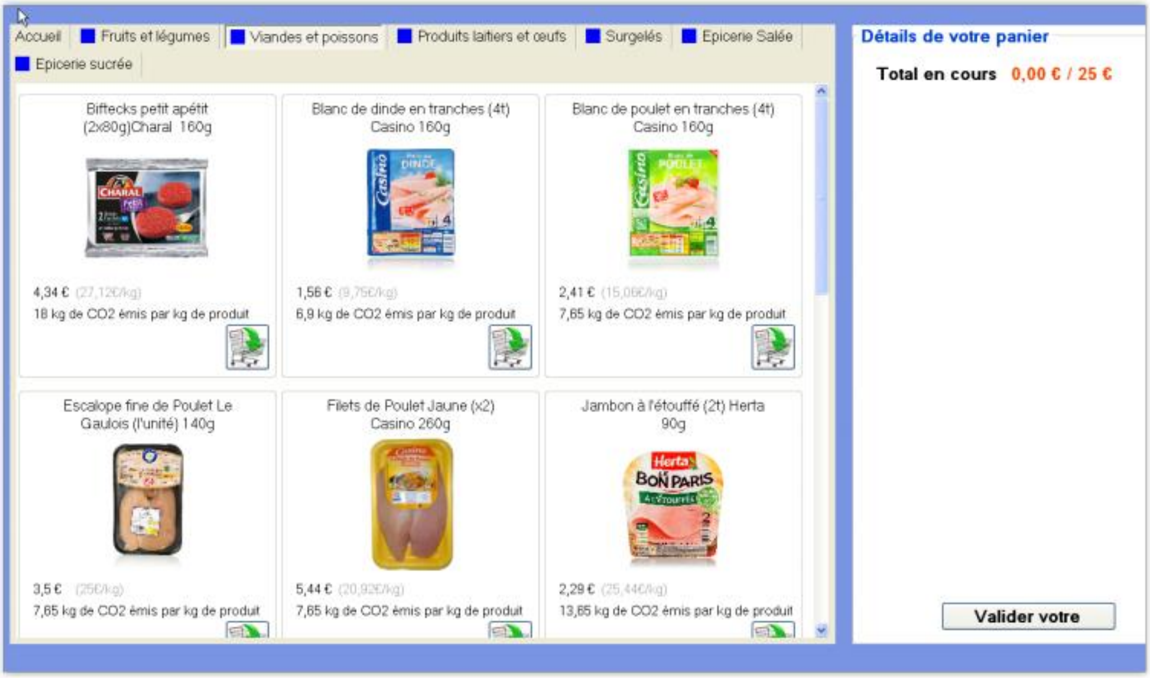




Appendix B

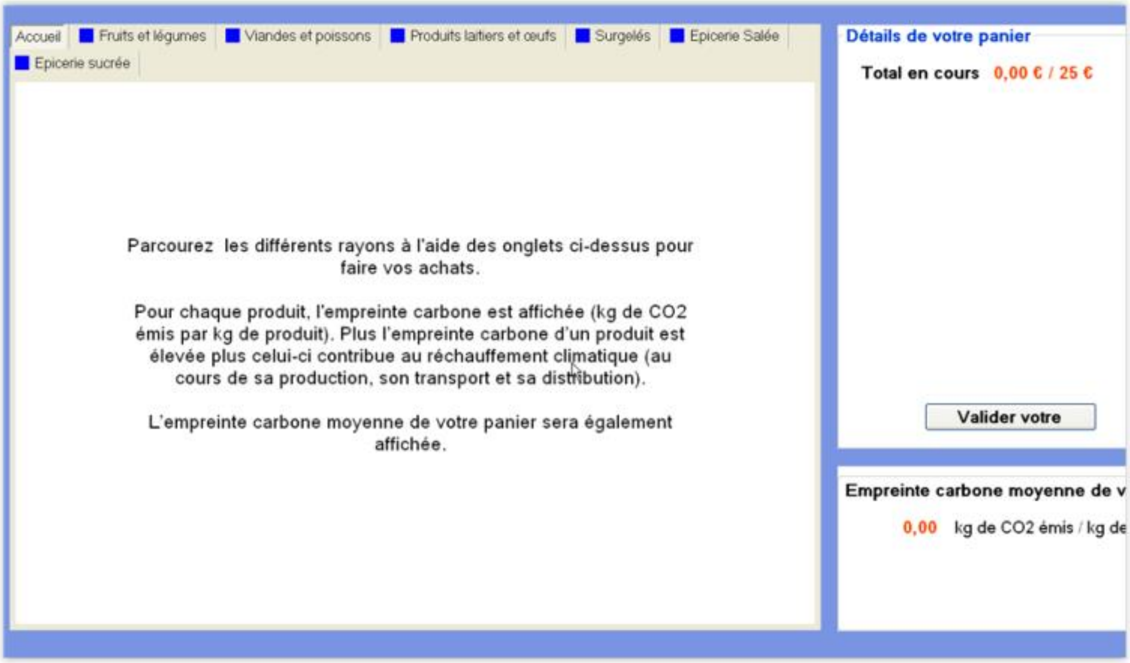
Product Numerical Footprint Condition

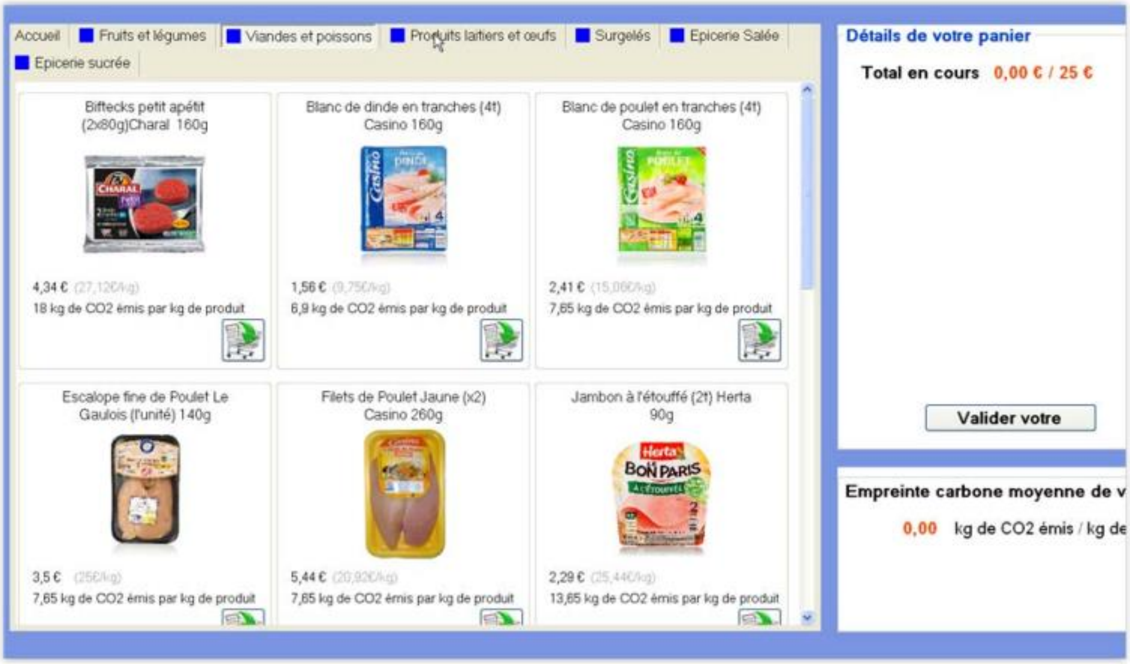




Appendix C

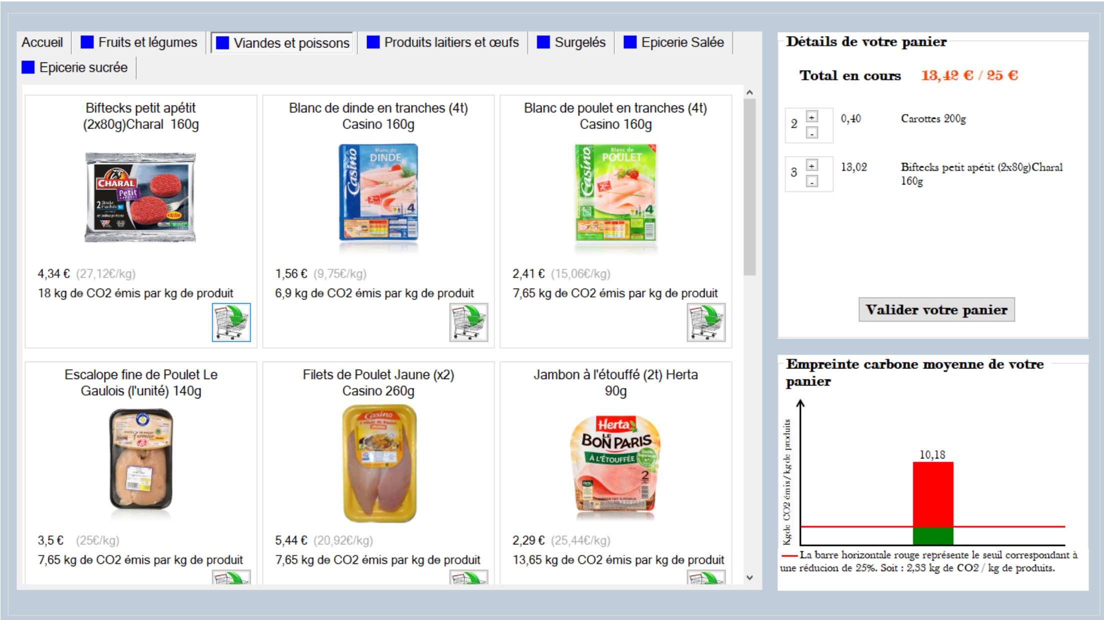
Numerical Product & Basket Footprint Condition





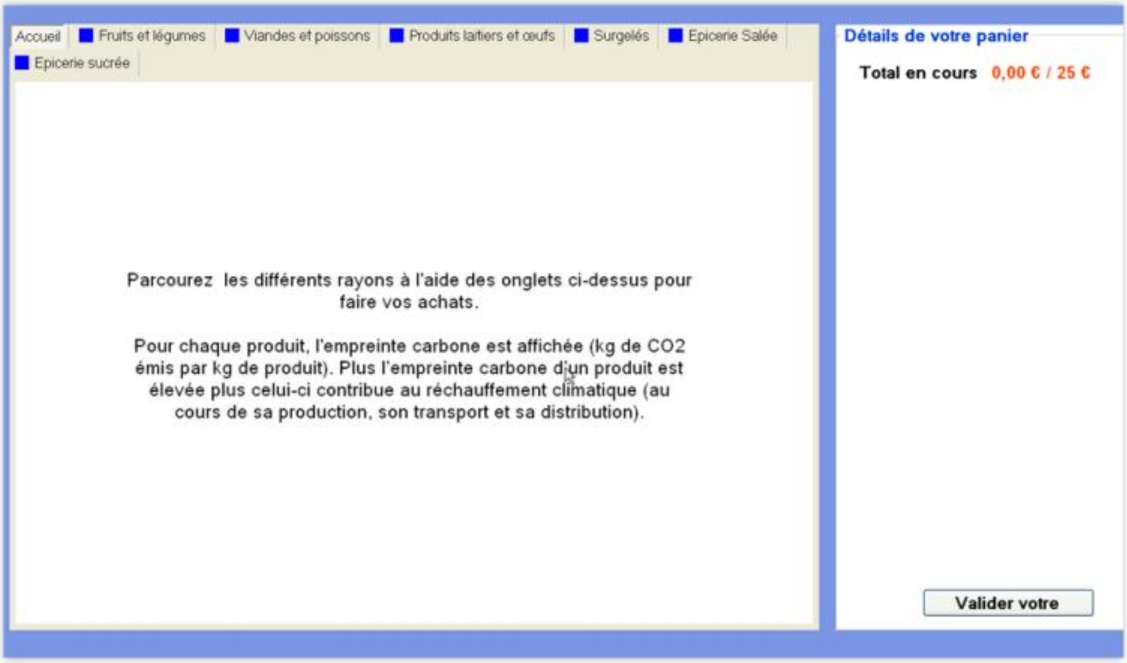
Appendix D

Graphical Thermometer Goal Setting Condition with Example of a Basket Exceeding Sustainable Threshold



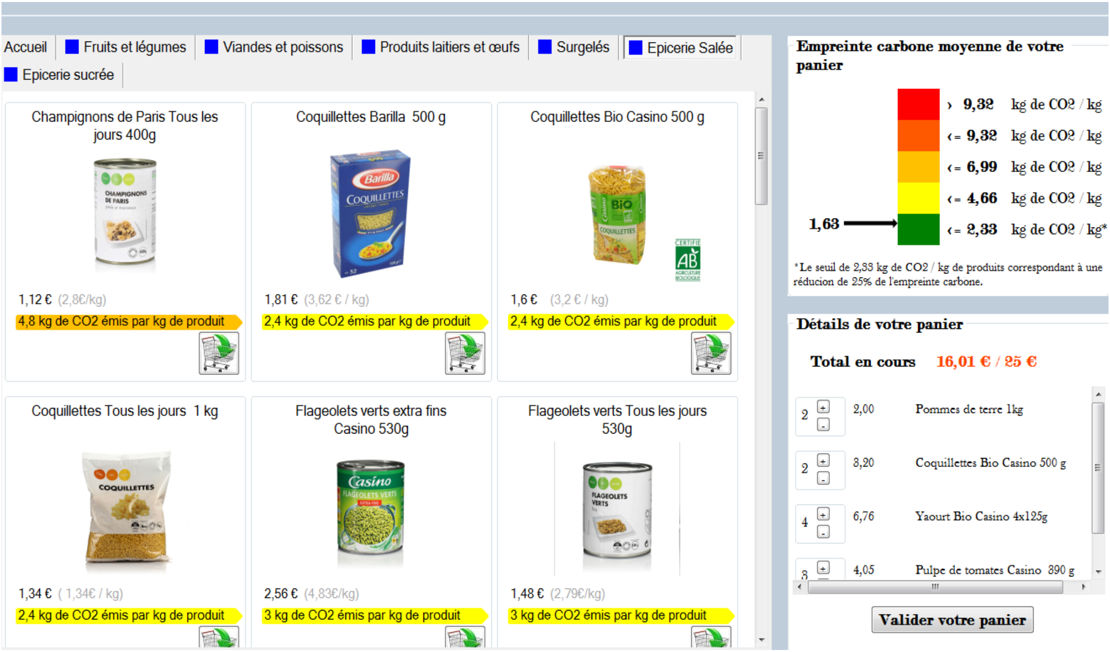
Appendix E

Colour Coded Product Numerical Footprint Condition



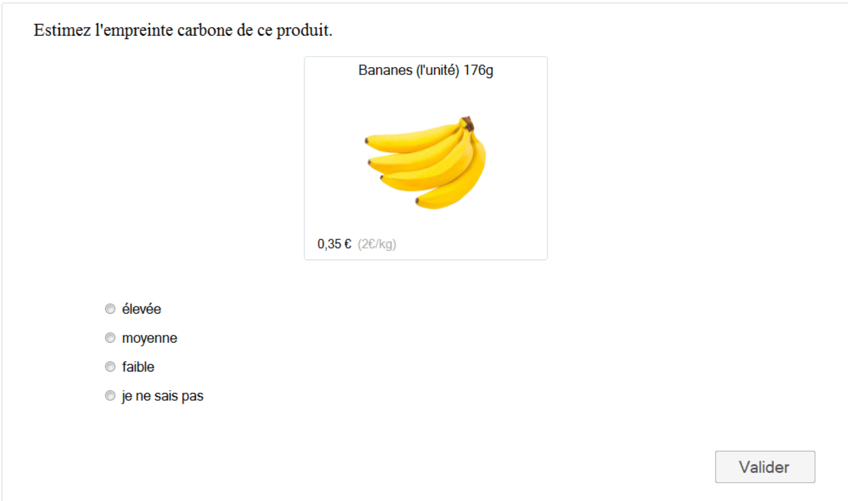
Appendix F

Multi-coloured Thermometer Goal Setting Condition with Example of a Shopping Basket Respecting the Sustainable Level



Appendix G

Example of an Item In Carbon Footprint Knowledge Survey



Estimez l'empreinte carbone de ce produit.

Bananes (l'unité) 176g

0,35 € (2€/kg)

- élevée
- moyenne
- faible
- je ne sais pas

Valider