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Traffic light labelling of meals to promote sustainable consumption and healthy eating

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ABSTRACT

The focus of the present study is to examine the impact of behavioral interventions designed to encourage consumer change around food choices in line with more sustainable consumption as well as healthy eating. More specifically, as a potential method of persuasion, we test the effect of the provision of information using traffic light labelling attached to different meal options signalling their impact on the environment (e.g. carbon emission levels) as well as on their health (e.g., calorific content). While traffic light labelling has shown some success in encouraging both healthy and sustainable food consumption, there is still limited work demonstrating the impact on choice behavior. The present study includes two experiments (Experiment 1, N = 120 [approximately 40 per condition], Experiment 2, N = 297 [approximately 95 per condition]). They examined the impact of the presentation of single (traffic light labelling of calorific content, traffic light labelling of carbon emission levels) and dual (both calorific content and carbon emission levels) traffic light labels in a hypothetical simulated canteen environment. For some participants, the traffic light labels were supplemented with additional information which either contained general information regarding calorific content and carbon emissions, or specific reference values regarding the relationship between particular calorific or carbon emission levels to other activities (i.e. walking, driving). The Results from both experiments show that, compared to baseline, the presence of traffic light labels led to positive shifts towards lower carbon emission and lower calorific content meals. Both general and specific information supported positive behavioral change towards healthier and sustainable meal choices. The findings are discussed in relation to existing work examining the impact of behavioral interventions designed to support positive change in consumer behavior.

1. Introduction

The present article presents work designed to inform research in the area of behavioral change towards sustainable consumption (e.g., environmentally sustainable "green food", organically grown foods, locally produced foods, limited carbon emission foods). There is considerable work showing that, when surveyed, people show a positive attitude towards changing dietary habits in line with more sustainable options (e.g., reducing meat consumption) (Alves & Edwards, 2008; Grimmer & Miles, 2017), but when examining patterns of behavior (e.g., actual meat consumption), there is limited evidence to suggest corresponding changes in that behavior (Carringdon, Neville, & Whitwell, 2010; Rees et al., 2018; Stubbs, Scott, & Duarte, 2018). The present study includes two hypothetical choice experiments designed to investigate the impact of simple traffic light food labelling methods as a potential behavioral change technique for achieving positive behavior change towards sustainable consumption.

1.1. Sustainable consumption

The production and consumption of food is responsible for around 30% of total European greenhouse gas emissions (European Comission, 2006). One way of significantly lowering carbon emissions that contribute to the greenhouse effect is to change individual consumption patterns away from resource intensive foods such as meat and dairy (Westhoek et al., 2014). For this reason, encouraging environmentally conscious food decisions at the consumer level has been an important target for behavioral change (e.g., Carfora, Caso, & Conner, 2017; Grimmer & Miles, 2017; O'Neill & Hulme, 2009; for a recent review see; Stoll-Kleemann & Schmidt, 2017).

Research exploring sustainable consumption, via behavioral change, has largely been developed from Azjen's (1991) Theory of Planned Behavior (TPB). TPB asserts that there are components (attitudes, subjective norms, perceived behavioral control) that directly determine intentions, which in turn determine behavior (e.g. Carfora et al., 2017; Rees et al., 2018; Vermeir & Verbeke, 2008). For instance, Terlau and Hirsch (2015) use TPB to explain survey responses examining attitudes towards sustainability. They suggest that the responses often reflect a need to comply with accepted social norms (Carrington et al., 2010; Godfrey & Feng, 2017); this refers to the relationship between attitudes and subjective norms in TPB. In practice, positive attitudes towards sustainable food consumption are not reflected in intentions (Grimmer & Miles, 2017; Vermeir & Verbeke, 2006) or in actual behavior (Carrington et al., 2010; Rees et al., 2018; Stubbs et al., 2018). This is

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often because consumer purchasing decisions are informed by a number of complex individual and social factors (Murcott, 2019), many of which pertain to behavioral control, another key component of TBP. In the context of sustainable consumption, behavioral control refers to the ease or difficulty of obtaining or consuming a specific product (Vermeir & Verbeke, 2006, 2008). While there is a willingness to adopt changes in purchasing behavior, consumers may struggle to do so because of low availability of sustainable food items, or because they perceive that their behavior has limited personal impact in addressing a complex global issue (Gilg, Barr, & Ford, 2005; Graham & Abrahamse, 2017; Rees et al., 2018; Van Loo, Hoefkens, & Verbeke, 2017).

1.2. Barriers to sustainable consumption

Several reasons have been proposed for the apparent difficulty in translating consumer's general acknowledgement of the importance in targeting issues of sustainability into actual changes in food habits (Grimmer & Miles, 2017). One main reason is that consumers appear to be largely unaware of the significant impact of their personal food choices (e.g., red meat consumption) on increasing greenhouse gas emissions (Feucht & Zander, 2017; Macdiarmid, Douglas, & Campbell, 2016; Sharp & Wheeler, 2013). As a corollary to this, several studies point to the importance of perceived consumer effectiveness (PCE); PCE refers to the extent to which the consumer believes that his personal efforts can contribute to the solution of a problem (Vermeir & Verbeke, 2006). In support, evidence shows that consumers typically report that changing their behavior would have a limited impact on reducing greenhouse emissions (e.g., Graham & Abrahamse, 2017; Rees et al., 2018; Van Loo et al., 2017). In turn, this may also explain a consistent lack of motivation consumers show towards adopting pro-environmental consumption habits (Ellen, Weiner, & Cobb-Walgren, 1991; Guyader, Ottosson, & Witell, 2017; Stoll-Kleemann & Schmidt, 2017; Straughan & Roberts, 1999; Stubbs et al., 2018; Vermeir & Verbeke, 2006). A reason for this that has been proposed is that consumers underestimate the causal relationship between their personal food consumption habits, and the direct effects their habits have on the environment (Feucht & Zander, 2017; Lea & Worsley, 2008; Spaargaren, van Koppen, Janssen, Hendriksen, & Kolfschoten, 2013).

Another barrier to pro-environmental consumption habits is that consumers may treat sustainability as a less salient factor as compared to the many other factors (e.g., healthy eating, price, taste, availability, social trends) that inform, and influence their food choices (Alves & Edwards, 2008; Stubbs et al., 2018). Recent work examining the types of factors that consumers prioritise in their decision-making has shown that personal health goals tend to compete with, and have a greater influence over food choices than environmental concerns (e.g., Feucht & Zander, 2017; Wellesley, Happer, & Froggatt, 2015).

1.3. Methods for overcoming barriers to sustainable consumption

One approach taken to overcoming the aforementioned barriers to adopting sustainable consumption habits is information provision. This is aimed at increasing consumer awareness, knowledge, and understanding of sustainable consumption. One example used to achieve this is marketing campaigns and education programs. Such methods have been a useful tool for shaping attitudes in a variety of contexts (Michie et al., 2013; BIO Intelligence Service, 2012); though they don't guarantee reliable and sustainable behavioral change (Murcott, 2019; Osman & Nelson, under review). Feucht and Zander (2017) propose that presenting the information at the point of sale maximises the impact it can have in being attended to and in influencing behavior, because it can be integrated into the choices that consumers make at the time of purchase.

One example of a product label that has been developed to signal items that are pro-environmental consumption is the 'green' product labelling system (e.g., Carfora et al., 2017; Filimonau, Lemmer, Marshall, & Bejjani, 2017; Guyader et al., 2017; Lehner, Mont, & Heiskanen, 2016; Olofdotter & Juul, 2008; Röös & Tjärnemo, 2011; Young, Hwang, Mcdonald, & Oates, 2009). Consumers show favourable attitudes towards the label and their subjective judgments indicate that they find it useful when deciding what to buy (e.g., Filimonau et al., 2017; Pelletier, Sullivan, Wilson, Webb, & Egger, 2016, Röös & Tjärnemo, 2011; Upham & Bleda, 2009). An example of a green labelling system that is used in the UK is the 'Carbon Footprint' label (see Fig. 1). It is the most widely used product labelling method that indicates the impact of food on climate change. It does this by presenting the total greenhouse gas emissions produced during a products life-cycle, measured in tonnes of carbon dioxide equivalent (tCO2e) (CarbonTrust, 2008). However, while there is evidence to suggest that consumers are aware of this type of product label, and subjectively report using the information, objective measures suggest that it has had limited impact on actual changes in consumption behavior (Grunert, Hieke, & Wills, 2014; Hornibrook, May, & Fearne, 2013).

Fig. 1. The carbon trust footprint.

One reason for the limited success with 'Carbon Footprint' labelling is that consumers have reported that they find it confusing and difficult to interpret (Gadema & Oglethorpe, 2011; Sharp & Wheeler, 2013). This is consistent with findings from studies examining similar labelling systems on consumers understanding. The studies report that consumers have difficulty identifying the causal impact that their personal food choices have in reducing overall carbon emissions based on the labels they are presented (Feucht & Zander, 2017; Lea & Worsley, 2008; Spaargaren et al., 2013). For example, when consumers are informed that a product has, for example, a Carbon Footprint of 100 g CO2e, consumers report uncertainty as to how to translate this into whether the value indicated low or high emission levels (Beattie & Sale, 2009; Upham, Dendler, & Bleda, 2011). To overcome this, one approach that has had some success is the implementation of a traffic light color scheme (e.g., red, amber, green). Work has shown that the colors are intuitively understandable because consumers instantly recognise that a red label indicates a 'bad' choice and a green label indicates a 'good' choice (Signal et al., 2008). Furthermore, a system like this enables the consumers to make easy comparisons between food products on the same dimension (e.g., carbon emission levels, healthy eating) (Sharp & Wheeler, 2013).

Several studies exploring the use of traffic light labels in nutrition labelling, such as calorific content of meal, have shown that the labels encourage healthier food choices (e.g., Cecchini & Warin, 2016; Graham & Jeffery, 2011; Thorndike, Riis, Sonnenber, & Levy, 2014; VanEpps, Downs, & Loewenstein, 2016). A similar positive pattern has been reported in studies investigating traffic light labelling of carbon emissions on increases in greener food choices (Spaargaren et al., 2013; Vanclay et al., 2011; Vlaeminck, Jiang, & Vranken, 2014).

Although the implementation of traffic light labelling as a way to inform the consumer about the impact of food products on the environment has had some success, several researchers have identified

ways in which this type of information provision can be improved (Spaargaren et al., 2013; Tan, Tan, & Kohh, 2014). For example, Spaargaren et al. (2013) reported that traffic light carbon emission labels on food products have contributed to minor reductions (3%) in carbon emission levels overall. To understand the reasons for this, Spaargaren et al. (2013) consumer focus groups revealed that they had a low PCE because they felt that other factors such as transportation had a higher impact on carbon emission levels than their own food choices. Spaargaren et al. (2013) proposed that a better approach is needed so that consumers can understand clearly how their meal choices impact climate change, such as the use of reference values. The same issue has been raised in studies examining consumer understanding of calorie information through nutritional traffic light labelling (e.g., Elbel, 2011). Dowray, Swartz, Braxton, and Viera (2013) examined the impact of adding a reference value in the form of physical activity associated with calorie expenditure. The reference values presented the average minutes or miles of walking needed to expend calories in association with the traffic light labels. Dowray et al. (2013) found that this manipulation significantly reduced calorie consumption when compared to simple traffic light labels indicating low, medium and high calorific content of food items. The presence of reference values enabled consumers to make relative comparisons as well as to translate their purchasing choices into actual physical outcomes (Dowray et al., 2013; Swartz, Dowray, Braxton, Mihas, & Viera, 2013). Given the positive influence of reference values in conjunction with traffic light labelling in the nutritional domain, the positive effects may generalise to the domain of sustainable consumption, however, thus far, few studies have explored the effectiveness of reference values in this domain.

Traffic light labelling indicating carbon emission levels of food products has been used as a method of information provision to help increase consumer awareness around the subject, and to motivate behavioral change. Along with low PCE, and low motivation, another barrier to effective sustainable consumption is the prioritisation of personal health over sustainability (Feucht & Zander, 2017; Wellesley et al., 2015). To examine this, a recent study compared the impact of dual labelling (e.g. nutritional labelling – low to high nutritional content, environmentally friendly labelling – low to high greener choices) of food products on consumer choices (Pelletier et al., 2016). Pelletier et al. (2016) reported a positive trend towards greener choices when both label types were presented together compared to no labelling of the same products. However, the study did not compare the relative impact of dual labelling on food choices against single traffic light labelling of healthy only, and green only, food choices. Without a comparison of this kind, ambiguity remains in determining the extent to which the choices consumers made were based on incorporating both health and sustainable consumption, or whether consumers focussed more on one factor over another when both labels were presented.

1.4. Present study

Several factors have been identified as psychological barriers that prevent consumers from changing their behavior towards more sustainable consumption, these include: 1) a lack of understanding of the issues of sustainability; 2) low PCE that in turn reduces motivation for change; 3) competition from alternative salient goals such personal health. One approach to targeting these barriers is through the provision of information. One method of information provision which has been empirically investigated is traffic light labelling of food products communicating the products' associated level of carbon emissions. Two areas for which there is limited empirical evidence are: 1) the extent to which further information is needed to supplement traffic light labelling, such as the presentation of reference values, 2) the extent to which health is traded off against environmental concerns when making consumer choices. To address both, the present study investigates the impact of single (either nutritional value-*calorific content* or sustainable consumption-*carbon emission levels*) vs. dual traffic (both nutritional value and sustainable consumption) light labelling on meal choices, and manipulates the presence and absence of references point values in both single and dual labelling methods. Experiment 1 was a 3 (traffic light label types: single nutritional traffic light food labelling, single sustainable consumption traffic light food labelling, dual traffic light food labelling) x 3 (information content: baseline – no explicit information, general information, specific reference point value information) design, and Experiment 2 was a replication study. Based on previous work, Experiment 1 and Experiment 2 were designed to test the following hypotheses:

Hypothesis 1. In line with previous work (Filimonau et al., 2017; Slapo, 2016; Vanclay et al., 2011; Vlaeminck et al., 2014), compared to a baseline in which no explicit information on traffic light labels is presented, in the presence of information aligning the labels (red, amber, green) to sustainable consumption, meal choices should increase towards preference for low carbon emission meals.

Hypothesis 2. In line with previous work (Dowray et al., 2013), compared to traffic light labels with general information about sustainable consumption, the addition of information containing specific reference values will increase choices for low carbon emission meals.

Hypothesis 3. In line with previous work (Feucht & Zander, 2017; Wellesley et al., 2015), there should be greater changes towards meal options for traffic light labelling regarding nutritional content compared to sustainable consumption.

Hypothesis 4. In line with previous work (Pelletier et al., 2016), the presentation of dual traffic light labelling of meal choices, that indicate *both* the level of sustainability and level of nutrition, will lead to greater shifts in positive behavioral change for both, compared to the single traffic light labelling of the same meal choices with either one benefit (sustainable consumption or health).

2. Experiment 1

Experiment 1 was designed to test hypotheses 1–4 in a hypothetical choice environment in which participants were required to select meals in a simulated lunch time canteen set-up. Basic questions regarding demographics, and general attitudes towards health and sustainability were collected along with choices prior to and during the presentation of traffic light labels. The labels contained information regarding the level of nutritional content of the meal options, and level of carbon emissions associated with each meal option. In addition, supplementary information presented alongside traffic light labels (e.g., general information, specific information – reference values) was examined as a potential way to enhance the impact of traffic light labels in supporting positive behavioral change towards sustainable consumption and healthy eating.

2.1. Method

Participants: Participants were English speaking (first language), over 18, and were non-vegan; the meal choices included in the experiment were only suitable for vegetarians, pescaterians, and omnivores. A total of 120 participants (84 Females and 36 Males) were recruited to take part, with a mean age of $M = 26.6$ ($SD = 9.22$), with a range of 19–64 years. Approximately 40 participants in each of the three between-subject conditions. Participants were recruited using an opportunistic sampling method. They were asked to follow a link that was presented to them via social media sites, and if they were interested, they then followed the link that would take them to a 5-min experiment investigating food choices. Participants did not receive payment for taking part in the experiment.

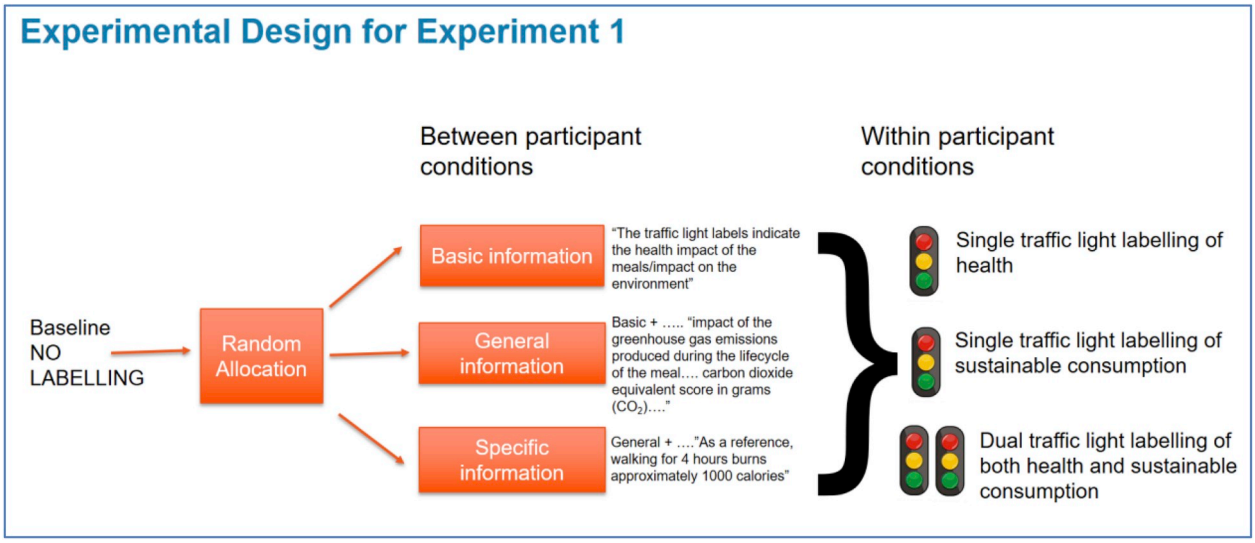

Fig. 2. Graphical presentation of the design of Experiment 1.

Ethical statement. The experiment received ethics approval from the University College London Research Ethics Committee (13323/001). Prior to taking part, participants were informed about the basic requirements of the study, and that they had the right to withdraw at any time, and were asked to provide their consent before being presented the experiment. When complete, all responses from participants were anonymised.

Design: A 3 within (traffic light label types: single nutritional traffic light food labelling, single sustainable consumption traffic light food labelling, dual traffic light food labelling) x 3 between (information content: basic information, general information, specific reference point value information) design was implemented. For an outline of the basic set up of Experiment 1 see Fig. 2.

All participants were required to answer a total of 30 questions (3 demographic questions, 20 forced choice questions, 4 general judgment questions, 3 specific judgment questions) to complete the experiment.

Demographic Questions: Participants were presented with three basic demographic questions regarding their age (that they typed into a text box), gender (selecting from the following options, male, female, other (specify), prefer not to say), and their dietary habits (i.e. omnivore, pescatarian, vegetarian, vegan). Though initial screening during recruitment informed participants about the eligibility to take part in the experiment (i.e. non-vegans only), some participants nevertheless still took part even though they were no eligible. In anticipation of this, participants were also required to indicate their dietary habits, which included the option of vegan. If they indicated that they were vegan, participants were directed towards a screen thanking them for their interest in their experiment and an explanation regarding why they could no longer continue with the experiment.

Forced-choice Questions: Once completed, participants were presented with the main part of the experiment in which there were presented with a total of 20 trials, blocked into 4 ([1] Baseline – no labelling, [2] Single nutritional traffic light food labelling, [3] Single sustainable consumption traffic light food labelling, [4] Dual traffic light food labelling) (see Fig. 2). In each block participants were asked "Please select the option you would most likely choose in the canteen each day". They were presented with 4 meal options from a hypothetical canteen for each simulated working day of the week (5 days) (See Fig. 3), for which the dependent variable was the meal they had selected that day.

General Judgment Questions: After the presentation of the three demographic questions participants were presented with 4 judgment questions. These were designed to ascertain participants' concern for health and environmental issues. They were asked to judge the extent to which they agreed with the following four statements: 1) on a scale of 1 (not at all important) to 10 (extremely important); '*I care about the environment*', '*I regularly take action to reduce my carbon footprint*', '*I care about being physically healthy*' and '*I regularly take action to improve my health*'. These items were based on previous work from which the scales were based (Bissonnette & Contento, 2001; Sinatra, Kardash, Taasoobshirazi, & Lombardi, 2012).

Specific Judgment Questions: For the three main experimental blocks of the experiment (Single nutritional traffic light food labelling, Single sustainable consumption traffic light food labelling, Dual traffic light food labelling) information corresponding to the traffic light labels was presented, after which participants made each of their meal choices for the week, and were then asked to respond to the question: "To what extent did you use the additional labelling to inform your decisions?" on a scale from 0 (not at all) to 10 (entirely).

Materials: There were two critical components regarding the preparation of materials for both experiments, the allocation of the color coding (red, amber, green) of the 20 meal options that participants were choosing from, and the level of information they were presented that accompanied the traffic light labelling scheme (Basic information, General information, and specific reference value information).

Allocation of color coding of meal options: The options per day contained meals that were of a similar type (e.g., variations on a theme of pasta, sandwich, curry etc …), and were likely meal options that would appear in lunch time canteens (See Table 1). At least one meal option per simulated day was vegetarian. Introducing more than one vegetarian option per day was not possible given the other key criteria that were imposed in order to generate the meal options. The criteria that were applied in order to implement the traffic light labelling methods involved finding estimates of calorific content of meal options, along with their associated carbon emission levels.

In general, the estimated recommended calorie intake of an average meal at lunch time is between 501 and 799 calories. The estimated moderate level of carbon emissions associated with a meal ranges between 501 and 1299 (gCO2e). Based on these estimates, as well as the extreme ends of the scale of calorie content, and carbon emission levels of typical meals in a lunch time canteen, we established the following: Nutritional content of meal options labelled red = / > 750 calories, amber = 501–749 calories, green = / < 500 calories. Sustainable consumption of meal options labelled as red = / > 1300 g CO2e, amber = 501 g–1299 g CO2e, green > 500 g CO2e. From this it was possible to generate the meal options (see Table 1) for each day, from

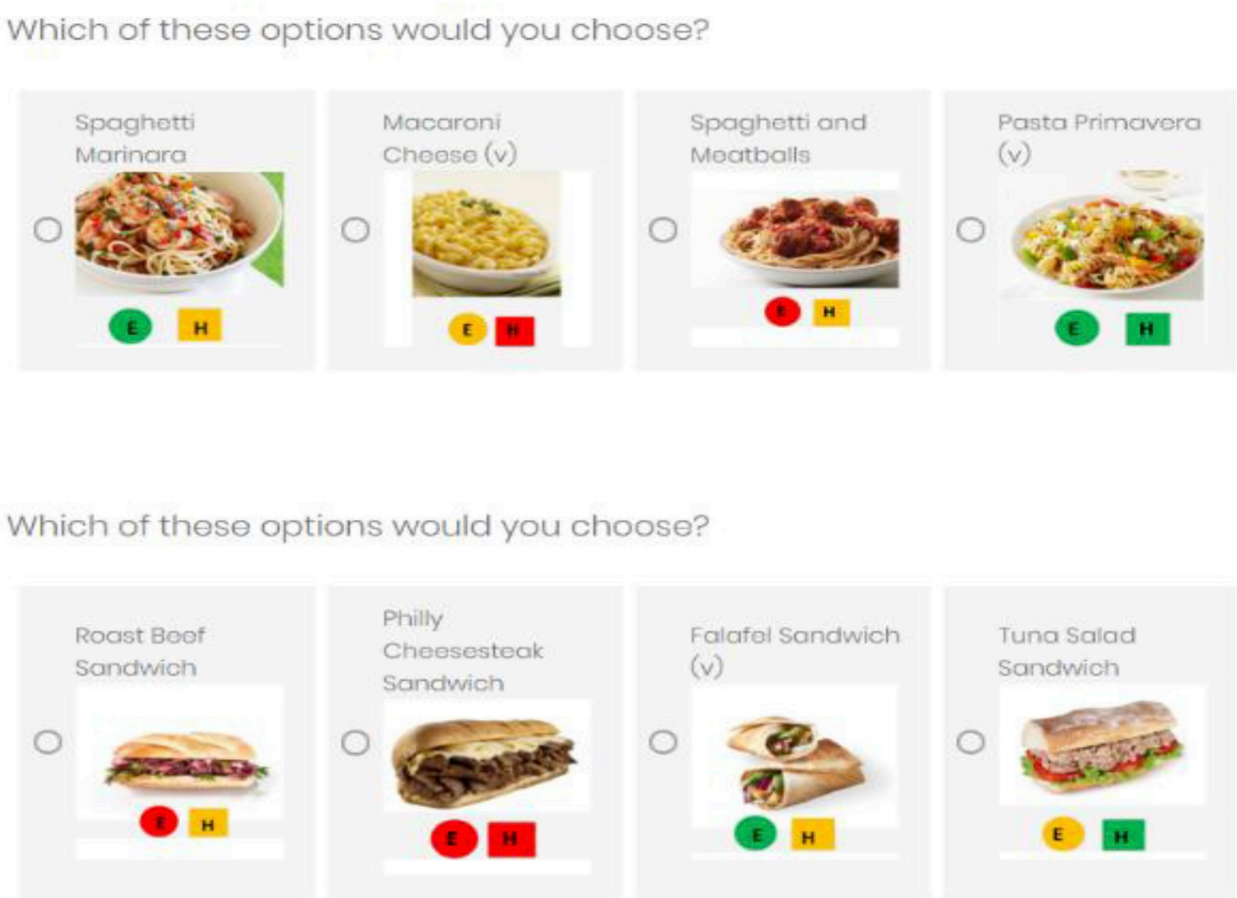

Fig. 3. Screenshot of the forced choice trials for two meal choice days under dual traffic light label trials in Experiment 1 and 2.[1].

which we could allocate the corresponding traffic light labels (red, amber, green). We were unable to ensure that the same number of meal options allocated as red, green, and amber were held constant for each day (e.g. 1 red, 2 amber, 1 green), and not all days had the same distribution of red, amber and green options. Nevertheless, each day had at least 1 red, 1 amber and 1 green meal option. With these exceptions, the criteria we developed to generate the materials for the experiment were sufficient to detect potential changes in meal choices in response to the manipulations we introduced.

Basic information, General information and Specific reference value information: For the basic information condition for single nutritional traffic light food labelling trials participants were informed 'The traffic light labels indicate the health impact of the meal' and for the single sustainable traffic light food labelling trials 'The traffic light labels indicate the impact of the meal on the environment'. When presented with the dual traffic light food labelling trials both nutritional content and sustainable consumption statements were displayed.

For the General Information condition, participants were provided with the basic level information as well as additional information (see Fig. 2). To illustrate, for the single sustainable traffic light food labelling trials participants were also told, '*The traffic light labels indicate the impact of the greenhouse gas emissions produced during the lifecycle of the meal. This is conveyed as a carbon dioxide equivalent score in grams (CO_2e)*', they were also informed about the CO_2e values of each meal option. For the dual traffic light food labelling trials participants were presented with both sets of general information (i.e. nutritional and sustainable consumption).

For the Specific Information condition, participants were given exactly the same information as those in the 'General Information' condition but were also given a reference value. To illustrate, for the single sustainable consumption traffic light food labelling trials participants were also told '*As a reference, 2000g CO2e is approximately equal to driving 11 miles in a car or boiling a kettle 89 times*'. For the dual traffic light food labelling trials participants were presented with both sets of reference value information (i.e. nutritional and sustainable consumption).

Procedure: In the main part of the experiment participants were asked to imagine themselves in a typical university or workplace canteen at lunchtime. For each simulated day they were presented with photographs of four meal options and asked to choose the option they would most likely pick on a typical day. This was repeated five times, with different meal options, to represent a typical working week eating in the canteen (see Table 1). Each participant saw the same meal options but the order in which the trials were presented was randomised to avoid order effects. In each experimental condition, red, amber or green labels were added to each meal. Depending on which condition (basic, general, specific) participants were allocated to, they were then presented with the same meal options for each of the 5 days for the single nutritional traffic light food labelling block, single sustainable consumption traffic light food labelling block, and the dual traffic light labelling block (see Fig. 2). After they made their choices for each day, at the end of each block they were presented with a specific judgment question for which they indicated the extent to which they considered the information provided, in addition to the traffic light labels,

[1] Photographs of meals were collected from online image searches. Descriptions of the meals were added above the photographs (e.g. Vegetable Curry (v)). Red, amber or green labels were added below the photograph of the meal corresponding to the nutritional food traffic light labelling scheme, and/or the sustainable consumption food traffic light labelling scheme.

Table 1
Details of the allocation of the traffic labelling color scheme for each meal option presented for each of the 5 days of the week in both Experiment 1 and 2.1

	Day of the Week				
Labelling Context	Day 1	Day 2	Day 3	Day 4	Day 5
	Beef, Bean and Cheese Burrito	Roast Beef Sandwich	Beef in Black Bean Curry	Bacon and Cheese Omelette	Spaghetti and Meatballs Pasta
Nutrition Environment	Red Red	Amber Red	Amber Red	Red Red	Amber Red
	Vegetable, Bean and Cheese Burrito (V)	Falafel Sandwich (V)	Chicken Tikka Masala Curry	Bacon Omelette	Pasta Primavera (vegetables) (V)
Nutrition Environment	Amber Amber	Amber Green	Red Amber	Amber Amber	Green Green
	Chicken, Bean and Cheese Burrito	Tuna Sandwich	Vegetable Curry (V)	Vegetable and Cheese Omelette (V)	Macaroni cheese pasta (V)
Nutrition Environment	Amber Amber	Green Amber	Green Amber	Green Red	Red Amber
	Chicken and Vegetable Burrito	Philly (with beef) cheese Sandwich	Tofu Curry (V)	Vegetable Omelette (V)	Spaghetti Marinara (seafood)
Nutrition Environment	Green Green	Red Red	Green Green	Green Green	Amber Green

informed their decisions (indicating their responses on a scale from 0 not at all to 10 entirely). The order of the blocks was randomised for each participant. Once they had completed all 4 blocks, they were informed that the experiment was complete, and then thanked for their time.

Scoring procedures: *Scoring of forced choice responses*: In order to measure hypothetical choice behavior regarding meal choices, each meal was given a score; a red label = 1, amber label = 2, and a green label = 3. This was done separately for single nutritional traffic light food labelling scores and single sustainable consumption traffic light food labelling scores. Scores for each of the five meal choices were combined to give an overall score that could range between 5 and 15, with a higher score indicating more sustainable consumption/nutritional choices. This process of scoring was applied for each of the three main experimental blocks, single nutritional traffic light food labelling, single sustainable consumption traffic light food labelling and dual traffic light food labelling. For the first block in which no information regarding labelling of the traffic light system was presented, the meal options selected were separately scored according to nutritional content, and sustainable consumption in order to assess the extent to which free choices made prior to the introduction of manipulations were healthy and sustainable. To ensure that the scoring enabled fair comparisons, and given that the options for vegetarians and pescatarians were limited as compared to omnivores (Experiment 1, N = 101), we restricted our analyses to only omnivores.[2]

Scoring to test for Hypothesis 2: To address Hypothesis 2, difference scores were calculated. This involved subtracting baseline scores from scores in the single sustainable consumption traffic light food labelling block. These were used to carry out a Univariate analysis with information type as the between subject factor (Basic information, General Information, Specific information).[3]

Scoring to test for Hypothesis 3: The same scoring method and statistical analysis used to test Hypothesis 2, was also used to test Hypothesis 3, this time applied to nutritional meal choices.

Scoring to test for Hypothesis 4: In order to examine Hypothesis 4, meal choices for the dual traffic light food labelling block were scored separately according to nutrition and sustainable consumption to determine the extent to which meal options were influenced by the two different label types. The scores were then subtracted from Block 1,

[2] Although not included in the main analyses, there were a total of 45 pescatarians and vegetarians from Experiment 1 and 2 that were excluded. After establishing that there were no significant differences between Experiment 1 and 2, the responses from the 45 participants were collapsed across experiment

(*footnote continued*)
to run simple t-tests to determine if the use of traffic light food labelling impacted changes in meal options for Day 5 which met the conditions for both dietary types (i.e. that there was enough of a selection for both). A paired *t*-test compared the baseline trial ($M = 2.27$, $SD = 0.94$) (scored based on nutrition) with the nutrition traffic light food labelling Day 5 ($M = 2.53$, $SD = 0.79$), $t(44) = 2.29$, $p < .05$, $d = 30$ (small effect). Also, a paired *t*-test compared the baseline trial ($M = 2.62$, $SD = 0.53$) (scored based on sustainable consumption) with the sustainable consumption traffic light food labelling Day 5 ($M = 2.77$, $SD = 0.47$), $t(44) = 2.46$, $p < .05$, $d = 30$ (small effect). Both analyses suggest that food labelling for both nutrition and sustainable consumption positively shifted meal choices towards lower calorific content, and low carbon emissions. These findings are in line with the findings reported in the main Results sections.

[3] For a demonstration of the validity of using difference scores and their reliability see Trafimow (2015).

Table 2
Mean choices (scored according to sustainability) according to the traffic light labelling manipulations for sustainable consumption for each condition (Basic, General, Specific information) and by experiment (Experiment 1 and Experiment 2).

Experiment	Condition	No Traffic Light label	SINGLE Traffic light labelling	DUAL Traffic light labelling
Experiment 1 (N = 101)	Basic	**10.14** *(SD = 2.17)*	**11.17** *(SD = 1.58)*	**12.86** *(SD = 2.17)*
	General	**10.00** *(SD = 1.89)*	**12.09** *(SD = 1.93)*	**12.24** *(SD = 1.91)*
	Specific	**10.28** *(SD = 1.84)*	**12.47** *(SD = 2.01)*	**12.46** *(SD = 2.03)*
Experiment 2 (N = 273)	Basic	**9.18** *(SD = 1.81)*	**10.12** *(SD = 2.06)*	**11.00** *(SD = 2.32)*
	General	**9.18** *(SD = 1.91)*	**11.33** *(SD = 2.33)*	**11.37** *(SD = 2.42)*
	Specific	**9.01** *(SD = 1.90)*	**10.64** *(SD = 2.70)*	**11.00** *(SD = 2.59)*

which was the baseline block.

3. Results

This section will be divided into four sections, each presenting analyses that directly address the four hypotheses. The main statistical tests performed on the data were t-tests, and analysis of variance.

Hypothesis 1: The findings provide support for Hypothesis 1, suggesting that the presence of traffic light labels promoted positive behavioral change in line with sustainable consumption. To show this we first performed a simple paired sample *t*-test in which the scores from Block 1 (baseline no information of traffic light food labels) were compared with the Single sustainable consumptions traffic light food labelling Block (see Table 2 for specific break down by condition). Experiment 1 revealed a significant shift towards low carbon emission meals ($M = 11.87$, $SD = 1.91$) from baseline ($M = 10.14$, $SD = 1.96$), $t(101) = 9.83$, $p < .0005$, $d = 0.89$ (large effect).

Alongside these analyses we also examined the extent to which the traffic light labelling of nutrition impacted meal choices. This was done in order to examine the extent to which our traffic light procedure generated positive behavioral change in line with previous studies in this domain (e.g., Cecchini & Warin, 2016; Graham & Jeffery, 2011; Thorndike, Riis, Sonnenberg, & Levy, 2014; VanEpps et al., 2016). We conducted the same analyses but this time comparing scores from Block 1 with the Single nutritional traffic light labelling Block (see Table 3 for specific break down by condition). The analysis revealed a significant shift towards lower calorific content meals ($M = 11.89$, $SD = 2.31$) from baseline ($M = 10.34$, $SD = 2.15$), $t(101) = 8.75$, $p < .0005$, $d = 0.69$ (medium effect). Consistent with previous evidence, the findings from Experiment 1 suggest that the traffic light labelling system used successfully achieved positive changes in choices towards more nutritional meal choices.

Hypothesis 2. Our findings did not support Hypothesis 2. Compared to basic information, the presence of additional information (general, specific) in general encouraged a positive shift towards meals choices that have low carbon emission. To show this, before carrying out the analyses, skewness (.80, SE = .24) and kurtosis (1.09, SE = .47) of the difference scores were assessed and were found to be within acceptable bounds (Bulmer, 1979) to conduct t-tests. Experiment 1 revealed a main effect of information type (Basic $M = 1.03$, $SD = 1.38$; General $M = 2.03$, $SD = 2.08$; Specific $M = 2.19$, $SD = 1.60$) on meal option scores, $F(2, 101) = 4.06$, $p < .01$, partial eta = .09 (small effect). Applying Bonferroni correction, *t*-test comparisons revealed that compared to basic information, the presentation of general information positively shifted choices towards low carbon emission meals, $t(67) = 2.49$, $p < .04$, $d = .57$ (medium effect), as did the presentation of specific information, $t(65) = 3.19$, $p < .01$, $d = .77$ (large effect), with no significant difference between general and specific conditions, $t(64) = .35$, $p = .73$.

Hypothesis 3. Overall, the findings did not provide support for Hypothesis 3, instead they suggest that there was no main difference in the magnitude of positive change on meal choices towards nutritional meals and sustainable meals. To show this, first of all, tests of skewness and normality were assessed and found to be within acceptable bounds: skewness (.63, SE = .24) and kurtosis (.60, SE = .47). To examine Hypothesis 3, both sets of difference scores were used (difference score Nutrition, difference score Sustainable consumption), and a 2 (Context: Nutrition, Sustainable consumption) x 3 (information condition: Basic, General, Specific) ANOVA was performed. There was no main effect of context, suggesting that any positive shifts towards nutritional meals and low carbon emission meals from baseline were not significantly different in magnitude, $F(1, 98) = .89$, $p = .34$, partial eta = .01 (very small effect). There was an overall main effect of information condition, $F(2, 98) = 5.05$, $p < .01$, partial eta = .10 (small effect). There was no interaction between context and condition, $F(2, 98) = 1.85$, $p = .16$, partial eta = .04 (very small effect). To explore the effect of condition on difference scores, *t*-test comparisons were conducted with Bonferroni correction applied. They revealed that compared to basic information ($M = 1.06$, $SD = 1.24$), general information ($M = 2.09$, $SD = 2.06$) positively shifted choices towards nutritional and low carbon emission options, $t(136) = 3.57$, $p < .001$, $d = .60$ (medium effect), as did the presentation of specific information ($M = 1.81$, $SD = 1.80$), $t(132) = 2.86$, $p < .01$, $d = .48$ (medium effect), with no significant difference between general and specific conditions, $t(130) = .82$, $p = .38$.

Hypothesis 4. There was no overall support for Hypothesis 4 suggesting that under the presentation of dual traffic light labelling shifts in meal choices towards sustainable meals were similar to shifts towards nutritional meal options. To show this, first of all normality was assessed and the Results revealed that it could be assumed: skewness (nutrition .53, SE = .24; sustainable consumption .63, SE = .24) and kurtosis (nutrition .60, SE = .47; sustainable consumption .29, SE = .47). Using both sets of difference scores (difference score Dual-Nutrition, difference score Dual-Sustainable

Table 3
Mean choices (scored according to nutrition) according to the traffic light labelling manipulations for nutrition for each experiment (Experiment 1 and Experiment 2).

Experiment	Condition	No Traffic Light label	SINGLE Traffic light labelling	DUAL Traffic light labelling
Experiment 1 (N = 101)	Basic	**10.37** *(SD = 2.00)*	**11.46** *(SD = 1.99)*	**12.54** *(SD = 2.05)*
	General	**10.09** *(SD = 2.23)*	**12.24** *(SD = 2.51)*	**12.35** *(SD = 2.39)*
	Specific	**10.56** *(SD = 2.26)*	**12.00** *(SD = 2.41)*	**12.34** *(SD = 2.12)*
Experiment 2 (N = 273)	Basic	**9.68** *(SD = 2.14)*	**10.79** *(SD = 2.28)*	**10.79** *(SD = 2.23)*
	General	**9.83** *(SD = 2.07)*	**11.68** *(SD = 2.21)*	**11.82** *(SD = 2.20)*
	Specific	**9.49** *(SD = 2.13)*	**11.45** *(SD = 2.28)*	**11.45** *(SD = 2.49)*

consumption), we performed a 2 (Context: Nutrition, Sustainable consumption) x 3 (information condition: Basic, General, Specific) ANOVA. The findings did not reveal a main effect of context on sustainable consumption ($M = 2.39$, $SD = 1.84$) and nutrition ($M = 2.08$, $SD = 1.78$) in the dual label trials, $F(1,98) = 3.10$, $p = .08$, partial eta = .03 (small effect). There was also no main effect of condition $F(2,98) = 3.53$, $p = .50$, partial eta = .01 (small effect), and no significant interactions.

4. Experiment 2

Experiment 2 was also designed to test hypotheses 1–4 in the same hypothetical choice environment as that used in Experiment 1 in order to examine the replicability of the findings reported in Experiment 1.

4.1. Method

Participants: A total of 297 participants (99 Females, 197 Males, 1 non-binary) were recruited to take part, with a mean age of $M = 37.9$ ($SD = 11.96$) ranging 18–75 years, with approximately 98 participants in each of the three between-subject conditions. Along with the application of the same eligibility criteria specified in Experiment 1, in Experiment 2 participants were only eligible to take part if they were UK citizens, born in the UK, and with English as their first language. Participants were paid 50 pence ($0.65) for completing the same online experiment as Experiment 1, and were recruited via an online crowd sourcing platform (Prolific academic).

Design, Procedure, Materials, and Scoring procedures: The exact same experimental set up, materials, and scoring system used in Experiment 1 was also used in Experiment 2. As with Experiment 1, in Experiment 2 for all analyses presented in this Results section only those self-identifying themselves as Omnivores were included (Experiment 2, N = 273). The main statistical tests used were t-tests, analysis of variance, and regression analyses.

4.2. Results

This section will be divided into five presenting analyses that directly address the four hypotheses tests, with the final section examining the relation between demographics, judgments and choice of meal options based on the findings from Experiment 1 and 2 combined.

Hypothesis 1. Consistent with Experiment 1, and in support of Hypothesis 1, Experiment 2 (see Table 2 for specific break down by condition) also revealed a similar significant shift in meal options towards low carbon emission meals ($M = 10.70$, $SD = 2.42$) compared to baseline ($M = 9.12$, $SD = 1.87$), $t(273) = 14.21$, $p < .0005$, $d = .73$ (large effect). Also, consistent with previous findings using traffic light labelling designed to signal nutritional content of food items, Experiment 2 (see Table 3 for specific break down by condition) revealed a similar significant shift in meal options towards lower calorific content meals ($M = 11.30$, $SD = 2.28$) compared to baseline ($M = 9.67$, $SD = 2.11$), $t(280) = 14.87$, $p < .0005$, $d = .74$ (medium effect).

Hypothesis 2. Experiment 2 replicated the same findings as Experiment 1. Overall, there appeared to be no significant advantage in the presentation of a reference point over general information, thus failing to find support for Hypothesis 2. To show this, normality tests were conducted (skewness (.83, SE = .15) and kurtosis (.30, SE = .29)) and were found to be within acceptable bounds to carry out t-tests. The analysis also revealed a main effect of information type (Basic $M = .95$, $SD = 1.39$; General $M = 2.16$, $SD = 2.05$; Specific $M = 1.64$, $SD = 1.81$) on meal options, $F(2, 273) = 10.72$, $p < .0001$, partial eta = .07 (small effect). Applying Bonferroni correction, *t*-test comparisons revealed that compared to basic information, the presentation of general information positively shifted choices towards low carbon emission meals, $t(180) = 4.66$, $p < .001$, $d = .69$ (large effect), as did the presentation of specific information, $t(181) = 2.90$, $p < .01$, $d = .42$ (small effect), with no significant difference between general and specific conditions, $t(179) = 1.80$, $p = .14$.

Hypothesis 3. Overall, consistent with Experiment 1, Experiment 2 did not find support for Hypothesis 3, instead the pattern of findings indicated that there was no main difference in the magnitude of positive change on meal choices towards nutritional meals and sustainable meals. To examine this, first tests of skewness and normality were assessed (skewness (.75, SE = .15) and kurtosis (.26, SE = .29)) and were within acceptable bounds to carry out an ANOVA. The ANOVA revealed that there was no significant main effect of context, $F(1, 270) = .20$, $p = .65$, partial eta = .001 (very small effect). There was an overall main effect of condition, $F(2, 278) = 11.61$, $p < .0001$, partial eta = .08 (small effect), and no interaction between context and condition, $F(2, 270) = 2.25$, $p = .11$, partial eta = .02 (very small effect).

To explore the effect of condition on difference scores, *t*-test comparisons were conducted with the application of Bonferroni correction. They revealed that compared to basic information ($M = 1.03$, $SD = 1.41$), general information ($M = 2.00$, $SD = 2.03$) positively shifted choices towards nutritional and low carbon emission options, $t(362) = 5.39$, $p < .001$, $d = 0.55$ (medium effect), as did the presentation of specific information ($M = 1.80$, $SD = 1.84$), $t(374) = 4.50$, $p < .01$, $d = 0.47$ (medium effect), with no significant difference between general and specific conditions, $t(360) = 0.99$, $p = .36$.

Hypothesis 4. Experiment 2 found support for Hypothesis 4, suggesting that shifts in meal choices towards sustainable meals was greater than nutritional meal options under the presentation of dual traffic light labelling. To examine this, An ANOVA was conducted, given that tests of skewness and normality were within normal bounds (skewness (nutrition .87, SE = .15; sustainable consumption .55, SE = .15) and kurtosis (nutrition .26, SE = .29; sustainable consumption −.68, SE = .29)). The findings were similar to Experiment 1, suggesting a greater shift towards sustainable consumption ($M = 1.99$, $SD = 1.88$) compared to nutrition ($M = 1.68$, $SD = 1.86$) in the dual label trials, $F(1, 270) = 12.77$, $p < .0005$, partial eta = .04 (small effect). There was also a main effect of condition, $F(2, 270) = 3.57$, $p < .05$, partial eta = .03 (small effect). There was also a condition and context interaction, $F(2, 270) = 4.89$, $p < .01$, partial eta = .04 (small effect). To locate the source of the interaction, *t*-test analyses were conducted, with the application of Bonferroni correction, and once applied, two comparisons remained significant. When compared against Basic information ($M = 1.11$, $SD = 1.43$), there were positive shifts towards nutritional meal options in the presence of general information ($M = 1.98$, $SD = 1.94$), $t(180) = 3.49$, $p < .01$, $d = .51$ (medium effect), and specific information ($M = 1.96$, $SD = 2.03$), $t(181) = 3.26$, $p < .005$, $d = .48$ (medium effect).

4.3. Regressions analyses

To examine an association with age, gender, 4 general judgments (caring about the environment, reducing carbon footprint, caring about physical health, improving health), specific judgement (use of additional information on meal option decisions), condition (Basic, General, Specific information) and Experiment (Experiment 1, 2) on difference scores, regression analyses were conducted separately for single and dual labelling. The reason for this was that simple paired t-tests revealed that scores between nutritional and sustainable consumption for dual labelling trials, $t(373) = 3.66$, $p < .000001$, $d = 0.17$ were significant, though not for single labelling trials, $t(373) = 0.50$, $p = .96$, $d = 0.0005$. Therefore, for the single labelling, difference scores were collapsed across context, but for dual labelling. Only significant

findings are reported from the regression analyses.

For the single labelling trials, the Results of the regression indicated the nine predictors explained 32% of the variance ($R^2 = 0.29$, $F(9, 371) = 13.92$, $p < .0005$). It was found that condition significantly predicted difference scores ($t = 5.46$, $\beta = 0.23$, $p < .0005$), as did specific judgements on nutritional information ($t = 4.18$, $\beta = 0.25$, $p < .00005$), and specific judgements on the sustainable consumption ($t = 4.16$, $\beta = 0.24$, $p < .00005$).

For dual labelling, performing the analyses on the difference scores for nutrition only, the Results indicated the nine predictors explained 28% of the variance ($R^2 = 0.30$, $F(9, 371) = 17.17$, $p < .0005$). Condition significantly predicted difference scores ($t = 2.78$, $\beta = 0.12$, $p < .01$), as did specific judgments ($t = 10.27$, $\beta = 0.48$, $p < .0005$). Performing the same analyses on the difference scores for sustainable consumption, the results indicated the nine predictors explained 36% of the variance ($R^2 = 0.38$, $F(9, 371) = 24.10$, $p < .0005$. It was found that specific judgements significantly predicted difference scores ($t = 10.65$, $\beta = 0.58$, $p < .00005$), as did general judgments on caring about the environment ($t = 2.35$, $\beta = 0.13$, $p < .05$).

Overall the regression analyses revealed that what was common to both single and dual labelling trials was that difference scores were predicted by specific judgements. This suggests that the influence of additional information accompanying the traffic light labels was the most reliable predictor, relative to the other predictors entered into the regression, of shifts from baseline to meal option choices that were lower in calorific content and had lower carbon emissions.

5. General discussion

The aim of the present study was to examine the extent to which traffic light labelling impacts meal choices and to investigate the additional benefits on choice behavior when providing additional information (general information, reference values) and dual traffic light labels that also take into account consumers interest in health. By setting up as simulated choice experiment in which people had to make choices about the meals they would eat during lunch time in a canteen, the aim was to investigate the extent to which positive behavioral change could be achieved based on the various factors we manipulated in a hypothetical choice environment.

Overall, two experiments provided evidence that when using a traffic light labelling method positive behavioral change can be achieved in line with hypothetical meal choices that have lower carbon emissions and lower calorific content (support for Hypothesis 1). Both general information (recommendations regarding acceptable levels of carbon emission/daily calorie consumption) and specific information (references values) that accompanied the traffic light labelling of meal options led to greater shifts in lower carbon emission meals compared to the provision of basic information. The presentation of a specific reference value for people to better gauge the relative impact of changes in the meal choices had no statistically detectable advantage over the provision of general information (failure to support Hypothesis 2). There was no statistically detectable difference between traffic light labels signalling nutritional levels of food and sustainable consumption on meal choices, when presented individually (failure to support Hypothesis 3). Under dual traffic light labelling trials, in Experiment 2 there was a more discernible shift towards lower carbon emission meals than lower calorific meals, suggesting that under dual labelling trials participants were guided by the impact of their choices on sustainable consumption (support for Hypothesis 4 in Experiment 2). Overall, demographic details such as age and gender as well as general pro-environmental and physical health attitudes failed to reliably predict meal options. However specific judgments regarding the use of additional information regarding nutritional content and sustainable consumption did reliably predict positive shifts in meal choices towards low calorific content meals and low carbon emission meals; thus suggesting that people subjectively reported the use of additional information when making their meal choices.

In sum, our findings show that traffic light labelling of meal options can lead to behavioral change and that the provision of additional information, regardless of whether it was general or contained a specific reference value, leads to further positive behavioral changes. In the remainder of this discussion we focus our attention on the implications of these findings, particularly the limited evidence for the effectiveness of providing a reference value, and the potential limitations of our study, as well as future directions.

Implications of our findings: The present study provides evidence that supports the idea that a carbon emission labelling decision-support tool utilising traffic light colors is an effective means to raise awareness of consumers' choice behavior in the context of sustainable consumption. We found that in the presence of the traffic light method, a student sample (Experiment 1) and wider broader demographic sample (Experiment 2) shifted their meal choices in line with associated lower carbon emissions. One of the novel aspects of the present study was that it explored the utilisation of traffic light labelling for meal options, rather than for specific food products, which is more commonly investigated (Spaargaren et al., 2013; Vlaeminck et al., 2014). A few recent studies also used traffic light labelling for meal options on menus (Filimonau et al., 2017; Slapo, 2016). For instance, Slapo (2016) found that basic environmental traffic light labelling can be an effective means of behavioral change, but the effects are small, which is consistent with Filimonau et al.'s (2017) findings. However, there are critical differences between Slapo's (2016) and Filimonau et al.'s (2017) field studies and the present study. In the former studies, actual behavioral change was measured by total sales of meat and vegetarian meals, in which small changes in sales were detected, whereas in the later individual meal choices in a simulated canteen environment were measured and substantial changes were detected. Consumers not only make food choices in supermarkets, but in a variety of contexts, in which food labelling is less prevalent (e.g. canteens, restaurants, cafes). Thus, our findings show that when meals contain simple labels that signal sustainable and healthier options, albeit it in a simulated canteen, people, in principle, can be persuaded to positively change their behavior.

In contrast to previous work suggesting that consumers are more motivated to change their consumption habits around healthy eating than sustainable consumption (e.g., Feucht & Zander, 2017; Wellesley et al., 2015), our findings revealed that the use of traffic light labelling, and the provision of additional information (general, specific reference value) positively impacted behavioral change similarly for health and sustainable consumption; if anything, in some of our analysis there were indications that people were more persuaded to change towards sustainable consumption compared to healthier options (particualrly in the dual-labelling set up). One reason for the difference in findings is that few studies have directly compared actual consumer choice behavior in a single study to determine how consumers might differentially weight options in line with either health or sustainable consumption (e.g., De Magistris & Gracia, 2014; Koistinen et al., 2013; Pelletier et al., 2016; Øvrum, Alfnes, Almli, & Rickertsen, 2012), and for these studies choice behavior concerns only single item food products rather than meals. Therefore, this study provides important insights on two factors, the impact of food labelling on meal choices rather than individual food items, and what impact labelling has when signalling information about both health and sustainable consumption.

To this end, when compared under single traffic light labelling conditions, and under dual traffic light labelling conditions, both experiments revealed shifts towards healthier and sustainable lunch time meals. Moreover, we found that dual traffic light labelling conditions did not overly burden consumers to the extent that they ignored both labels or only prioritised one. The use of dual traffic light labelling supported positive behavioral change in both contexts; though in Experiment 2, in line with Pelletier et al. (2016), the magnitude of positive behavioral change was even greater (statistically significant

with a small effect size) for sustainable consumption than healthier meal choices.

It is important to draw attention to the fact that Experiment 1 and 2 failed to provide evidential support for the additional benefits of a reference value over the presentation of general information, since both seemed to achieve a similar level of positive behavioral change. We speculate that there are several reasons to account for this. Exposure to excessive information can lead to some confusion leading individuals to base their decisions on their own more simplified interpretation of the information (Iyengar & Lepper, 2000; Upham & Bleda, 2009). Participants were given just one reference value with which they could compare their choices against. This required some effort on their part to compare the carbon emission levels/calorific content values given for each traffic light label with the specific reference point that recommended an ideal level of carbon emission/calorific content of a meal. This added burden may have led participants to quickly ignore making the comparison and simply rely on the traffic light labelling values themselves. If carbon labels with a reference value were to be implemented in a way that could maximise their impact, then it might be preferable for each meal to have a personalised reference value label so as to avoid a complex mental calculation (e.g., that a beef curry would be the equivalent of nine car miles). It is therefore possible that the cognitive effort required to incorporate all the information provided in the specific reference value condition prevented the potential benefits of this manipulation being expressed on meal choices. This may also explain why it is that, regardless of context (i.e. health, sustainable consumption), the general information condition was as effective in shifting behavior than the specific reference value condition, because the former contained less information and was potentially less cognitively effortful to incorporate when making meal choices. However, we did not include any manipulation checks in order to determine the extent to which general or specific reference value information was persuasive, or what participants specifically attended, and so this constitutes a limitation. Thus, we can only speculate as to our failure to find any impact of our reference value manipulations in our study.

Another finding that is worth drawing attention to is the fact that the present study revealed that neither general attitudes towards health or environmental issues reliably predicted shifts in meal choice behavior. One reason for this is that the present study inadequately probed for participants' general attitudes, and so only including 4 items was insufficient for determining the extent to which general attitudes towards sustainability and healthy eating could predict meal choices. Nevertheless, specific judgments about the use of additional information provided did predict the direction of change in behavior. This suggests that attitudes and judgments in and of themselves may not be misaligned with actual choice behavior, but rather that subjective judgments correspond more closely to choice behavior, when the content of judgment and choice refer to the same specific context. It is worth noting that in the context of measuring public attitudes in the domain of social policy interventions, attitudes are sensitive to the measurement tools used to probe them (Feldman & Lynch, 1988; Osman, Fenton, Pilditch, Lagnado, & Neil, 2018; Powell, 2013) and vulnerable to failures in properly validating question items (Maul, 2017, pp. 1–19). This means that attitudes as revealed in public surveys may only give a partial indication of the public's disposition towards a particular issue. Moreover, attitudes as predictors of behavior can change profoundly as a result of the way the issues are communicated (e.g., Lu, McComas, & Besley., 2017; Osman et al., 2018) as well as how they are measured.

Limitations: The major limitation of this study is that it used an experimental design that simulated a choice environment rather than a field study (e.g., Pelletier et al., 2016; Slapo, 2016). Work suggests that in highly familiar contents in which repetitive choices are made, such as around food consumption, choices are often determined by habit (Grankvist & Biel, 2007), and so they become hard to change when confronted with information that is designed to break these habits. It is therefore possible that participants would not have made the same choices in a real canteen, as they did in our task, especially considering the large influence that habit plays, along with external factors such as the canteen environment, price of meals, and social factors (Murcott, 2019; Stroebele & De Castro, 2004). Furthermore, studies comparing self-reported choice behavior with actual choice behavior regarding the influence of nutritional labelling of food reveal a tendency to over-report the positive influence of labelling on choice behavior (Buttriss, 2018; Grunert, Wills, & Fernandez-Celemin, 2010; Hess, Visschers, & Siegrist, 2012). To ameliorate this, several measures were taken to create a situation in which choice behavior in our study mimicked a canteen set up. Participants were reminded on each trial that they were making choices in a canteen, and the picture of the meal options approximated the kinds of pictures that are available in canteens. Additionally, the anonymous nature of the survey attempted to minimise the risk of social desirability bias. Nevertheless, it is possible that the positive behavioral change reported in the present study is larger than would be achieved in a field study.

Given that the context in which our participants made choices was hypothetical it is hard to determine the extent to which our interventions could generalise beyond an online controlled study to real lunch time canteen environments. In addition, a related limitation is that no follow-up study was conducted to track the extent to which the manipulations introduced in the experiment carried over to actual lunch time canteen environments; though given that as yet canteen environments do not include traffic light labelling (either for nutrition or sustainable consumption) this would have been hard to test. Nevertheless, the broader point, which also paves the way for future empirical work, is to examine the correspondence between hypothetical choices in response to traffic light labelling systems used to communicate levels of carbon emissions of meal options, with real choice behavior in canteen environments in which the same traffic light labels would be implemented.

Given this limitation, this research still allows for some basic insights to be gained into the potential effects of traffic light labelling on intended sustainable meal options under controlled conditions. Thus, we show that, in principle, traffic light labelling along with additional information (general information, specific reference values) helps to increase knowledge and PCE, which has been documented as a barrier in supporting positive behavioral change towards sustainable consumption (Vermeir & Verbeke, 2006).

Two other limiting factors in this study that need to be considered are that meal choices were not entirely substitutable, and no information was provided regarding the price of the meal options. For instancec, taste has been shown to be one of the most important influences on food choices (Hartikainen, Roininen, Katajajuuri, & Pulkkinen, 2014; Röös & Tjärnemo, 2011). The meal options were chosen to reflect realistic options that would appear during lunch time in a canteen, whilst allowing for a range of options that varied in nutritional value and sustainable impact. However, it is possible that some meals were generally disliked on the basis of estimated taste levels, and so this presents an upper limit of the potential behavioral changes towards sustainable consumption and health that could be achieved. Moreover, meal options per simulated day would vary by price (e.g., fish/meat options would be more expensive than vegetarian options), and so as a result it is not possible to determine the extent to which pricing of meals would present a stronger influence on choice behavior above and beyond the labelling of the options in line with health and sustainable consumption.

6. Conclusions and suggestions for future directions

In the present study we found that adding traffic light labels indicating the calorie content or carbon emissions related to a meal was successful in shifting hypothetical choices towards healthier and lower carbon emission options. General and specific information was more

successful than basic traffic light labels, suggesting that supplementing traffic light labels with additional information is more effective at increasing knowledge than the presentation of a traffic light label alone.

Our findings present promising avenues in examining methods of behavioral change, particularly since our study was novel for several reasons. First, it examined behavioral change in the context of meal choices rather than single item food product. Second, the study was the first of its kind to directly compare the impact of dual-traffic lighting systems to communicate the impact of food choices on health and sustainable consumption. The success of dual labelling in this study is encouraging. The reference points investigated in this study showed no additional benefit above general information in promoting healthier or sustainable meal choices, though there are potential methodological reasons for this. However, future research might want to explore alternative ways of communicating reference points that may better aid consumer understanding of carbon information, as well as calorific content of foods/meals, while ensuring maximal impact by being presented at the point of sale.

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