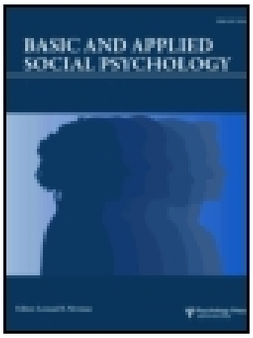

Basic and Applied Social Psychology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/hbas20

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To cite this article: Magda Osman, Pauline Schwartz & Saul Wodak (2021): Sustainable Consumption: What Works Best, Carbon Taxes, Subsidies and/or Nudges?, Basic and Applied Social Psychology, DOI: 10.1080/01973533.2021.1889553

To link to this article: https://doi.org/10.1080/01973533.2021.1889553

Published online: 17 Mar 2021.

BASIC AND APPLIED SOCIAL PSYCHOLOGY
https://doi.org/10.1080/01973533.2021.1889553

Sustainable Consumption: What Works Best, Carbon Taxes, Subsidies and/or Nudges?

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ABSTRACT

Behavioral change techniques may show positive changes to sustainable consumption, but as with many other domains, how they interact with other typical regulatory measures is unknown. To address the empirical lacuna, the present study uses a discrete-choice set-up to simulate a lunchtime canteen in order to investigate the effects of choice preserving and choice incentivizing interventions on meal choices. Carbon tax (Experiment 1, Experiment 2) alone, behavioral interventions (Experiment 1) alone, as well in combination (Experiment 1, Experiment 2) shifted choices to a less degree than in combination. The most compelling positive behavioral change was found when introducing a redistributive pricing system that combines carbon tax and subsidies (Experiment 2), in combination with choice preserving instruments (Experiment 2, Experiment 3).

Introduction

Food production is estimated to be responsible for 28% of anthropogenic greenhouse gas ($C0_2e$) emissions (Rogissart et al., 2019), and shifting food preferences to low-carbon alternatives is now recognized as a necessary climate change mitigation strategy (Intergovernmental Panel on Climate Change, 2019) critical to meeting the UN Sustainable Development Goals (Lucas & Horton, 2019). This would seem to be a problem applied social psychology could offer several valuable solutions to, in particular through the employment of behavioral change techniques (e.g. nudges). For instance, behavior change at the consumer level can play an important role in shifting dietary decisions. This raises the following questions: what behavioral change techniques are most effective in this context to support positive sustainable consumptive behavioral change? How effective are behavioral change techniques relative to commonplace regulatory instruments (e.g. taxes, mandates, bans)? Are there additive effects on positive behavioral change if commonplace regulatory instruments are combined with behavioral change techniques? The empirical work examining these questions is limited (e.g. Hagmann et al., 2019), particularly in the domain of sustainable food consumption. Therefore, the main objective of the present study is to address this by providing empirical answers to these questions. We begin by examining frameworks for behavioral change, and the challenges faced by applied researchers when devising appropriate interventions to promote effective changes in sustainable food choices. We then go on to review previous research findings that have trialed interventions in this domain to determine the rationale for their use from which we set out the rationale for the specific hypotheses tested in this study.

Regulatory versus behaviorally informed interventions

How do researchers and practitioners go about determining which interventions are most appropriate to achieve behavioral change in a given social policy domain? The key to the success of any behavioral intervention designed to achieve positive behavioral change is to ensure that it is a good fit for the local and broad context in which the behavior is observed (Meder et al., 2018). A systematic understanding of the behavioral problem, its environment, and the potential interactions of environment and possible interventions is therefore necessary to design effective behavior change interventions.

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To guide researchers and practitioners to design a behavioral intervention, often the first port of call is to analyze the behavioral factors that are most relevant to the context, to then devise the appropriate levels to motivate change. Three of the most common behavior change frameworks used by several established public institutions, such as the OECD, World bank, and several governments are The Behavior Change Wheel (hereafter BCW) (Michie et al., 2011), the Behavior, Analysis, Strategies, Interventions, Change (hereafter BASIC) toolkit (Hansen & Jespersen, 2013), and the Easy, Attractive, Social, and Timely (hereafter EAST) framework developed by the Behavioral Insights Team (Service et al., 2014).

BCW, EAST, and BASIC share several critical features in common. They are prescriptive in outlining the process of developing behavioral change interventions for targeting social policy issues. They each serve as behavioral change toolkits, through charts (BASIC), diagrams (BASIC, BCW), and checklists (EAST) where the framework provides the researcher and practitioner with details associated with the methodology of change derived from psychological (e.g. Theory of Planned behavior (Ajzen, 1991), Social Cognitive Theory (Bandura, 1991), COM-B model (Michie et al., 2011); capability, opportunity, and motivation each have a causal influence on behavior) and behavioral economic theories. The frameworks and even formal models (West et al., 2019) are used to identify the general behaviors of interest, and the frameworks are used to help define the policy problem (i.e. the context for behavior change), and the appropriate intervention that suits the context and target behavior. In all three frameworks, the establishment of criteria for success of behavioral interventions is quite stringent, since the requirement is that *a priori*, the researcher and the practitioner need to assert a directional association, along with the magnitude and period in which the outcome following the intervention will be.

The critical issue raised by BCW, EAST, and BASIC, and discussed at length by Meder et al. (2018) and Osman et al. (2020), is that real-world contexts in which behavioral change techniques are employed (e.g. labeling, educational campaigns, defaults, incentivizing sets of options) are often in the context of typical regulatory instruments (e.g. taxes, mandates, bans). This is because compensatory additional measures might be necessary to boost the efficacy of behavioral interventions (House of Lords, 2011; Meder et al., 2018). To analyze this further, the *Nuffield* Council on Bioethics *ladder* of intervention (Nuffield Council on Bioethics, 2007) is a useful taxonomy that organizes interventions hierarchically depending on the level of intrusiveness into the individual agent's intentional sphere of action. The basic idea is that it is possible to correspond two factors (public benefits, autonomy (choice preserving)) against each other such that, as the interventions become more intrusive with respect to the individual/group/population's autonomy, the greater the efforts need to be to justify the use of the measure for the public good. The bottom rung of the ladder is to do nothing, and the following steps are to provide information, enable a choice, guide choices through changing the default policy, guide choices through incentives, guide choice through disincentives, restrict choice, to finally eliminate choice. The bioethics ladder points to balancing ethical justifications with how policies are trialed, what the target of the policy is, and what other promising policies can be trailed in conjunction.

None of the reviewed frameworks give a precise answer to whether and when a combination of behaviorally informed and regulatory measures might be more suitable. In this sense, the frameworks broadly tell researchers and practitioners what to look out for when designing public policy interventions based on behavioral insights, but crucially, none provide sufficient information on what to expect when combining behavioral interventions with regulatory instruments, such as taxes, even though in many real-world situations a combination of choice preserving and choice incentivizing measures are used.

In general, what researchers have found is that "soft" interventions are popular with voters and policy-makers (Hagman et al., 2015; Petrescu et al., 2016; Reisch et al., 2017) even when there is less or no evidence for their effectiveness (Diepeveen et al., 2013; Li et al., 2017). From a standpoint of effectiveness, this has led some researchers to question whether such 'soft' behavioral interventions are the most effective tools available to encourage sustainable consumption (Lehner et al., 2016; Nellen & Miles, 2007). However, there is an amassing evidence base showing general perceived effectiveness of behavioral interventions to be an important predictor of acceptability of interventions (e.g., Bang, Shu, & Weber, 2020; Bos et al., 2015), with important caveats concerning the transparency of the interventions themselves and supporting arguments for their use (Gold et al., 2020), as well as the type of expert proposing their use (Osman et al., 2018). Besides, studies have revealed several potential unintended negative consequences associated with implementing 'soft' interventions (for review see

Osman et al., 2020). For instance, low-impact 'soft' interventions can provide the moral license to engage in behaviors that undo the original positive behavioral changes (Stibe & Cugelman, 2016; Tiefenbeck et al., 2013), or undermine support for more effective hard measures such as carbon taxes (Hagmann et al., 2019).

It is a widely shared view in the behavioral change community that 'soft' interventions be applied as a complement to rather than replacement of more traditional policy tools in the context of climate change (e.g. Halpern, 2016; Lehner et al., 2016). More specifically, Stern (2011) reviewed behavior change research targeting pro-environmental behaviors and concluded that the most effective interventions included both financial and behavioral components. For this reason, the present study will investigate the combined influence of pricing mechanisms and labeling interventions on sustainable food consumption.

Hard (choice restricting/choice incentivizing) interventions: carbon tax and subsidies

A hard choice incentivizing approach that has been taken to align consumer food choices to long-term sustainable environmental outcomes is 'guiding choice through disincentives'. This approach consists of regulatory or fiscal measures, such as the introduction of taxes to direct sustainable food consumption. As coercive or economic tools, these 'traditional' public policy measures can be criticized to eliminate or limit people's choices (Dolan et al., 2010; Hansen & Jespersen, 2013; Lehner et al., 2016). Additionally, regulations and fiscal incentives rest on standard economic assumptions of humans as rational decision-makers and utility-maximizers (Thaler & Sunstein, 2008). But as humans tend to fail to act in ways that promote their own or societies' benefit, even if the conditions for rational decision-making are set, (Hansen & Jespersen, 2013), these policies often don't lead to sufficient behavioral changes. This is with some exceptions such as the £0.05 Plastic Bag Tax that has reduced UK plastic bag use by 83% since its introduction in 2015 (Defra, 2017), with equivalent-sized reductions reported in several other countries (for a review see Xanthos & Walker, 2017).

One example of 'guiding choice through disincentives' is carbon taxation, which increases product prices in proportion to their embodied CO_2e content. This could lead to several benefits, such as changes in food consumption, production, and investment, and overall decrease GHG emissions from livestock (High-Level Commission on Carbon Prices, 2017). While not previously explored in empirical studies, a review of the existing research suggests that carbon taxation might be an effective means of increasing sustainable food choices. Yet, the suggested tax levels and effects differ. For example, *Ex ante* modeling studies exploring various carbon taxation scenarios have consistently predicted population-level shifts toward low carbon foodstuffs (Briggs et al., 2013; Briggs, Kehlbacher, Tiffin, & Scarborough, 2015; Edjabou & Smed, 2013; Gren et al., 2019; Säll & Gren, 2015; Springmann et al., 2017). For instance, Wirsenius et al. (2011), estimated that up to 32 million tons of CO_2e could be avoided by the introduction of an EU-wide weighted tax on animal food products with €60 per ton CO_2e. Briggs and colleagues (2016) claim that a tax of only £28.61/tCO_2e on food items could save 7850 kilotons of CO_2e. The World Bank's High-Level Commission on Carbon Prices concludes that a tax level of US$40–80/t$CO_2$e by 2020 is necessary to achieve the Paris 2015 temperature agreements (2017).

Field experiments provide further evidence for the potential to shift food consumption habits with small levies. For example, a £0.10 tax on sugar-sweetened beverages (SSB) introduced in 37 UK restaurant locations reduced consumption of SSB by 9% after six months (Cornelsen et al., 2017). Other field studies have similarly demonstrated that raising the price of high sugar foods can reduce their consumption (Block et al., 2010; Elbel et al., 2013). This shows that carbon taxation might be an effective means of increasing sustainable food choices. For this reason, using this type of hard intervention is worth examining in the context of increasing sustainable meal choices, and so this provides a good motivation for exploration in the present study.

Applying a behavioral change approach focusing on soft interventions: a worked example

The limitation of general behavioral change frameworks (BCW, EAST, BASIC) is that they aren't able to specify the type of intervention most suitable for achieving behavioral change in a given context. This is because they aren't focused on articulating a general process model of individual and social behavior, and absent from all of the frameworks are details of psychological mechanisms that drive behavior (Grüne-Yanoff, 2016). However, as mentioned, each of them prescribe the process that is needed in order to identify the most suitable interventions, once a social

policy issue, and context have been ear marked for behavioral change (Osman et al., 2020).

The general steps to reaching the point of implementing a set of behavioral interventions that underpins all behavioral change frameworks is identifying the candidate context for behavioral change, the psychological barriers to change, and what methods can be used to make salient the properties of the context that could give rise to change in behavior, so that positive behavioral change is achieved (for review see Coskun et al., 2015; Phipps et al., 2013; Vermeir et al., 2020). In the domain of sustainable food consumption, the candidate context for the application of behavioral change interventions could focus on where purchasing decisions for food items would be made (e.g. canteens, restaurants, supermarkets). Instead of, or in addition to, these specific localized contexts, an approach could be taken where the target area is much broader, such as addressing attitudes toward sustainable consumption at population level through the use of public campaigns. The decision of which context to target, localized or broad (or both), will then carry implications for which psychological barriers are identified, and what aspects of the context need to be made more salient for the behavioral interventions to target.

If we focus on the localized contexts, then here also a further distinction needs to be made with respect to how to motivate change and what salient features matter, for which Identity-based motivation (IBM) theory (Oyserman, 2009), Value-Beliefs-Norms (VBN) theory (Stern, 1999), as well as Social-Cognitive (SC) theory (Bandura, 1991) help to highlight some critical matters. IMB theory and relatedly VBN theory asserts that consumer behavior is motivated by either individual or group associated norms and values. Salience identity motivates actions, such that when personal identity salience is present then there is an emphasis on achieving personal norms, values, goals and strategies, and achieving agency and control. This type of salience might be more likely triggered in situations where consumer choices are made in isolation of others, such as in a supermarket, or solo dinning. A strategy that would drive choice is one of cost and health, where sustainability is not the presiding factor, because, along with the goal of reducing financial costs, ownership of responsibility for the goal of increasing healthy eating habits is also judged as greater than reducing anthropogenic climate change (Luchs et al., 2015). Social identity salience occurs where individuals are motivated to act in ways that are congruent with a group's norms, values, and goals (Costa Pinto et al., 2014; Griskevicius et al., 2010; Vermeir et al., 2020), which might be more common in contexts where meal choices are made in the presence of others, such as in a canteen or restaurant. Familiar dining companions' values and norms will be a strong motivating factor in each group member's meal choices. To the extent that sustainable consumptive choices are viewed as an important lifestyle choice by the dinning group, if collective action to surmount a social problem is seen as valuable and achievable, then pro-social mean options are chosen (Costa Pinto et al., 2014, 2016).

A lunchtime canteen presents a challenging candidate for exploring methods of behavioral change for the reason that it is likely that both personal and social identity salience will play a role because this is a context where we find solo and social dinning occurring (Lahad & May, 2017). For these reasons then, a lunchtime canteen would be a useful place to explore the application of behavioral change interviews. Psychological barriers present themselves in the guise of choices motivated by a personal identity where pro-self rather than pro-social goals are likely to be salient. Where social identity is salient (especially if familiar dinning companions are present), the attitudes and values might also be ones that conflict with pro-social options, such as where groups lean toward indulgent unhealthy meal options (Cruwys et al., 2015).

Having identified the context for behavioral change (i.e. lunch time canteen), and the psychological barriers (i.e. the motivations behind choice-behavior in connection to personal or social identity), then the next stage is to determine what specific behavior(s) to target, and which interventions could target them given the presiding motivational barriers, and which are less likely to be pertinent. There are three critical dining experience stages preprocess (arrival & ordering), in-process (consuming) and post-process (paying) (Noone et al., 2007), where the first and last are usually combined in canteens. Starting with signaling the particular ethos of the dining environment, this provides a general frame of reference for individuals and groups as to the kinds of expectations they should have about how the canteen is designed (e.g., convenience, health, artisan, pro-environmental). The presentation of the menu, as well as in some cases the physical presentation of the meal options, is the next possible access point for targeting behavior. Here a commitment to a meal choice is made, and also a point of no return, because at the point of purchase there is limited opportunity for revising meal choices.

A critical focus for targeting behavior is directly at the point where a selection of a meal choice is made based on the available menu options. Given that both personal and social types of identities may be salient and competing motivations are likely to be experienced (e.g. pro-self vs. pro-social), then a critical focus for targeting behavior is directly at the point where a selection of a meal choice is made, based on the available menu options. We now reach the point where we can consider the range of behavioral interventions that should be under consideration, and those that can be eliminated. For instance, while reported to be effective in a number of contexts, defaults (preselected options) are less commonly employed in canteens, with the common exception of the children's meal; evidence shows that employing healthy default children's meals does improve nutritional choices (Peters et al., 2016). Introducing a default sustainable meal option in a canteen, unless couched in terms of a "special" meal, is potentially risky, and liable to backfiring (Osman et al., 2020), because food choices are often considered a value to be protected and a cultural right, and a threat to choice here can be a seen as a threat to personal agency and control (Maffei, 2012; Osman, 2014). Instead, there are other ways of providing an informational signal of the "better" option, other than through defaults which target inertia and procrastination, which are less of a priority in the context of dining where choice is critical. Signaling a preferred choice on menus through social norms (Schultz et al., 2007) which communicate behaviors of a target group, is a way to invoke a social identity mode for solo diners that might then be motivated by pro-social values attributed to a group perceived as relevant to the dining environment. In addition, social norms can also invoke a different salient social identity to that typically adopted by a group of diners, in order to orientate them toward pro-social values. Stronger forms of this method include injunctive norms (which might be typical or atypical) which communicate (dis)approved of behaviors and which often have a tendency to fail or backfire (Osman et al., 2020). For this reason, here, social norming would be considered a viable behavioral change intervention.

Solo diners (and to some degree communal diners) in a personal identity mode are, as has been discussed, motivated by their own values and goals. For instance, the pricing of meal options is likely to be an important, if not critical, incentive over health or sustainability (Vermeir et al., 2020). Misperceptions that price of sustainable food options are higher than less sustainable options can also contribute to prioritizing pro-self over pro-social goals (Hebda & Wagner, 2016). As well as correcting misperceptions regarding the price of sustainable options, accompanying meal options on a menu with the provision of general information regarding which options are more or less sustainable, can be used to help consumers easily identify meal options as sustainable or not, and can also make salient the "better" option if directly incorporated into menus in the form of labeling.

Having applied the critical steps that behavioral change frameworks (BCW, EAST, and BASIC) prescribe in the process of determining the candidate interventions worth trialing, this worked example has done the following. It has identified an area for behavioral change (encouraging sustainable consumption), as well as the potential psychological barriers to this positive change based on existing basic and social psychological theorizing (IBM, VBN, SC) and evidence (e.g. Costa Pinto et al., 2014, 2016; Griskevicius et al., 2010; Luchs et al., 2015; Vermeir et al., 2020). It has provided a rationale for the specific context of behavioral change (lunchtime canteen) to be targeted, and when, in this content, interventions could be implemented (point of choice), and where (menus). Finally, this discussion has articulated two candidate behavioral interventions that could be trialed (provision of information in the form of labeling, social norming) while also eliminating other potential behavioral change interventions that might otherwise be problematic or less appropriate given the specifics of the context for behavioral change (injunctive social norms, defaults, public campaigning). The only remaining detail that needs to be considered is the specific measure of behavior that would best illustrate the influence of behavioral change interventions, which in this case would be an increase in selection of more sustainable lunchtime meal options relative to appropriate baselines. This ought to be determined by the specific design of the experiment. Before the details of this are provided, the next section discusses in more detail the two types of behavioral interventions that this study will investigate.

Soft (choice preserving) interventions: labeling and social norming

Labeling

One of the most recognized applications of labeling to support sustainable consumption is the carbon labeling system used in the UK, which is the 'Carbon Footprint Label' (CFL). It displays the CO_2e content

associated with a product's lifecycle including production, transport, and consumption (www.carbontrust.com). Despite being largely aware of the CFL, consumers report low usage of it when shopping (Grunert et al., 2014). Furthermore, analysis of supermarket loyalty card data found the introduction of the CLF had no discernible impact on purchasing behavior (Hornibrook et al., 2015). One explanation for the limited effectiveness of the CFL is that UK consumers report being generally confused by eco-labels (Eden et al., 2008), which are insufficiently salient to compete in information-saturated consumer choice environments (Owen et al., 2007).

Another form of labeling is the use of traffic lights on food items, much as the same type of labeling used to indicate the nutritional content of food. Traffic light labeling (TLL) of CO_2e content of food has been proposed to enhance the efficacy of carbon labeling (Schuldt, 2013). TLL is hypothesized to simplify information provision by facilitating relative comparisons between different levels of a product attribute, due to automatic associations between colors (e.g. green, yellow, red) and moral imperatives (Schuldt, 2013). A review of extant empirical research finds mixed results for the effectiveness of TLL in increasing sustainable consumption. In discrete choice tasks conducted online, carbon TLL of food products shifted hypothetical consumer choices toward more sustainable options (Bernard et al., 2015; Feucht & Zander, 2017; Osman & Thornton, 2019), increased the effectiveness of the CFL (Thøgersen & Nielsen, 2016). For instance, Osman and Thornton (2019) explored hypothetical consumer choices in a mock cafeteria scenario and found that TLL of both $C0_2$e and calorie content shifted food consumption toward more sustainable and more healthy options respectively. However, this study investigated meal choices in the absence of menu prices which would be a more robust test of the effectiveness of TLL given that price matters for the way people make their meal choices (Osman & Thornton, 2019). However, one field study reported no impact (Vanclay et al., 2011); TLL only increased sustainable choices when low $C0_2$e items were also the cheapest available option. Similarly, Bernard et al. (2015) reported that TLL of carbon content had a diminished impact on price-sensitive participants in a multi-attribute choice task exploring consumer preference for coffee brands.

One explanation for these discrepant results is that the effectiveness of TLL is moderated by consumer price sensitivity. This would suggest that the impact of TLL might have been exaggerated when investigated in the absence of price differentials (for example Bernard et al., 2015; Feucht & Zander, 2017; Slapø & Karevold, 2019). To address this concern, the present study attempts to extend the work of Osman and Thornton (2019), by investigating TLL of menu items in a hypothetical cafeteria scenario with the addition of realistic menu prices.

Social norms

The provision of social norm messages alters behavior by making salient others' typical behavior in a similar context (descriptive norms) or highlighting their (dis)-approval of certain behaviors (i.e. injunctive norms) (Abrahamse & Steg, 2013; Cialdini et al., 1991; Dolan et al., 2010). Several conditions need to be satisfied for social norm messages to effectively influence behavior: identification with the reference group, observability of the behavior, and salience of the social norms (e.g. Abrahamse & Steg, 2013; Kallgren et al., 1990). What is clear is that there is little evidence from which to determine the effectiveness of social norms or the corollary social comparisons (i.e. using a social reference class to evaluate personal beliefs, attitudes, actions – under the assumption that the reference class is "similar" to the self) in the domain of sustainable food consumption. Demarque et al. (2015) study is one of few examples. They used descriptive norms with positive quantifiers based on true but minority behaviors of people who consumed an organic product in a simulated online supermarket with real incentives. Their findings show positive behavioral change.

Given the paucity of studies examining social norms in the context of sustainable consumption, we look to evidence where social norms have been applied to promote pro-environment behaviors (e.g. recycling), and healthy eating. In the former case the evidence regarding their effectiveness is mixed (see e.g. de Groot et al., 2013; Goldstein et al., 2008; Kallgren et al., 1990; Schultz et al., 2007). In the context of healthy eating, descriptive social norms show a consistent, positive effect in promoting healthy, but the effects are limited when injunctive norms are introduced (Robinson, 2015) (see e.g. Croker et al., 2009; Higgs, 2015; Litt & Stock, 2011; Mollen et al., 2013; Robinson et al., 2013; Robinson et al., 2014; Vasiljevic et al., 2015).

Given that social norm interventions are common in the behavioral change domain but have been applied infrequently in the domain of sustainable consumption, we investigate the effectiveness of

descriptive social norm messages on sustainable meal consumption.

Present study

The objective of the present study is to use a combination of choice-preserving (e.g. labeling, social norms) and choice-incentivizing (e.g. tax, subsidy) interventions in the context of sustainable food consumption. The key motivation is that the evidence base is limited with respect to investigating the impact that choice-preserving and choice-incentivizing methods have individually and in combination to promote behavioral change. No study so far has investigated this in the context of sustainable food consumption. In addition, the study is of value in the context of behavioral change frameworks, because evidence of this kind could help to clarify how to combine multiple methods to achieve behavioral change. Thus, based on the work reviewed, we derive the following hypotheses that we subject to empirical investigation in Experiments 1 to 3.

Hypothesis 1

In line with previous research (Demarque et al., 2015; Osman & Thornton, 2019; Vermeir & Verbeke, 2006), the presentation of choice preserving interventions such as Traffic Light Labeling (TLL) and Social Norm Comparison (SNC) labeling will encourage people to choose more sustainable options (lower CO2e) compared to Baseline.

Hypothesis 2

In line with previous research (Briggs et al., 2013, 2015; Edjabou & Smed, 2013; Gren et al., 2019; Springmann et al., 2017), the presentation of carbon taxation on meal choices will encourage people to choose more sustainable options (lower CO2e) compared to Baseline.

Hypothesis 3

In line with previous research (Lehner et al., 2016; Stern, 2011), the combination of carbon taxation and choice preserving interventions (i.e. Carbon Tax + TTL, Carbon Tax + SNC) on meal choices will encourage people to choose more sustainable options (lower CO2e) compared to Baseline.

Hypothesis 4

In line with previous research (Lehner et al., 2016; Stern, 2011), the combination of both financial and behavioral features, will lead to increases in the choice of more sustainable options (lower CO2e) when both choice incentivizing and choice preserving interventions (i.e. TTL, + SNC) are presented together, compared to Baseline.

Experiment 1

Experiment 1 involved a hypothetical choice environment in which participants were required to select meals in a simulated lunchtime canteen set-up. The Experiment was designed to test hypotheses 1 to 3. The experiment comprised three stages. The first involved the presentation of basic questions regarding demographics, followed with the core choice task, and ending with general questions regarding attitudes toward carbon taxation. Two behavioral choice preserving instruments (traffic light food labeling, social "norm" comparison messaging) and one choice incentivizing instrument (carbon tax) were introduced. The impact on meal choices toward lower carbon emissions was compared for each of these, along with a combination of them, relative to a baseline.

Method

Participants

Participants were English speaking (first language), over 18, resident to the UK, living in the UK, and born in the UK; the emphasis on only sampling from participants in the UK was because the meal options included details of their price, and so we wanted participants to have experience of interpreting the values of the meal options to determine maximal sensitivity to price changes. To ensure that each participant could select equally from the available menu options, only individuals with no dietary restrictions were included. Therefore, vegans, vegetarians, pescatarians, and individuals with any food allergy or intolerance were excluded. Participants were recruited via Prolific Academic (an online crowdsourcing site) and were paid £0.50 ($0.64) for completing the experiment (£7.50 ($9.62)/h). A total of 597 participants (439 Females, 156 Males, 1 Other, 1 Prefer not to say) were recruited to take part, with a mean age of $M = 35.03$ ($SD = 10.59$), with a range of 18–65 years (3 reported they Preferred not to say). There were approximately 100 participants in each of the six between-subject conditions. In previous laboratory and field studies (e.g. An, 2013; Osman & Thornton, 2019; Slapø, 2016) examining the impact of choice preserving interventions on sustainable consumption, the number of participants included ranged between 12 to 49 per

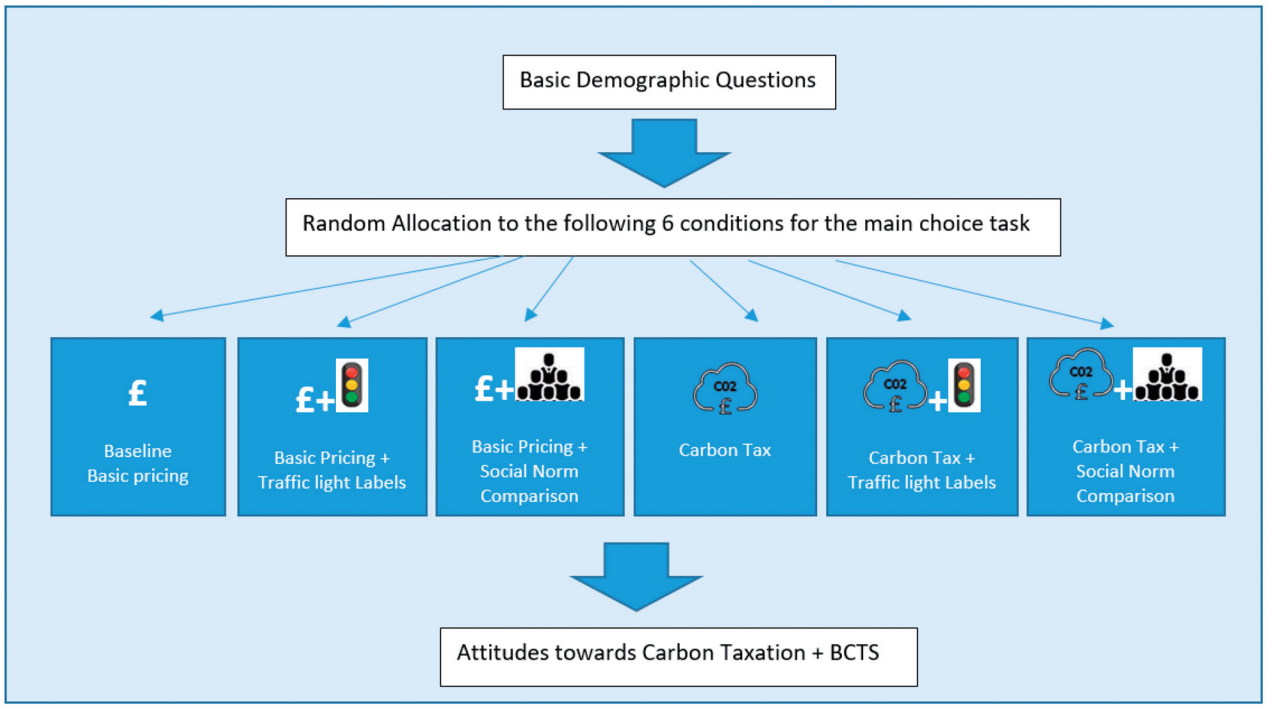

Figure 1. Schematic of the Design of Experiment 1. Participants in each condition were required to answer a total of 14 questions (5 demographic questions, 5 forced choice questions, one for each of the simulated canteen lunch time meal options presented for each working week day, and 4 attitudinal questions, to complete the experiment.

condition. On this basis, we considered that anything from 50 to 100 participants in any of the conditions we tested in our study would be a comfortable number to detect any impact of the interventions we tested.

Ethical statement

The experiment received ethics approval from the University College London Research Ethics Committee (Ethics Ref- UCL 15557/001). Before 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 completed, all responses from participants were anonymized.

Design

A 6 between (Baseline Condition, TTL Condition [behavioral change technique- traffic light label], SNC Condition [behavioral change technique – Social Norm Comparison], Carbon Tax condition, Carbon Tax + TTL condition, Carbon Tax + SNC condition) subject design was implemented (see Figure 1 for a schematic of Experiment 1). Whichever condition participants were randomly assigned to, they were made explicitly aware of changes in pricing (e.g. those signed in the Carbon Tax condition) through instruction, or through explicit instruction of traffic light labels or social norm labels.

Demographic questions. Participants were presented with six 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), Nationality (selecting from the following options English, Northern Irish, Scottish, Welsh), Education (selecting from the following options: GCSE or equivalent, High School Diploma, Bachelor degree or equivalent, Master's degree or equivalent, Ph.D. or equivalent), Income (selecting from the following options: less than £25,000, £25,000 to £34.999, £35,000 to £49,999, £50,000 to £74,999, up to £150,000 or more), Political affiliation (selecting from the following options: Left, Center-Left, Center, Center-right, Right). These were taken from the Qualtrics UK Demographic User Library (https://www.qualtrics.com/support/survey-platform/account-library/survey-library/). Before they started the main experiment participants also had to specify their dietary restrictions (vegan/vegetarian/pescatarians/intolerances/allergies) and were informed that they could no longer take part in the study if they had indicated any restrictions. This was a second screening that we introduced in addition to the first screening which was included in the advert to the

study to ensure that only participants that were eligible to take part were included in the study.

Attitudinal questions. The final stage of the experiment involved presenting participants with four questions each regarding the acceptability, effectiveness, fairness, and their approval of carbon tax, on a scale of 1 (strongly disagree) to 7 (strongly agree), and also with respect to each type of BCTs (TTL, SNC). All participants were presented with the four attitudinal questions regarding tax, and for those either presented with TTL or SNC, they were asked the four attitudinal questions specific to the BCT they were exposed to.

Forced-choice questions. Once completed, participants were presented with the main part of the experiment in which they went through a total of 5 trials designed to mimic 5 days of a working week. On each trial, they were asked "Please select the option you would most likely choose in the canteen each day". They were presented with 4 meal options, for which the dependent variable was the meal they had selected that day.

Materials

There were five critical components regarding the preparation of materials for all three experiments: 1) The menu design and options for each day of the simulated week of a lunchtime canteen; 2) the allocation of the color-coding (red, amber, green) of the 20 meal options that participants were choosing from, 3) the allocation of the social comparison label to introduce a social norm, 4) the pricing of the meal options, and 5) the level of the carbon tax.

The canteen menu. The menu was designed to resemble a typical lunch-time canteen, in that it had four daily options from one food category (e.g. curry, burrito, pasta, stir-fry, sandwich) including at least one red-meat, one white-meat, and one vegetarian option daily. There were five rounds of meal choices, one for each day of the week (for example, see Figure 2). The four daily meal options were presented both in text and with pictures. The menu's content was adapted from a previous study (Osman & Thornton, 2019). When choosing the pictures to be presented on the menu, the authors considered their appeal and similarity in terms of presentation (e.g. the angle of plate and dish used) within each day to minimize extraneous differences. All participants saw the same menu in the same sequence of days, but within each day the order of meal options was randomized to reduce ordering effects.

Traffic light labeling. For the TLL condition, labels were assigned according to the $C0_2e$ content of each meal portion (See Figure 2). Estimates were compiled from peer-reviewed lifecycle assessments for each ingredient of each item, including transport, processing, and agricultural inputs (data available at http://www.eatlowcarbon.org/). The ranges for assigning labels were: green= $\leq$ 500g$C0_2e$, amber = 501g–1299g$C0_2e$, and red= $\geq$1300g$C0_2e$. In total there were seven red meals, seven yellow meals, and six green meals. An effort was made to balance the number of each label that appeared per day, however this varied slightly from day to day. Each day contained at least one option from each label category. The design of the label was adapted from previous work (Osman & Thornton, 2019), with traffic light color coding added to the standard CFL logo.

Social norm comparison. For the SNC condition, a label stating 'customers' favorite' was introduced (see Figure 2). In each round, the label was allocated to the meal option with the lowest CO_2e footprint, allowing direct comparison with the tax intervention, as both interventions then promoted the most sustainable meal choice. 'Customers' favorite' was chosen as a tag, as it gave the impression that the labeled option was chosen and liked by many other customers and hence acted as a descriptive norm.

Meal pricing. To create baseline menu prices with ecological validity, purposeful sampling of 80 cases from 27 lunchtime restaurants was conducted in London from December 2018 to June 2019 (See Table 1). Five exemplar cases were collected for each type of each food category. The mean price of the five cases was adopted for each corresponding menu item (see Table 2 for the pricing of the different meals).

Carbon tax. For the carbon tax intervention, the base price of each menu item was adjusted according to a carbon price of £28.6 ($37.33)/t$CO^2$e. This rate was selected to represent a realistic and politically viable carbon tax scenario for the UK in 2019. Briggs et al. (2015) simulated this rate and predicted that the impact on food choices would reduce annual UK emissions by 18,900 ktCO^2e. This rate closely resembles the UK shadow price of carbon of £28 ($36.55)/t$CO^2$e (2011 prices) set by the UK Department for Business Energy and Industrial Strategy (see https://

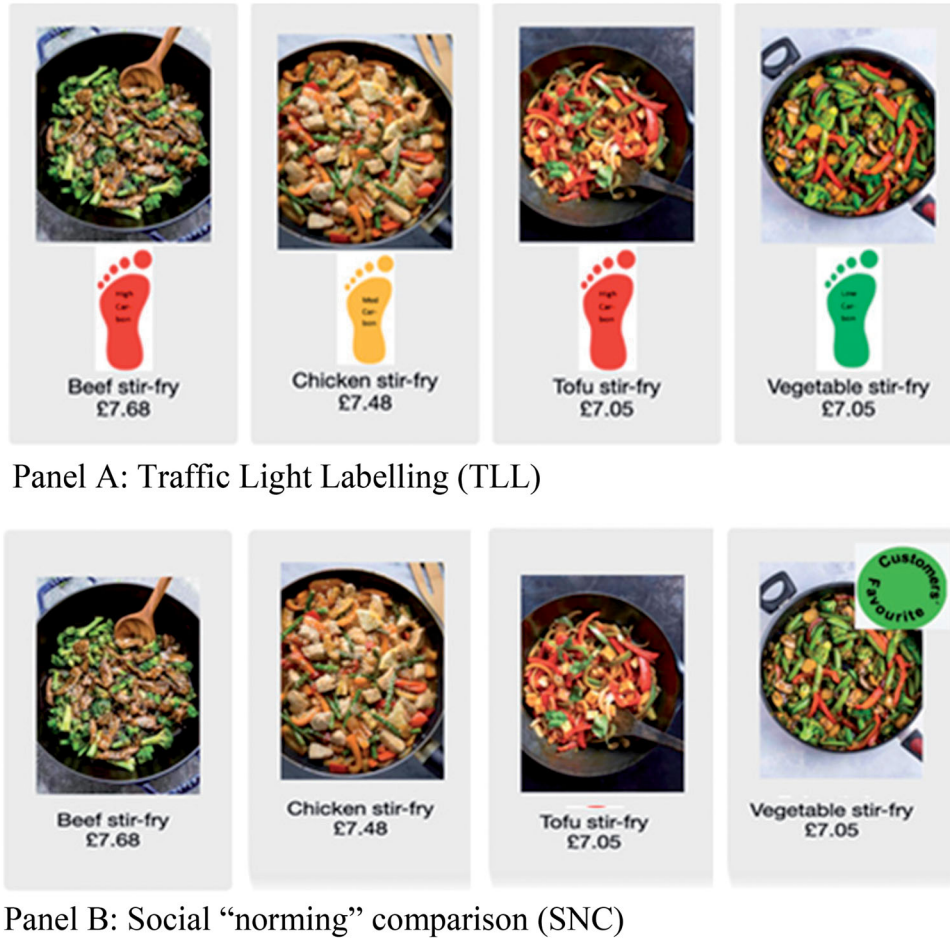

Figure 2. Example items from the simulated choice task presented in Experiments 1, 2, and 3 for which participants were asked to select a meal they would have from the lunchtime canteen menu. Figure 2.A is a screenshot of the Traffic light (TTL) labeling system. Figure 2.B is a screenshot of the Social Norm Comparison (SNC) labeling system which was placed on a pre-selected meal option (a meal option that was associated with the least $C0_2e$ emission of all four options) for each day of the simulated week. Panel A: Traffic Light Labeling (TLL). Panel B: Social "norming" comparison (SNC).

Table 1. Average Prices in UK pounds (£) and in dollars ($)for all Baseline (i.e. Control) Conditions presented in Experiments 1, 2, and 3. These were based on 80 sampled food items of lunchtime meal options from 27 London food establishments. Sampling was conducted from December 2018 to June 2019, (£1 = $ 1.275, approximately at the time).

Average prices calculated for each menu item		
		Average Price
Burrito	Red Meat	£7.90 ($10.07)
	White Meat	£7.70 ($9.82)
	Vegetables	£7.45 ($9.50)
Curry	Red Meat	£6.74 ($8.60)
	White Meat	£6.34 ($8.09)
	Vegetables	£6.04 ($7.70)
Stir Fry	Red Meat	£7.68 ($9.79)
	White Meat	£7.48 ($9.54)
	Vegetables	£7.05 ($8.99)
Pasta	Red Meat	£6.37 ($8.12)
	Seafood	£6.58 ($8.39)
	Vegetables	£5.75 ($7.33)
Sandwich	Red Meat	£3.62 ($4.17)
	White Meat	£3.52 ($4.49)
	Seafood	£3.36 ($4.29)
	Vegetables	£3.13 ($3.99)

www.gov.uk/government/collections/carbon-valuation–2). Furthermore, this system of taxation also approximates the lower cutoff of the range (US$40–80/$tCO^2e$) currently advocated by the World Bank's Carbon Pricing Leadership Coalition (2017). In addition, conditions with manipulated carbon tax had two levels (low, high). The low rate which was £28.6 ($37.33)/$tCO^2e$, and a higher rate of £63.20 ($82.50)/$tCO^2e$. The higher tax rate was equivalent to the upper-cut off of the range recommended by the World Banks's Carbon Pricing Leadership Coalition (2017). Half of all participants in Carbon Tax conditions (e.g., Carbon Tax, Carbon Tax + TLL, Carbon Tax + SNC) received the low tax version, and the remainder received the high tax version[1].

Scoring

The dependent variable was the total $C0_2e$ content of meal choices for the hypothetical week, calculated by

Table 2. Menu by treatment group matrix for Experiments 1, 2, and 3.

	Monday	Tuesday	Wednesday	Thursday	Friday
Menu item	Beef, Bean and Cheese Burrito	Roast Beef Sandwich	Beef Curry	Spaghetti and Meatballs Pasta	Beef Stir-fry
Baseline Price for all baseline conditions	£7.90	£3.62	£6.74	£6.37	£7.68
$C0_2$e Levels	2257	2839	2584	1659	2629
Low Carbon tax	£7.96	£3.70	£6.81	£6.42	£7.76
High Carbon tax	£8.04	£3.80	£6.90	£6.47	£7.85
Distributive pricing (tax + subsidy)	£8.04	£3.80	£6.90	£6.47	£7.85
Menu item	Chicken, Bean and Cheese Burrito	Philly (with beef) cheese Sandwich	Tofu Curry	Macaroni and Cheese	Chicken Stir-fry
Baseline Price	£7.70	£3.62	£6.04	£5.75	£7.48
CO2e g. (TLL)	741	3228	1295	906	608
Low Carbon tax	£7.72	£3.71	£6.08	£5.78	£7.50
High Carbon tax	£7.75	£3.82	£6.12	£5.81	£7.52
Distributive pricing (tax + subsidy)	£7.70	£3.82	£6.04	£5.75	£7.48
Menu item	Pork Burrito	Tuna Sandwich	Chicken Curry	Spaghetti marinara (seafood)	Vegetable Stir-fry
Price	£7.90	£3.36	£6.34	£6.58	£7.05
CO2e g. (TLL)	950	529	563	352	305
Low Carbon tax	£7.93	£3.37	£6.35	£6.59	£7.06
High Carbon tax	£7.96	£3.39	£6.38	£6.60	£7.07
Distributive pricing (tax + subsidy)	£7.90	£3.36	£6.34	£6.36	£6.81
Menu item	Vegetable, Bean, and Guacamole Burrito	Falafel Sandwich	Vegetable Curry	Pasta primavera (veg)	Tofu Stir-fry
Price	£7.45	£3.13	£6.04	£5.75	£7.05
CO2e g. (TLL)	427	300	260	392	1340
Low Carbon tax	£7.46	£3.13	£6.05	£5.76	£7.09
High Carbon tax	£7.48	£3.15	£6.06	£5.77	£7.13
Distributive pricing (tax + subsidy)	£7.20	£3.02	£5.83	£5.55	£7.13

Menu program adopted for the hypothetical choice task in a simulated canteen

Note. Low Carbon Tax = Carbon tax-adjusted price according to a tax rate of £28 ($36.55)/t$CO^2$e . High Carbon Tax = Carbon tax-adjusted price according to a tax rate of £63.20 ($82.50)/t$CO^2$e. Traffic light labelling assigned according to the following ranges: green = ≤500g CO^2e, amber = 501g–1299 g, CO^2e, red = ≥1300g CO^2e.

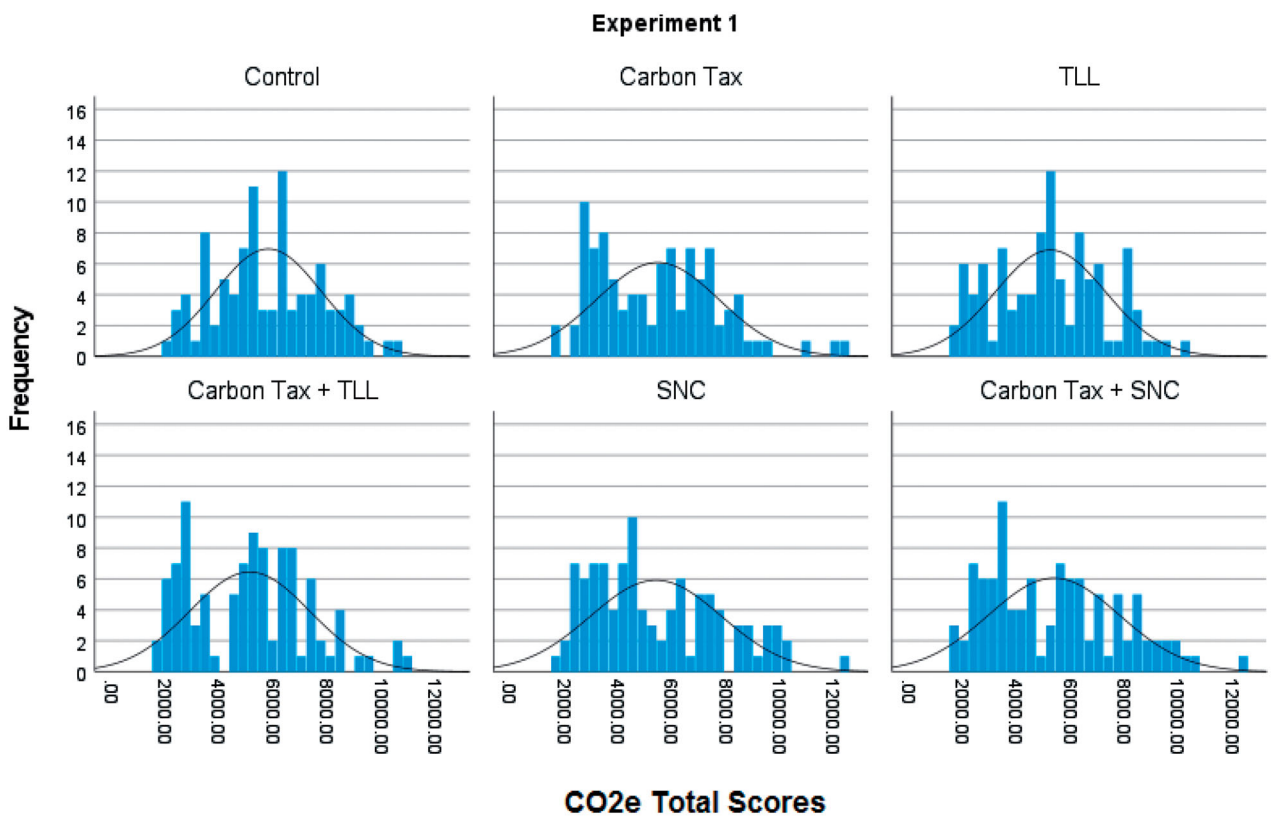

Figure 3. Histogram of Total $C0_2e$ Scores from Experiment 1 for all 6 conditions based on meal choices across a simulated working week.

adding together the number of $C0_2e$ grams associated with each meal selected on each day (http://www.eat-lowcarbon.org/) ; this scoring system was used for all experiments in this study. For responses to the attitudinal questions, a simple scoring was adopted, in which responses were summed for each participant for each set of questions (e.g. acceptable [1–7], effective [1–7], fairness [1–7], and approval [1–7] of the carbon tax, total = 28).

Results

Meal choices

The aim here is to examine important differences between the $C0_2e$ total scores Mean and SD scores by the five main experimental conditions against the baseline (See Figure 3, and Table 3). Overall, when compared against baseline, all 5 experimental manipulations generated lower $C0_2e$ total mean scores, suggesting an impact on choice behavior. TLL revealed a similar important reduction on $C0_2e$ scores ($N = 99$, $M = 5176.35$, $SD = 2045.44$) as SNC ($N = 101$, $M = 5328.51$, $SD = 2428.13$) and Carbon Tax ($N = 97$, $M = 5396.98$, $SD = 2270.94$) when compared against baseline ($N = 96$, $M = 5737.31$, $SD = 1962.99$), and when taking into account location (see Table 3). Compared against baseline and taking into account location as well, the presence of the TLL behavioral intervention in combination with a carbon tax lowered $C0_2e$ scores to a greater extent (Carbon Tax + TLL ($N = 101$, $M = 5049.04$, $SD = 2228.93$)) than the Carbon Tax + SNC combination ($N = 103$, $M = 5305.48$, $SD = 2421.80$).

Attitudes

Attitudinal total mean scores (which were summed across 4 categories: acceptable, effective fairness, approval) for carbon tax were collected for all 6 conditions. While we focused our presentation of the results on aggregate scores, we none the less present the internal reliability (Cronbach's alpha) of the four attitudinal questions here for: Carbon Tax ($\alpha = .976$), TLL ($\alpha = .974$), and SNC ($\alpha = .856$).

When looking at the pattern of scores against baseline, the scores did not seem to differ substantially (Baseline, $M = 15.84$, $SD = 6.30$, $SE = .64$; Carbon Tax, $M = 16.86$, $SD = 6.73$, $SE = .69$; TLL, $M = 15.90$, $SD = 7.22$, $SE = .72$; SNC, $M = 16.19$, $SD = 6.60$, $SE = .65$), but were marginally boosted under conditions when participants experienced tax in combination with a behavioral intervention (Carbon Tax + TLL,

Table 3. Detailed descriptive statistic for Total $C0_2e$ Scores for each condition for Experiment 1, 2 and 3.

Exp	Condition	Mean	SD	Median	SE	Skewness	Kurtosis	Location*
1	Baseline	5737.31	1962.99	5679	200.35	.203	−.518	5687.17
	Tax	5396.98	2270.94	5657	230.58	.622	.224	5232.59
	TLL	5176.35	2045.44	5103	205.57	.170	−.642	5127.12
	SNC	5328.51	2428.13	4634	241.61	.608	−.465	5028.55
	Tax + TLL	5049.04	2228.93	5178	221.79	.402	−.292	4935.57
	Tax + SNC	5305.48	2421.80	5103	238.63	.523	−.487	5079.84
2	Baseline	6195.26	2385.05	5866	232.76	.282	−.516	6089.90
	Tax	5891.34	2358.33	5721	233.51	.352	−.591	5769.89
	Tax + Subsidy	5266.42	2218.71	5354	222.99	.183	−.808	5196.86
	Tax + Subsidy + TLL	4758.41	1809.13	4840	253.32	.412	.555	4756.21
	Tax + Subsidy + SNC	4955.77	2712.21	4400	391.47	.882	.036	4479.37
3	Baseline	5916.65	2695.23	5496	272.26	.387	.862	5700.12
	Tax	5265.51	2292.37	5139	232.75	.267	−1.06	5164.36
	Tax + Subsidy	5359.98	2494.36	5368	251.97	.652	−.151	5114.06
	Tax + Subsidy + TLL	4956.34	2439.36	4886	247.68	.878	.428	4642.77
	Tax + Subsidy + SNC	4929.37	2272.19	4625	230.71	.511	−.669	4691.25
	Tax + Subsidy + TLL + SNC	4453.18	2183.84	4100	220.60	.982	.976	4171.48

*Huber's M-estimator of location.

$M = 17.41$, $SD = 6.33$, $SE = .63$; Carbon Tax + SNC, $M = 17.37$, $SD = 6.11$, $SE = .60$).

Attitudinal total mean scores for the TLL behavioral intervention, alone as well as in combination with carbon tax, were higher than all attitudinal scores for carbon tax, (Baseline, $M = 21.38$, $SD = 4.40$, $SE = .62$; TLL, $M = 20.37$, $SD = 5.38$, $SE = .76$; Carbon Tax + TLL, $M = 20.92$, $SD = 4.35$, $SE = .62$). The same pattern was found for the SNC behavioral intervention alone and in combination with carbon tax (Baseline, $M = 19.66$, $SD = 4.42$, $SE = .63$; SNC, $M = 20.50$, $SD = 4.37$, $SE = .61$; Carbon Tax + SNC, $M = 20.00$, $SD = 3.40$, $SE = .49$).

Discussion

In summary, the findings here generally indicate that, relative to baseline, TLL alone was more effective in generating behavioral change than SNC and a carbon tax, but was most effective when combined with a carbon tax, though in the latter case the variance in responses was greater. Given the implied pattern of findings, they lend greatest support to Hypothesis 3, and some support to Hypothesis 1 (with respect to TLL as an effective behavioral intervention alone) and less support for Hypothesis 2 (with respect to the impact of a carbon tax). In addition, looking at the attitudinal data, overall the pattern of findings would suggest that participants looked upon carbon tax less favorably than behavioral interventions. Attitudes toward carbon tax improved, when attitudinal responses were given from those in conditions in which they experienced a combination of carbon tax and behavioral interventions. This may reflect the fact that attitudes toward both types of behavioral interventions were positive and that there may have been spillover effects to carbon tax.

Given the implied pattern that TLL was more effective than social norms when combined with carbon tax, we consider some of the factors that might explain this. Evidence on the use of social norming in the domain of pro-environmental behaviors has been reportedly mixed. Therefore, because of the potential fragility of this type of intervention, we looked to Demarque et al. (2015), which has reported positive effects specifically in the domain of sustainable consumption. They used true descriptive norm information to the social norms label, and so we consider this as a possible way to improve on the intervention in Experiment 2.

Regarding taxes, there are two potential explanations for the muted support for Hypothesis 2. First, the reason might be the size of the price changes introduced by the intervention relative to the baseline price differences between menu options. To illustrate this point, the mean price change introduced by the tax level of £28.60/tCO_2e was £0.03 per item, while the average menu price was £6.18. This represents an average price change of less than 0.05%. To address this issue, Experiment 2 introduced a new pricing scenario. Firstly, only the carbon taxation scenario at the rate of £63.20/tCO2e was carried forward. Secondly, a redistributive tax scenario which included both a tax (£63.20/tCO_2e) on high $C0_2e$ items and a subsidy on low $C0_2e$ items was added to the design, as proposed by Galinato and Yoder (2010). The second potential explanation comes from the attitudinal data which indicates that participants were less positively disposed to carbon tax than behavioral interventions, and only when combined with behavioral interventions were there increases in attitudinal scores for carbon tax. Given this, the aim of Experiment 2 is to examine this further, by focusing

on the efficacy of combinations of different hard and soft interventions.

Experiment 2

Given that the findings from Experiment 1 indicate the positive impact of combing hard and soft interventions, Experiment 2 examined further the extent to which different combinations could support effective behavioral change, in this case through the introduction of subsidies in combination with a carbon tax - via a redistributive pricing mechanism. Moreover, given that there are so few studies that have examined the effectiveness of combinations of hard and soft interventions, this provided further reason for focusing on manipulations which concerned different combinations of this type to determine which combinations were most effective.

Subsidies are an example of 'guiding choice through incentives' from the Nuffield Intervention Ladder. Field studies have demonstrated that subsidies are effective at shifting food preferences toward healthier options (An, 2013; French, 2003; French et al., 2001). Furthermore, research suggests that voters support environmental subsidies more than environmental taxes (Cherry et al., 2012) and that redistributive pricing mechanisms are as effective (Briggs et al., 2015), more popular (Gren et al., 2019) and more socially equitable (Briggs et al., 2015; Combet et al., 2010; Jensen et al., 2011) than regressive taxes in the context of food systems.

Additionally, in Experiment 2, to boost the effectiveness of the SNC in combination with hard measures, we made changes to the SNC by adding true descriptive norm information to the social norms label, which was a minor modification to the basic SNC used in Experiment 1, and we kept with the same TLL system as used in Experiment 1. Thus, Experiment 2 followed a similar design to Experiment 1, but this time the choice-preserving and choice incentivizing methods were paired with subsidies, and their potential effects were compared against a baseline. Thus, Experiment 2 tested hypotheses 2 and 4.

It is worth noting that the full combination of conditions was not included in Experiment 2, where we omitted to include conditions in which we examined the effects on CO_2e total scores, based on TLL alone, and SNC alone, along with Carbon Tax + TLL, Carbon Tax + SNC, and Carbon Tax + TLL & SNC. Given that no study, to the authors knowledge, has explicated investigated the use of a redistributive pricing system alone and in combination with other choice preserving interventions, and to make the design of the study manageable, we focused primarily on examining the impact of Carbon Tax + Subsidy alone and in combination with TLL and SNC, at the expense of a full design (which would have involved an additional 5 conditions on top of the 5 included in Experiment 2).

Method

Participants

Participants were English speaking (first language), over 18, resident to the UK, living in the UK, and born in the UK. All other criteria applied in Experiment 1 were also applied in Experiment 2, including the same payment schedule. A total of 405 participants (296 Females,108 Males, 1 Prefer not to say) were recruited to take part, with a mean age of $M = 34.94$ ($SD = 10.73$), with a range of 18–69 years. Approximately 48 to 100 participants were in each of the five between-subject conditions.

Design

A 5 between (Baseline Condition, Carbon Tax condition, Carbon Tax + Subsidy condition, Carbon Tax + Subsidy + TLL condition, Carbon Tax + Subsidy + SNC condition) subject design was implemented. In all other aspects, Experiment 2 was identical to Experiment 1, including the 10 questions (5 demographic questions, 5 choice questions) presented to participants (for a full list of details of conditions see Table 4).

Materials

There were four critical differences between Experiments 1 and 2. The first was the introduction of subsidies in the choice component of the experiment. The second was the presentation of the four attitudinal questions on subsides. The third was that all participants were presented sets of questions on the carbon tax and subsidies, but that, consistent with Experiment 1, participants were asked about their attitudes toward TTL in conditions where they had experience of them, and the same for those in conditions where they experienced SNC (making a total of 22). Fourth, there was a small change made to the social comparison intervention.

In all other aspects, the critical components of Experiment 2 were the same as Experiment 1 regarding the menu design and options, the implementation of the two choice preserving manipulations (Traffic Light Labeling, and Social Comparison label), the

Table 4. Details of conditions included in Experiment 1, 2 and 3.

Conditions	Details of conditions	Exp.1	Exp. 2	Exp. 3
C1	Baseline control condition, participants only saw the meal options and their prices. **Baseline**	C1	C1	C1
C2	Choice incentivizing instrument used here was a carbon tax. Participants saw the meal options and their prices which included the carbon tax. **Carbon Tax**	C2	C2	C2
C3	Choice preserving instrument used here was a Traffic light labeling system. Participants saw the meal options and their prices along with traffic light labels. The meal options were labeled according to traffic light labels (green = low $C0_2e$ emissions, amber = moderate $C0_2e$ emissions, red = high $C0_2e$ emissions) to signal levels of $C0_2e$ emissions. **Traffic Light Label (TLL).**	C3		
C4	Choice preserving instrument used here was the presentation of a social comparison "norm" which labeled the lowest $C0_2e$ emitted food as the "customer's choice". Participants saw the meal options and their prices along with the social norm. **Social Norm Comparison (SNC)**	C4		
C5	Participants saw the meal options and their prices which included the carbon tax and the Traffic light label (TTL). **Carbon Tax + TLL**	C5		
C6	Participants saw the meal options and their prices which included the carbon tax a social "norm" comparison (SNC). **Carbon Tax + SNC**	C6		
C7	Choice incentivizing instrument used here was a distributive pricing system (subsidy and carbon tax). Participants saw the meal options and their prices which included the carbon tax and the subsidy. **Carbon Tax + Subsidy**		C7	C7
C8	Participants saw the meal options and their prices which included the carbon tax and the subsidy and the Traffic light labeling system. **Carbon Tax + Subsidy + TTL**		C8	C8
C9	Participants saw the meal options and their prices which included the carbon tax and the subsidy and the social norm comparison label. **Carbon Tax + Subsidy + SNC**		C9	C9
C10	Participants saw the meal options and their prices which included the carbon tax and the subsidy, and the Traffic light labeling system and the social norm comparison label. **Carbon Tax + Subsidy + TTL + SNC**			C10

basic pricing of the meals, and the Carbon Tax (for which the high level was implemented in all conditions in which Carbon taxation was applied to the price of the meals).

Social norms comparison label. Participants were now also informed about how many previous participants had chosen the labeled option to provide them with a true and concrete descriptive norm, as done by Demarque et al. (2015). The relevant percentage was based on data from Experiment 1 and ranged from 16% to 28%. For example, a statement would read: "For your information, 19% of previous customers have opted for the 'customers' favorite' sustainable meal choice of the day'". While the true social norm information did not convey the most commonly selected, it was the most common selection of the available sustainable options with the lowest possible $C0_2e$ levels for a given day.

Subsidies. The carbon tax/subsidy intervention was designed as a redistributive fiscal scenario (see Tables 1(A–C)). Consumption patterns for Experiment 2 were first based on participant response data from Experiment 1 (tax condition only). The modeled consumption of meals with the highest levels of associated $C0_2e$ (meals with levels $\geq$300g$C0_2e$) under the high taxation rate (£63.20/tCO^2e) was used to estimate the total revenue collected from meals with the highest levels of associated $C0_2e$. This revenue was then redistributed to subsidize meals with the lowest levels of associated $C0_2e$ (meals with levels $\leq$ 500g$C0_2e$), in proportion to each item's baseline price and predicted selection. Meals with intermediate levels of associated $C0_2e$ (meals with levels $\geq$300g$C0_2e$) remained at their baseline price (meals with levels 501 g–1299g$C0_2e$) (for details see Table 2).

Results

Meal choices

To examine important differences in $C0_2e$ total scores based on the various manipulations included in Experiment 2, the Mean and SD scores of the four main experimental conditions were judged against the baseline (See Figure 4 and Table 3). Overall, the patterns suggest that, when compared against baseline, all 4 experimental manipulations generated lower $C0_2e$ total mean scores, suggesting a positive impact on choice behavior. Specifically, when compared against the baseline ($N = 105$, $M = 6195.26$, $SD = 2385.05$), the lowest $C0_2e$ total scoring conditions were when

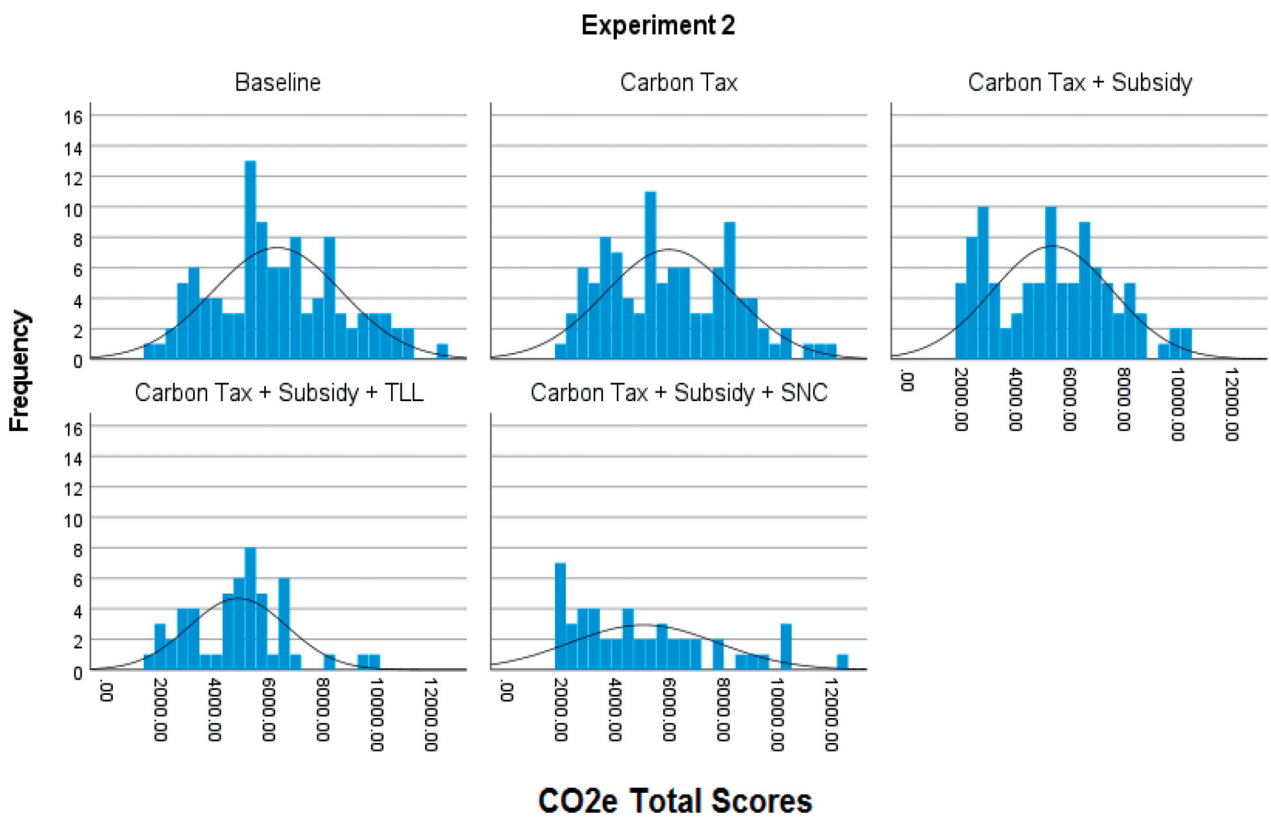

Figure 4. Histogram of Total $C0_2e$ Scores from Experiment 2 for all 5 conditions based on meal choices across a simulated working week.

carbon tax and subsides were combined with behavioral interventions: Carbon Tax + Subsidy + TLL ($N = 51$, $M = 4758.41$, $SD = 1809.13$), Carbon Tax + Subsidy + SNC ($N = 48$, $M = 4955.77$, $SD = 2712.21$); reflected also in the location (see Table 3). When presented without behavioral interventions, compared to baseline, Carbon Tax + Subsidy ($N = 99$, $M = 5266.42$, $SD = 2218.71$), led to lower scores than Carbon Tax ($N = 102$, $M = 5891.34$, $SD = 2358.33$), again consistent with the pattern indicated in location (see Table 3).

Attitudes

Attitudinal total mean scores for carbon Tax were collected for all 5 conditions. As with Experiment 1, we focused our presentation of the results of the attitudinal measures based on aggregate scores, but we none the less present the internal reliability (Cronbach's alpha) of the four attitudinal questions for: Carbon Tax ($\alpha = .936$), Subsidies ($\alpha = .955$), TLL ($\alpha = .865$), and SNC ($\alpha = .870$).

When looking at the pattern of scores against baseline, the scores did not seem to differ substantially (Baseline, $M = 16.15$, $SD = 6.33$, $SE = .65$; Carbon Tax $M = 16.39$, $SD = 6.59$, $SE = .65$; Carbon Tax + Subsidy, $M = 16.87$, $SD = 6.54$, $SE = .66$) apart from when behavioral interventions were included in combination with the hard measures (Carbon Tax + Subsidy + TLL, $M = 17.96$, $SD = 6.65$, $SE = .91$; Carbon Tax + Subsidy + SNC, $M = 18.19$, $SD = 5.82$, $SE = .84$); this is consistent with the pattern reported in Experiment 1.

Focusing on attitudinal total mean scores for subsidies that were also collected for all 5 conditions, the scores were consistently higher than those for carbon tax, (Baseline, $M = 19.64$, $SD = 5.71$, $SE = .81$; Carbon Tax, $M = 17.48$, $SD = 6.68$, $SE = .96$; Carbon Tax + Subsidy, $M = 18.97$, $SD = 7.15$, $SE = .1.02$; Carbon Tax + Subsidy + TLL, $M = 20.16$, $SD = 6.44$, $SE = .90$; Carbon Tax + Subsidy + SNC, $M = 19.58$, $SD = 6.19$, $SE = .87$).

Attitudinal total mean scores for a TLL behavioral intervention were higher than all attitudinal scores for carbon tax (Baseline, $M = 21.84$, $SD = 4.21$, $SE = .60$; Carbon Tax + Subsidy + TLL, $M = 21.29$, $SD = 5.46$, $SE = .77$). The same pattern was found for the SNC behavioral intervention alone and in combination with carbon tax (Baseline, $M = 19.56$, $SD = 4.86$, $SE = .69$; Carbon Tax + Subsidy + SNC, $M = 21.06$, $SD = 4.74$, $SE = .66$).

Discussion

Overall, the pattern of findings regarding choice behavior suggests that the most effective approach to encouraging sustainable consumption was a redistributive pricing mechanism (Carbon Tax + Subsidy) in combination with either behavioral intervention (TLL, SNC), where TLL had some advantage over SNC, and lower variability in scores. Relative to baseline, the marginal decrease in scores was lower when carbon tax was presented alone than Tax + Subsidy. Given these results, there is some basis for speculating an additive effect of choice preserving interventions on the Carbon Tax + Subsidy-based intervention, given the magnitude of difference in scores when compared against Carbon Tax + Subsidy alone, and compared against baseline. Thus, from these findings, there is good support for Hypothesis 4, and somewhat less support for Hypothesis 2, the latter of which is consistent with the findings from Experiment 1.

Turning to the attitudinal data, consistent with Experiment 1, the overall pattern of findings in Experiment 2 would suggest that participants were consistently more positively disposed to either behavioral interventions and subsidies compared to carbon tax; but that when participants were from conditions experiencing carbon tax, subsidies, and behavioral interventions combined, then attitudes toward carbon tax improved. The mean total attitudinal scores for subsidies and behavioral interventions appeared to be generally within the same range, indicating that this type of hard measure as well as the soft measures were judged as equally acceptable; we also infer this because there was no substantive boost to attitudinal scores for subsidies for those in conditions where subsidies were combined with behavioral interventions. These findings lend further weight to the ethical debates surrounding the use of choice incentivizing interventions in social policy domains (e.g. Heilmann, 2014), and indicate a preference for particular types of interventions over others in the context of sustainable food consumption.

Given the positive findings with respect to the Carbon Tax + Subsidy intervention, Experiment 3 was designed to replicate and extend these effects by examining if there were a further boost to positive behavioral change if paired with both TLL and SNC simultaneously.

Experiment 3

The findings from Experiment 2 revealed that the most compelling impact of the manipulations on choice behavior resulted from the introduction of the redistributive pricing scheme, which supported positive behavioral in combination with choice preserving methods. Thus, Experiment 3 followed a similar design to Experiment 2, but this time included a further condition in which both choice-preserving methods were paired with the Tax + Subsidy intervention. Hence, Experiment 3 tested hypotheses 2 and 4. For the same reasons provided in Experiment 2, we opted for a reduced design were we omitted the inclusion of TLL alone, and SNC alone, along with Carbon Tax + TLL, Carbon Tax + SNC, and Carbon Tax + TLL & SNC.

Method

Participants

Participants were English speaking (first language), over 18, resident to the UK, living in the UK, and born in the UK. All other criteria applied in Experiment 1 were also applied in Experiment 3, including the same payment schedule. A total of 585 participants (372 Females, 209 Males, 2 Other, 2 Prefer not to say) were recruited to take part, with a mean age of $M = 36.00$ ($SD = 12.23$), with a range of 18–65 years. Approximately 97 participants in each of the six between-subject conditions.

Design

A 6 between (Control Condition, Carbon Tax condition, Carbon Tax + Subsidy condition, Carbon Tax + Subsidy + TLL condition, Carbon Tax + Subsidy + SNC condition, Carbon Tax + Subsidy + TLL + SNC condition) subject design was implemented. Except for the introduction of new conditions, in all other aspects Experiment 3 was similar to Experiment 1 and 2 (for a full list of details of conditions included in Experiment 3 see Table 4).

Materials

There were only two critical differences between Experiment 2 and 3. The first critical difference was the addition of a condition where participants were presented with Carbon Subsides + TLL + SNC. In all other aspects, the critical components of Experiment 3 were the same as Experiment 2 regarding the menu design and options, the implementation of the two choice preserving manipulations. The second difference was that all participants were presented with attitudinal questions probing for their disposition toward choice preserving interventions in general (including descriptions of both TTL and SNC). This meant that

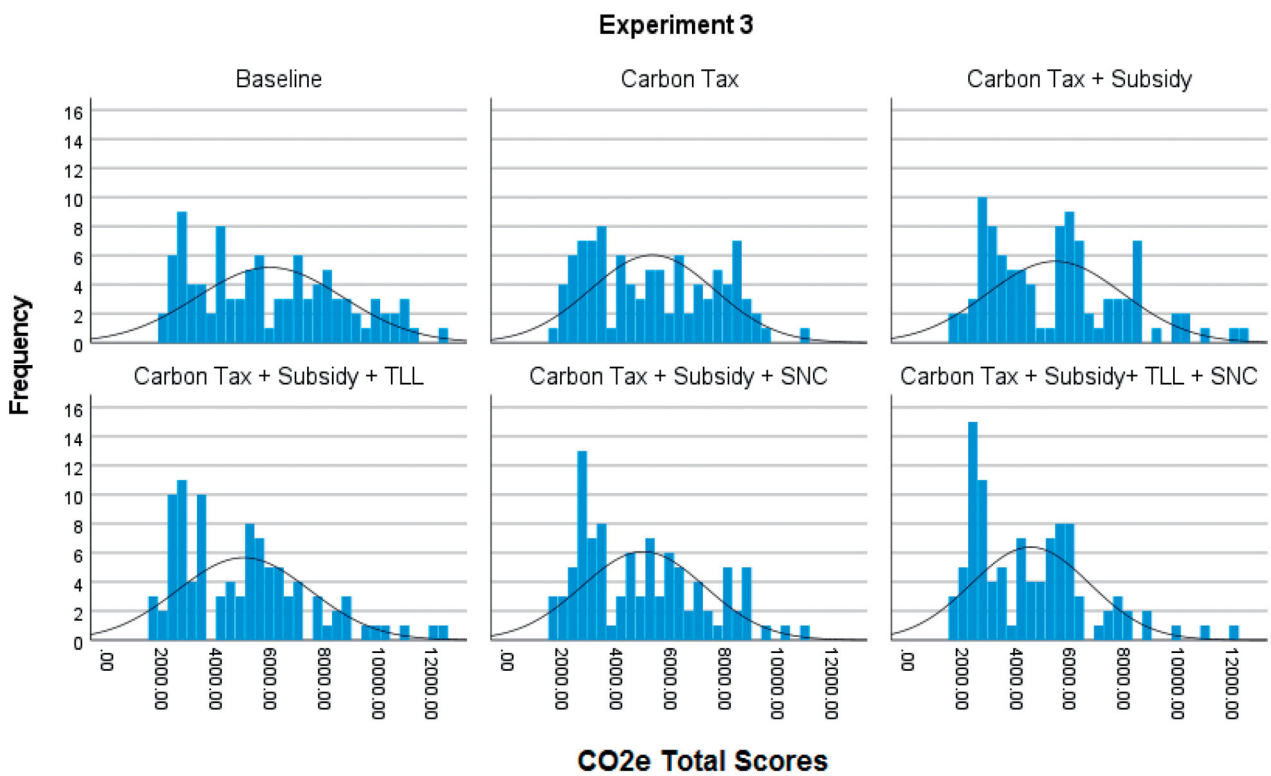

Figure 5. Histogram of Total $C0_2e$ Scores from Experiment 3 for all 6 conditions based on meal choices across a simulated working week.

those participants that were not exposed to them during the main choice experiment could volunteer their attitudes toward choice preserving interventions. Thus, no separate questions concerned either TLL or SNC, but instead the four attitudinal questions on choice preserving interventions indicated attitudes toward the use of them in general rather than a specific type. However, the experimental program failed to record a large proportion of responses to the attitudinal questions, therefore we were unable to perform a fair comparison, and so these responses were not submitted to statistical analysis.

Results

Meal choices

To examine important differences in $C0_2e$ total scores based on the manipulations included in Experiment 3, the Mean and SD scores by the 5 main experimental conditions were judged against the baseline (see Figure 5 and Table 3). Overall, consistent with Experiment 1 and 2, the patterns for Experiment 3 also suggest that, when compared against baseline, all 5 experimental manipulations generated lower $C0_2e$ total mean scores, suggesting a positive impact on choice behavior. Specifically, when compared against the baseline ($N = 98$, $M = 5916.65$, $SD = 2695.23$), the lowest $C0_2e$ total scoring conditions were when Tax and Subsides were combined with behavioral interventions: Carbon Tax + Subsidy + TLL + SNC ($N = 98$, $M = 4453.18$, $SD = 2183.84$) – see also location (Table 3) where the greatest reduction was observed, Carbon Tax + Subsidy + SNC ($N = 97$, $M = 4929.37$, $SD = 2272.19$), Carbon Tax + Subsidy + TLL ($N = 97$, $M = 4956.34$, $SD = 2439.36$). When presented without behavioral interventions, compared to baseline, Carbon Tax ($N = 97$, $M = 5265.51$, $SD = 2292.37$) and Carbon Tax + Subsidy ($N = 98$, $M = 5359.98$, $SD = 2494.36$) showed similar lower levels of $C0_2e$ total mean scores, as also reflected in the location scores (Table 3).

Discussion

Consistent with Experiment 2, the pattern of findings from Experiment 3 regarding choice behavior suggest that the most effective approach to encouraging sustainable consumption was a redistributive pricing mechanism (Carbon Tax + Subsidy) in combination with either behavioral intervention (TLL, SNC), where the biggest advantage was when the interventions were presented together with carbon tax and subsidies. Relative to baseline, when carbon tax was presented alone than Tax + Subsidy, both led to similar

levels of decrease in scores, but not as dramatic as when behavioral interventions were also introduced. Again, as with Experiment 2, the findings in Experiment 3 also indicate that there may be an additive effect of choice preserving interventions on the Carbon Tax + Subsidy-based intervention given the magnitude of difference in scores when compared against Carbon Tax + Subsidy alone, and compared against baseline. Thus, from these findings, there is good support for Hypothesis 4, and somewhat less support for Hypothesis 2, the latter of which is consistent with the findings from Experiment 1 and 2.

General discussion

The present study aimed to examine the impact of choice-preserving and choice-incentivizing interventions (separately and in combination) on promoting positive behavioral change toward sustainable consumptive choices in a simulated lunchtime canteen environment. To this end, we tested four hypotheses across three experiments. We found some support for Hypothesis 1 which asserted that choice preserving interventions (Traffic Light Labeling, Social Comparison – through social norming) would lead to positive behavioral change as compared to baseline (Experiment 1). We also found some support for Hypothesis 2 which asserted that Carbon Tax would encourage more selections of low carbon emission meals relative to baseline (Experiments 1, 2, and 3). We found compelling support for Hypothesis 3 which asserted that a combination of choice preserving interventions and Carbon Tax would lead to positive behavioral change relative to baseline (Experiment 1, 2). We found consistent compelling support for Hypothesis 4 which asserted that a redistributive pricing system (Tax + Subsidy) in combination with choice preserving interventions would lead to positive behavioral change relative to baseline (Experiment 2, 3).

Overall, the main take away from this study is that the presence of a redistributive pricing mechanism in combination with either or both behavioral interventions was the most effective in encouraging behavioral change relative to all types of manipulations, when judged against baseline. The most effective combination (Carbon Tax + Subsidy + TLL + SNC) substantially reduced emissions by 1533.59g$C0_2$e over the hypothetical week of choosing meals, with a reduction of 24.4% compared to the baseline condition. Over a year, this intervention would decrease the carbon footprint of an individual's weekday lunchtime meal choices by over 80Kg$C0_2$e. Thus the findings from the present study support the view that multipronged interventions are likely to be most effective at creating positive shifts in environmental behaviors (Frederiks et al., 2015; Lehner et al., 2016), especially those which include both choice preserving and choice incentivizing components (Stern, 2011).

We also explored people's attitudes by asking them to report the extent to which they judged carbon tax, subsidies, and choice preserving methods as acceptable, effective, fair, and whether they approved of them (Experiment 1, Experiment 2). Across both experiments, participants were consistently more positively disposed to behavioral interventions than carbon tax. In addition, relative to carbon tax, the use of a redistributive pricing system was judged more favorable, and with similar levels of approval to both types of behavioral interventions. These findings are consistent with previous work that suggest that the public are generally in favor of the use of choice preserving interventions (e.g., Bang et al., 2020; Bos et al., 2015), as well as the use of subsidies as a choice incentivizing mechanism specifically in the context of sustainable consumption (Gren et al., 2019).

Hard (choice incentivizing/choice incentivizing) interventions: carbon tax & subsidies

The present study indicates that for choice of meal, the use of a carbon tax alone was generally less effective in encouraging shift toward sustainable choices, relative to both choice preserving (TLL, SNC), and in combination with those and another choice incentivizing (Subsidy) method. In fact, boosts to positive behavioral change leading to choices with lower carbon emissions were only observed when carbon tax was combined with other measures. In addition, attitudinal data also suggest that approval was lower for a carbon tax relative to compared to the use of subsidies and the two behavioral change interventions. Field studies have found that taxes can effectively shift food choices toward healthier options (Block et al., 2010; Cornelsen et al., 2017; Elbel et al., 2013; French, 2003), or toward low carbon foodstuffs (Briggs et al., 2013, 2015; Edjabou & Smed, 2013; Gren et al., 2019; Säll & Gren, 2015; Springmann et al., 2017). Also, consistent with this, economic modeling studies have predicted that carbon pricing will be an effective means of shifting consumption toward low $C0_2$e foods (Briggs et al., 2013, 2015; Edjabou & Smed, 2013; Gren et al., 2019; Springmann et al., 2017).

Why might it be that the impact of carbon tax in the present study was somewhat limited given what has been

reported previously? There is one critical reason to suggest that the carbon tax intervention we used may not have been sufficient to shift food choices as compared to field studies and prior modeling work. The pricing mechanisms investigated in the aforementioned field studies were several magnitudes larger than those of the present study, providing greater extrinsic (dis)incentives for behavioral change. To illustrate this, French et al. (2001) investigated price reductions for healthy vending machine snacks of between 10% and 50%. One explanation for this discrepancy is that modeling studies predict changes over long-term periods taking into account repeated consumer purchasing habits; this methodology can therefore sensitively predict very small shifts in consumption patterns detectable at the population level.

In contrast, the price change introduced by the carbon tax in the present study was 0.5% (low carbon tax) and (high carbon tax) 1% of the price of each meal. It is important to note that the baseline prices of the meals were based on realistic UK lunchtime meal prices. Also, the levels of taxation we introduced were selected for their fidelity in line with current guidelines equivalent to the upper-cut off of the range recommended by the World Banks' Carbon Pricing Leadership Coalition and UK Department for Business Energy and Industrial Strategy (see https://www.gov.uk/government/collections/carbon-valuation – 2). In fact, given these factors, we would highlight that it is striking that we were able to find any positive behavioral change because the magnitude of the price change through the application of the carbon tax we used is lower than the levels tested in previous work.

Concerning the redistributive pricing mechanism (i.e. Carbon Tax + Subsidies) that we used, the present study is the first of its kind to investigate the impact on behavioral change, alone, but also crucially in combination with choice preserving interventions. In fact, the addition of subsidies to the tax pricing mechanisms was the pivotal element to achieving substantive positive behavioral change. This could partially be explained by an increased price difference through the inclusion of subsidies on more sustainable products as compared to the carbon tax only intervention. Additionally, the Subsidy intervention also met higher overall approval ratings from participants, which aligned with their choice behavior.

Finally, given the design of our experiments, it is worth noting that for the redistributive pricing mechanism and for carbon tax, it was possible to draw inferences with regards to the potential additive effect of combining these measures with behavioral change interventions. For both Experiment 2 and 3, the pattern of results (See Table 3) indicate that this is likely the case, whereby the addition of either or both behavioral interventions boosted the efficacy of the redistributive pricing manipulation, as well as and carbon tax manipulation (Experiment 1, Experiment 2).

Soft (choice preserving) interventions: labeling and social norming

Traffic light labels

TLL of the carbon content of meal options was found to encourage sustainable meal choices on its own (Experiment 1) when judged relative to the use of a carbon tax, and against baseline; though the TLL appeared to have a greater impact on choice behavior when combined with other measures. The former is consistent with previous work by Osman and Thornton (2019) and other prior studies examining TLL to encourage sustainable choices in hypothetical choice tasks (Bernard et al., 2015; Feucht & Zander, 2017; Thøgersen & Nielsen, 2016).

It is still worth highlighting that there are important differences between the use of TLL in the present study compared to previous studies, which mean that any inferences regarding the effectiveness of TLL needs to be caveated. Firstly, as we highlighted in the introduction, Osman and Thornton (2019) investigated labeling interventions in the absence of menu prices. The results of the present study suggest that TLL of carbon content is less effective at shifting meal choices when studied in relation to other combinations of interventions where pricing is taken into account. This explanation is supported by the results of other studies that showed greater precedence of price over labeling in determining consumer preferences (French et al., 2001; Thøgersen & Nielsen, 2016; Vanclay et al., 2011). Secondly, the dependent variable of the present study was the total $C0_2e$ content of meal choices, which was a continuous quantitative variable. In contrast, Osman and Thornton (2019) converted CO_2e scores into a cruder ordinal variable with diminished measurement granularity. Therefore, the current measures collected in the present study should be considered an improvement in measurement fidelity.

As discussed earlier, prompting consumers to consider internalized food-environment associations via food labeling was designed to impact both personal and social identity salience modes, based on basic and social psychological theorizing (IBM, VBN, SC) and evidence (e.g. Costa Pinto et al., 2014; Costa Pinto et al., 2016; Griskevicius et al., 2010; Luchs et al.,

2015; Vermeir et al., 2020). The fact that the food labeling manipulation appeared to be more effective in combination with choice incentivizing manipulations could be because, in combination, these targeted personal and social identity salience factors, where norms, values and goals are likely to be at odds with sustainable consumption. We know that in a personal identity salience mode consumer prioritize price, and nutrition above environmental concerns (de Boer et al., 2013; Feucht & Zander, 2017; Filimonau et al., 2017; Grunert et al., 2014; Walker, 2018). This may explain why field studies which measure food choices in the complexity of real consumer environments have found TLL to be limited in its effectiveness (e.g., Slapø & Karevold, 2019; Vanclay et al., 2011). Thus, in the present study, the provision of information through carbon labeling, along with the price of meals in a menu, together with the use of choice incentivizing methods might be a better approach to take. This is because in combination they signal which meal options are more or less sustainable, as well as targeting misperceptions that sustainable food options are more expensive than less sustainable options (Hebda & Wagner, 2016).

Social comparison

Social comparison interventions in the form of a descriptive social norm label, and true and concrete descriptive social norms alone (Experiment 1) appeared to be less effective than in combination with choice incentivizing methods. Though as with labeling, attitudinal data suggested that people were positively disposed to social norming as a behavioral intervention. One reason for this is that social norms work best in situations of high uncertainty (Cialdini & Trost, 1998), but choosing one's daily lunch meal in a canteen may not qualify as a high uncertainty situation given that food choices are identified as examples of highly habitual behaviors (Lehner et al., 2016), which are based on personal norms, values and goals, or influenced by group norms and values.

It is important to note that one mechanism through which descriptive norm messaging is often claimed to work is by majority ruling: people decide on their behavior based on what most others seem to do (Robinson, 2015). Minority norms might even have adverse effects, deterring people from following the desired behavior (Stok et al., 2012). Moreover, this is likely a relevant factor when considering persuasive tactics that are designed to target personal norms, values and goals, as well as alternative group norms and values. In this research, the descriptive norms ranged from 16–28% of previous customers who performed the desired behavior, even when balancing this against the fact that this research had four and not two meal options, most given norms were under 25%. However, the aim here, as with other stimuli used in the present study, was to maintain fidelity as much as possible. While details about social norms in the present study were accurate, prior work has presented details that can inflate the actions and choices of the social norms referred to. It is therefore not surprising that the effectiveness of social norming was less prominently observed. However, when combined with choice incentivizing methods such as a carbon tax (Experiment 1) and subsidies (Experiment 2 and 3), we were still able to find the additive effects of using social norming, even in the form we presented it.

Regulatory versus behaviorally informed interventions

One of the critical points we made about behavioral change frameworks (e.g. BCW, EAST, BASIC) is that while they incorporate the use of choice incentivizing/choice restricting interventions alongside their choice preserving interventions, it is beyond their scope to suggest through their frameworks what combinations work in a given social policy domain in advance. We also raised the issue regarding the value of considering the narrow and broader context in which behavioral change interventions are trialed. The specific context, with respect to increasing sustainable meal choices in a lunchtime canteen, involves targeting knowledge (i.e. knowing what meals are more or less environmentally sustainable), as well as correcting misperceptions, and personal as well as social norms, values and goals. In addition, it could involve targeting preferences (i.e. having an idea of common preferences as a guide to individual choice), and targeting price (Carbon Tax, Carbon Tax + Subsidy), as well as availability (i.e. the ratio of sustainable to less sustainable options). The broader context in this case also includes the application of pricing mechanisms that are implemented in various guises that could compete with, or complement the specific context (e.g. fat tax, sugar tax, meal offers), the competing eateries in the area, and attitudes toward different types of interventions. Examining these factors in a controlled experimental study helps to broaden the thinking on the contextual factors that promote or can inhibit behavior change. Developing an evidence base of this kind, where interventions are trialed systematically in various combinations to determine possible additive

effects, can inform formal modeling so that the likelihood of success of future single or combinations of interventions can be estimated in advance of trialing them (Osman et al., 2020). Even without formal modeling, carefully thinking through in advance the context (narrow and broad) in which an intervention will be applied can be useful. This can be represented by drawing a causal map of preexisting contextual factors and behavior, along with when and where an intervention is inserted (see Cartwright, 2009). Doing this can help the researcher/practitioner reason through possible countervailing factors that might inhibit the effectiveness of an intervention (for illustrations see, Osman et al., 2020). This type of approach is invaluable for anticipating the efficacy of interventions, as well as reducing costs in time and money when trialing interventions, especially when conducted in the field (Meder et al., 2018, Osman et al., 2020).

Conclusion

The present study is the first of its kind to directly compare the relative effectiveness of choice preserving interventions (e.g. Labeling, Social Norms) with choice incentivizing interventions (e.g. Carbon Tax, Tax + Subsidy) in the context of sustainable food consumption. The study revealed that traffic light labeling and social norm comparison interventions, and carbon tax were to some degree able to promote sustainable meal choices in a hypothetical lunchtime canteen. However, the introduction of a tax and subsidy intervention was most successful in increasing sustainable meal consumption, particularly in combination with traffic light labeling or social norm comparison interventions, and especially when the two behavioral interventions were combined. Overall this research is the first of its kind to provides empirical support for the synergistic effects of combining fiscal and behavioral interventions to increase sustainable meal choices.

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Data availability statement

The raw data for the Experiments 1, 2, and 3 will be made available on publication.

Note

1. The differences between high ($M = 5972.24$, $SD = 2299.54$) and low taxation ($M = 5344.27$, $SD = 2315.95$) - while present - were not deemed substantive, when comparing the means and standard deviations of the main dependent measure of total $C0_2e$. Therefore, we collapsed high and low taxation in each of the three conditions in which this manipulation was introduced: Carbon Tax, Carbon Tax + TTL, and Carbon Tax + SNC conditions.

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