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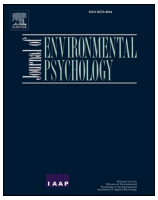

Personal or planetary health? Direct, spillover and carryover effects of non-monetary benefits of vegetarian behaviour

Ganga Shreedhar *, Matteo M. Galizzi

Department of Psychological and Behavioural Sciences, London School of Economics and Political Science, United Kingdom

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ABSTRACT

There is a debate about whether framing motivations as personal or planetary benefits - or both - is more effective at encouraging sustainable actions and promoting positive behavioural spillovers. In a pre-registered online longitudinal experiment, we randomly allocate n = 1242 respondents to either a control condition, or to one of three novel, interactive implementation intention interventions framing the benefits of a vegetarian diet in terms of either personal health, or planetary health, or both personal and planetary health. We ask respondents to choose between real vegetarian or non-vegetarian foods. We then ask them to donate part of their money to a charity. We finally measure their food choices three days and two months after the interventions. Compared to the control group, we find that participants assigned to any of the behavioural interventions are twice as likely to choose a vegetarian option. We find no statistically significant differences in the proportions of vegetarian options across the three experimental conditions. We find evidence of a positive behavioural spillover on the donations to charity amongst participants exposed to combined personal and planetary health. Three days after the interventions, participants allocated to this combined frame still reported to eat more vegetarian meals than in the control group. Such carryover effects, however, did not persist two months after the interventions. Overall, our research offers new insights about framing behavioural interventions to motivate sustainable actions and their potential behavioural spillovers.

1. Introduction

There is now a wide consensus that dietary shifts are needed to mitigate climate change. A fourth of global greenhouse gases emissions arise from food consumption (Vermeulen et al., 2012). Consuming more vegetarian meals and avoiding red meat can reduce these emissions (Bajželj et al., 2014; Camilleri et al., 2019; De Boer et al., 2013; Poore & Nemecek, 2018). The EAT-Lancet Commission recommends halving global consumption of red meat and doubling the intake of fruits, vegetables and nuts compared with present-day diets (Willett et al., 2019).

Debate exists, however, about how best to motivate this shift towards more sustainable diets. Increasingly, psychological and behavioural science interventions are attempting to 'nudge' pro-environmental behaviours like vegetarian eating by changing the decision-making context (Carlsson et al., 2020; Kaiser et al., 2020), for example by changing the location of the food items, their 'default' options, and other 'choice architecture' aspects (Gravert & Kurz, 2019; Kurz, 2018). Other lines of research are looking at sending daily text messages (Carfora, Bertolotti, & Catellani, 2019,b), or at reframing menus and food items without changing their descriptions (Bacon and Krpan, 2018; Krpan and Houtsma, 2020). As part of the broader literature on framing environmental choices (Cornelissen et al., 2008; Lacasse et al., 2016; Spence et al., 2014; Steinhorst et al., 2015; Steinhorst & Matthies, 2016; Whitmarsh, 2009), a parallel approach is exploring how best to frame the benefits of vegetarian behaviour, for example by comparing monetary vs. non-monetary benefits (Carrico et al., 2018; Wolstenholme et al., 2020).

Within this context, we test the direct, spillover, and carryover effects of framing the non-monetary benefits of vegetarian diet in terms of personal health, planetary health, or co-benefits combining the two. We randomly allocate respondents to either a control condition, or to one of three novel, interactive implementation intention (II) interventions which frame the benefits of a vegetarian diet in terms of either personal health, or planetary health, or both personal and planetary health. We then measure the impact of the II interventions on consequential vegetarian choices, on an unrelated real charity donation, and on self-

* Corresponding author. Department of Psychological and Behavioural Sciences, The London School of Economics & Political Science, Floor 3 (room 3.10) Connaught House, 63-65 Aldwych, London, WC2B 4EJ, United Kingdom.
E-mail address: g.s.shreedhar@lse.ac.uk (G. Shreedhar).

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reported diet at two points in time, three days, and two months after the interventions.

In the next sub-sections we first review the existing literature on framing benefits (1.1), behavioural spillovers and carryover effects (1.2), framing co-benefits, and II and food choices (1.4), including how we contribute to these streams of the literature. We then proceed by developing the hypotheses regarding the specific interventions used in the present study, and we describe our experimental design (1.5).

1.1. Framing personal versus environmental benefits

Framing can be seen as the process by which people develop a particular conceptualisation or reorient their thinking about an issue (Chong & Druckman, 2007). In the conventional expectancy-value model, an individual's attitude can be seen as comprised of a series of evaluative beliefs about a given issue (Ajzen & Fishbein, 2000). Framing communication and behaviour change interventions, therefore, often characterises an appeal to one of several possible attitudes or motivations for displaying a specific behaviour, for instance by making salient the environmental, health or financial dimensions of an issue (Steinhorst et al., 2015). This in turn can persuade people to interpret an issue under a new light by creating new beliefs, or by making existing beliefs accessible or salient, possibly leading to behaviour change.

Central tenets in standard economic theory are that people's choices are driven by economic self-interest, and they are strongly motivated by extrinsic monetary incentives (Benabou & Tirole, 2003). In a meta-analysis, Maki et al. (2016) found that financial incentives interventions had a small-to-medium effect on pro-environmental behaviours while incentives were in place and even after they were discontinued, thus causing both direct and carryover effects. Framing information interventions in terms of economic self-interest, for example by highlighting monetary savings from acting pro-environmentally, is one of the most employed ways to persuade people to undertake pro-environmental action (Carrico et al., 2018; Evans et al., 2013; Steinhorst et al., 2015; Steinhorst & Matthies, 2016; Xu et al., 2018a).

Other evidence, however, presents a more mixed picture. Several field studies show that financial incentives can backfire by crowding out cooperation in resource conservation dilemmas (Rode et al., 2015). This suggests that appealing to self-interested motives is not necessarily effective in all contexts (Taufik et al., 2015; Thøgersen & Crompton, 2009). Studies on framing also highlight that monetary appeals are not necessarily more effective than environmental appeals. For example, Asensio and Delmas (2015) found that environment- and health-based information interventions outperformed monetary savings information in driving energy conservation. Bolderdijk et al. (2013) found that fewer customers took a coupon for a free tyre pressure check when exposed to a monetary savings appeal compared to an environmental or a control appeal, possibly because participants experienced an intrinsic reward, i.e. they felt better when complying with environmental appeals. Taufik et al. (2015) show that compliance with environmental appeals can be related to self-concept and intrinsic motivations: participants perceive themselves as good people and feel a "warm glow" when learning that they acted pro-environmentally. Thus, despite the theoretical prediction that self-interest framing may be effective, and despite the encouraging evidence from studies using monetary incentives to motivate pro-environmental behaviour, other studies show that monetary incentives can have mixed effects. Existing studies on framing which primarily emphasise monetary gains also show limited and mixed empirical evidence that environmental appeals are less effective.

Furthermore, when comparing monetary versus environmental framing, previous studies tend to either club environmental and health benefits together (e.g. in Ansenio and Delmas, 2015), or change both the degree of self-interest *and* the behavioural domain (e.g. personal money savings vs. public environmental benefits). Furthermore, each of these framings may have an independent behavioural effect on subsequent behaviours. For instance, some domain-specific information campaigns may emphasise the environmental domain in the hope that it positively influences the takeup of other desirable behaviours (Thomas et al., 2019). Thus, another risk is that appealing to personal monetary benefits may backfire by causing unintended consequences on subsequent behaviours, as discussed below.

1.2. Behavioural spillovers and carryover effects

A growing literature examines whether pro-environmental behaviours are prone to "behavioural spillovers" whereby the adoption of one behaviour reduces or increases (negative or positive spillovers respectively) the likelihood of adopting another subsequent action (Maki et al., 2019). Interventions appealing to personal or environmental benefits can therefore impact the likelihood of the target behaviour *and* induce positive ('promoting') or negative ('permitting') behavioural spillovers (Dolan & Galizzi, 2015; Nash et al., 2017; Thøgersen, 1999; Truelove et al., 2014).

For instance, Evans et al. (2013) found recycling was significantly higher when participants were primed by reading environmental information about car-sharing but was not different from the control when they received information about monetary savings, or about both monetary and environmental benefits. In another study, when electricity saving tips were framed either as cash or CO_2 savings, both the monetary and the environmental framing showed higher intentions for saving electricity compared to the control group with no information (Steinhorst et al., 2015); however, positive spillovers via an increase in climate-friendly intentions – beyond electricity savings – were only found in the environmental framing condition. These studies suggest that, apart from inducing self-interested - rather than self-transcendent – mindsets, appealing to extrinsic monetary rewards can also potentially reduce psychological benefits such as warm glow and can crowd-out intrinsic motivation (Evans et al., 2013; Deci, Koestner, & Ryan 1999; Rode et al., 2015). Relatedly, van der Linden (2015) notes that extrinsically motivated incentives, like one-off monetary rewards, can be less likely to sustain pro-environmental behaviour change over time after they are removed than interventions seeking to strengthen intrinsic motivations.

Indeed, while evidence is fast growing on the spillover effects of interventions to promote environmental behaviours (Capstick et al., 2019; Carrico et al., 2018; Claes & Miliute-Plepiene, 2018; Cornelissen et al., 2008; Fanghella et al., 2019; Lacasse, 2016, 2019; Lanzini & Thøgersen, 2014; Lauren et al., 2016, 2019; Nash et al., 2018; Poortinga et al., 2013; Seebauer, 2018; Shreedhar & Mourato, 2019; Sorrell et al., 2009; Tiefenbeck et al., 2013; Thøgersen, 1999; Thomas et al., 2016, 2019; Truelove et al., 2014, 2016; van der Werff et al., 2014a,b; Whitmarsh & O'Neill, 2010; Whitmarsh et al., 2018; Xie et al., 2017; Xu et al., 2018a,b), there is limited and mixed evidence on the carryover effects of such behavioural interventions (Allcott & Rogers, 2014; Brandon et al., 2017; Ferraro et al., 2011; Kurz, 2018; van der Linden, 2015). Moreover, existing studies typically measure spillovers between pro-environmental intentions or self-reported actions, with very few studies measuring spillovers between directly revealed behaviours (Maki et al., 2019).

Little research systematically maps the direct, spillover and carryover effects of interventions framing the non-monetary benefits of reducing red meat consumption. To the best of our knowledge, only two studies have explored health versus environmental benefits of red meat eating specifically, and one of them studied carryover effects. Carrico et al. (2018) found that health and environmental frames reduced self-reported red meat consumption in an online diary study; while the environmental condition did not spillover onto charitable donations in the sub-sample of those who reporting reducing meat consumption, the health condition induced a small negative effect on green donations (there was no substantive difference in the results when those who had not changed their meat consumption were included). Wolstenholme et al. (2020) found that receiving information on the health or the

environmental impact of meat was effective in reducing red meat consumption compared to the control group during the intervention period, with some effects remaining one-month later, whereas they find little evidence of behavioural spillover when controlling for change in red meat consumption. Taken together, the evidence from these two studies suggest that health and environmental framing in information interventions can reduce red meat consumption, but whether spillover and carryover effects exist is unclear. These two studies do not examine whether combining both health and environmental frames is more effective.

1.3. Framing health and environmental co-benefits of sustainable food choices

To the best of our knowledge, the study by Evans et al. (2013) has been the first to look at the effect of 'co-benefits' framing, which emphasises both self-interested (personal) and public (planetary) benefits together: while they find evidence of positive spillovers from the environmental framing on subsequent recycling behaviour, they do not find any positive spillover effect associated to the 'co-benefits' framing. This may be because making self-interest salient may cause the co-benefit framing to 'crowd-out' the intrinsic motivation to undertake a personally costly behaviour which has planetary benefits.

An alternative view is that appealing to both the personal and environmental co-benefits of addressing climate change (e.g., save money or have a healthier life, *and* save the planet) can motivate sustainable actions (Bain et al., 2016; Karlsson et al., 2020; West et al., 2013). Since the costs of changing behaviours often appear more salient, the benefits from doing so are often overlooked. Appealing to co-benefits may also persuade people who are unconvinced or unconcerned about environmental change. Furthermore, given the shared, public good nature of many pro-environmental behaviours, including red meat reduction, a sufficiently large number of people need to take action to have a positive impact via emissions reduction. People can thus be hesitant to act if they perceive that they are in a minority, or because they do not want to be "suckered" (Ostrom, 2012). So making co-benefits salient could be more effective than only emphasising planetary benefits, since a person's choice may be good for themselves and for the planet, even if others don't undertake that action. Along these lines, a survey from 24 countries across the world found that stated motivations to act on climate change were significantly related to beliefs about co-benefits (Bain et al., 2016).

When it comes to changing diets, health and environmental co-benefits are still often overlooked in policy applications (Karlsson et al., 2020). This contrasts with the emerging evidence showing that reducing red meat and increasing plant-based foods in diets indeed yield both planetary environmental benefits (e.g., mitigating livestock emissions) and personal health co-benefits (e.g. lower risks of pancreatic cancers) (Thurston, 2013; West et al., 2013; Willett et al., 2019; Karlsson et al., 2020).

In sum, there is mixed evidence of direct and spillover effects of motivating pro-environmental behaviours using personal versus environmental benefits, with a limited focus on reducing red meat consumption. Only Wolstenholme et al. (2020) have studied carryover effects. We are not aware of any studies which also test if co-benefits framing is more effective. Past studies tend to change both the domain (e.g. health vs. environment) and the degree of self-interest. Most studies, moreover, rely on stated behavioural intentions or self-reported behaviours.

To unpack these mixed findings on the effectiveness of self-vs. environment-focused framing interventions, we believe it is important to hold the domain constant across the experimental conditions – for example by emphasising the health domain in the framing of all the interventions – but varying the framing only in terms of *personal* or *planetary* health, for example. So, we test a new frame in terms of planetary health. The notion of planetary health is linked to the framework advanced by The Lancet's 'Planetary Health' journal, and is a philosophical and scientific position explicitly acknowledging that human health depends on natural planetary systems, and there are positive intersections between the two (Horton & Lo, 2015). Specifically, we look at both the direct and the spillover effects of personal and planetary health benefits of vegetarian eating, as well as of their interaction in terms of co-benefits. We also look at the sustained carryover effects of the interventions, by looking at what happens both three days and two months after the treatment.

Our study is most comparable to Carrico et al. (2018) and Wolstenholme et al. (2020). The main differences of our study with respect to those two articles are that we consider II interventions instead of informational messages (discussed below); we keep the domain constant by framing benefits as personal or planetary health, rather than using health or environmental framing; we consider two sequential and consequential (i.e. incentive-compatible) choices, namely choosing a vegetarian item and donating to a charity; and lastly, following Galizzi and Whitmarsh (2019), we conceptualise spillover effects as changes in the second, non-target behaviour (i.e., donations) arising from exposure to the intervention itself. This is different from the spillovers considered by Carrico et al. (2018) that focus on the changes in the second behaviour for those participants for whom the intervention "worked" to change the first target behaviour (i.e. choosing a veg option).

1.4. Implementation intentions and sustainable food choice

Research on implementation intentions (II) demonstrates that prompting people to develop an 'if-then' plan (e.g., '*When situation x arises, I will do y in z way*') increases the likelihood that the targeted action is implemented. In if-then plans, situational cues specifying where, when and how the target goal will be achieved, can trigger an automatic association between the target behaviour and a particular future context.

In the recent years, a growing number of studies have tested the impact of II interventions to increase healthy eating - or decrease unhealthy eating (Adriaanse et al., 2009, 2011; Chapman & Armitage, 2010, 2012; Knäuper et al., 2011; Loy et al., 2016; Nooijer et al., 2006; Stadler et al., 2010). II interventions for healthy eating are if-then plans which specify the *where, when*, and *how* of goal striving (e.g., "*If* I am tempted to snack at work, *then* I will eat more fruits!") rather than just a desired end-state (e.g., "I want to eat more fruits!") (Gollwitzer, 1999). First, II interventions specify a critical situation in advance, to make it more accessible in memory, which in turn increases the likelihood that this situation can be recognised as an opportunity to act upon one's intentions. Second, II interventions use an if-then format is used to link the situation to a specific goal-directed behaviour, so that the behaviour is activated automatically when the individual encounters the situation.

The application of II interventions is especially relevant for food behaviours since there often is an intention-behaviour gap in food choices: e.g., even if people have good intentions to eat healthier, they do not necessarily do so (Gollwitzer & Sheeran, 2006; Sheeran & Webb, 2016). Thus, II interventions can make eating intentions more likely to be acted upon, by prompting individuals to commit to plans that specify when, where and how the most important behavioural steps towards the eating goal will be carried out. In a recent meta-analysis of the impact of II interventions for food behaviours, Adriaanse et al. (2011) found that II interventions are an effective tool for promoting the inclusion of healthy food items in one's diet (Cohen's d effect size = 0.51, medium), and diminishing unhealthy eating patterns (Cohen's d = 0.29) (although the latter effect is less strong). These studies largely rely on self-reported data on food choices through retrospective recall questions.

Most II intervention studies typically inform participants about the behavioural goal (e.g., increase intake of fruits and vegetables in Chapman & Armitage, 2010) and state all benefits from achieving, or working towards, the goal (e.g., health, environmental and ethical benefits of avoiding red meat in Loy et al., 2016) rather than in the

implementation intentions plan itself. However, making benefits salient in plans could be useful. Wood and Neal (2016) note that the three central components of habit formation are behavioural repetition, associated context cues, and rewards. In other words, habits are created through automatic repetition in relatively stable contexts, which cue what behaviours will likely be rewarded. As previously discussed, these rewards or benefits, in turn, can be intrinsic (e.g., warm glow) or extrinsic (e.g., monetary payoffs). So, associating the contextual cue to a benefit within the plan could potentially create or strengthen the association between the two.

This could be especially important when the goal is to create new habits whilst simultaneously breaking old ones (e.g., switch to vegetarian instead of non-vegetarian options). Whereas non-habitual behaviours can often be guided by intentions and motivations, habits can guide behaviour once they are in place (Wood, Tam & Whitt, 2005). Studies show that eating habits can be stronger determinants of food choices than intentions (Neal et al., 2013). To address this, II plans specify an alternative response which can overrule habits by specifying contextual cues (e.g., specific locations and times). It is possible, therefore, that II interventions making benefits – a critical component of habit formation - salient in the plan itself alongside contextual cues can help switching to new habits.

So we attempt to make benefits salient in the plan themselves, by reminding people *why* it is beneficial to change behaviour while simultaneously cueing them about *how* to do so in a specific context. To the best of our knowledge the only study that combines II interventions with motivational versus contextual cues is Adriaanse et al. (2009): according to self-reported data in a 7-day food dairy, they found that II interventions specifying motivational cues (e.g., 'snacking to be social') were more effective at increasing healthy snack consumption than an II intervention specifying only situational cues (i.e., place/where and time/when). We combine motivational and contextual cues within the plan, where the motivation is to do good for the personal or the planetary health.

Face-to-face II interventions can be resource- and time-intensive. They can also be influenced by the possibility that people with intentions to change their behaviours opt into the study, or assume that those participating have the intentions to change behaviour (unless adequate precautions are taking by the researchers during the recruitment phase e.g., blinding the study topic). However, an emerging strand of literature on 'planning prompts' shows that modified II plans can be used at scale, even when intentions are to change behaviour are not explicitly expressed and for behaviours which bring public benefits (e.g., vaccinations), or are desirable in themselves (e.g., voting). Planning prompts are light-touch II plans, where the goal is still to help people via implementation intentions by asking when and where they plan to act. They function like nudges because they don't necessitate face-to-face interactions, it is costless to drop-out, and they do not restrict choice. Simple, low-cost, paper-based planning prompts have shown promise in large-scale field experiments targeting flu vaccination (Milkman et al., 2011), preventive screenings (Milkman et al., 2013), and voter turn-out (Nickerson & Rogers, 2010). Like other II interventions, they also help create a mental association between engaging in the target behaviour and a specific future moment and context. It is possible that the act of making concrete plans addresses behavioural barriers to action, like inattention, forgetfulness, and impulsivity (Rogers et al., 2015). While there is now evidence of planning prompts impacting one-time actions, there is little comparable evidence that such simple and scalable planning interventions are effective for important repeated actions (like dietary choices) and on their spillover and carryover effects. Planning prompts also don't typically specify benefits alongside contextual cues.

Thus, despite the proven success of II interventions in the context of changing diets, we are not aware of studies that incorporate personal and planetary health benefits into the plans themselves or that test the direct, spillover and carryover impact of doing so on revealed behaviours. We are also not aware of past studies that leverage nudge-like II plans in the context of diets. We innovatively build on these literatures to test whether explicitly combining digital II interventions with either personal, planetary or a joint personal and planetary health framing affects food choices. To look at actual behaviours, we incorporate an incentive-compatible food choice task where participants reveal their preference over vegetarian and non-vegetarian food options immediately following an II intervention. We also collect self-reported data three days and one week following the intervention, to check for the persistence of potential effects.

1.5. Overview of the hypotheses and the study design

Based on the research reviewed above, we hypothesise that there is a direct positive effect of II interventions on vegetarian food choice, i.e., those individuals exposed to any II intervention are more likely to choose a vegetarian option in the food choice task compared to a control condition with no II intervention.

We also hypothesise that those exposed to the personal health II framing will be more likely to choose a vegetarian food option compared to the II interventions framed in terms of planetary health. Given the above evidence on co-benefits, we also hypothesise that the personal and planetary health framing is at least as effective as the personal health framing on influencing vegetarian food choice.

Given the mixed and conflicting previous evidence on unintended spillover effects on non-target behaviours, we hypothesise that there is no spillover effect from the II interventions on subsequent non-targeted charitable donations.

Finally, based on the limited previous evidence on carryover effects of behavioural interventions to reduce meat consumption, we hypothesise that II interventions have no sustainable carryover effects two months after the treatment, whereas they may still have some effect three days after.

To test these hypotheses, we conduct a longitudinal pre-registered online study with three rounds of data collection. Round one consists of three II interventions corresponding to the personal, planetary, or personal and planetary health benefits, where we look at their impact in terms of direct effects on vegetarian food choices, and of spillover effects on charitable donations. In rounds two and three, we follow up the same participants three days and two months later, respectively, to check if there is any persistent carryover effect of the II interventions on self-reported vegetarian food choices. Table 1 presents an overview of the study design. The pre-registration plan, data, and code for all parts of the study can be accessed via the Open Science Framework (link here).

2. Materials and methods

Using data from round one, we first test whether the II interventions with personal, planetary, or personal and planetary health frames increase vegetarian food choices compared to the control group with no II intervention (*Control-Food*). We then test if there is any spillover effect of the II health frames on a subsequent behaviour, charitable donations. To rule out of the possibility that the mere act of choosing food prior to facing a donation decision may have an independent effect on donations (Galizzi & Whitmarsh, 2019), we include another control group where participants directly face the donation task without any food choice task (*Control-Donations*). In rounds two and three, we check how persistent any effects are on vegetarian food choices, by testing whether the II interventions increase self-reported vegetarian food choices.

To probe how robust our results are, we also look at several covariates. Past behaviour (i.e., the number of days people have been vegetarian during the previous week, and if they have previously donated to charities) is used as a covariate because other studies have shown that past behaviour can predict current behaviour, including for vegetarian food and donation choices (Ouellette & Wood, 1998; Bacon & Krpan, 2018; Shreedhar & Mourato, 2019). We also control for people's self-identified diet types, for instance if they are flexitarian or

Table 1
Experimental design.

Sequence	Implementation Intentions intervention		Behaviour 1 (B1)	Behaviour 2 (B2)	Self-reported diet	
Treatment groups	Personal health framing	Planetary health framing	Food choice	Charitable donation	Three days after	Two months after
Control-Donations				✔	✔	✔
Control-Food			✔	✔	✔	✔
Personal	✔		✔	✔	✔	✔
Planetary		✔	✔	✔	✔	✔
Personal + Planetary	✔	✔	✔	✔	✔	✔

Note: ✔ indicates which frame, task and survey participants was exposed to in each condition.

omnivore. Hunger is measured because it can influence preference for high-calorie foods and can therefore potentially influence people to select a non-vegetarian option (Lozano, Crites, & Aikman, 1999). We also assess the role of socio-economic covariates, including gender, age, and political orientation, since being female, younger and left-leaning has been associated with vegetarianism and dietary choices in the past literature (Dhont & Hodson, 2014; Rozin et al., 2012; Ruby et al., 2016).

2.1. Experimental design, participants, and procedure

In round one, respondents are randomly assigned to one of five experimental conditions. In each of the three treatment conditions, participants are exposed to an II intervention that frames the benefits of plant-based foods in terms of either personal health (*Personal*), or planetary health (*Planetary*), or both personal and planetary health (*Personal + Planetary*). All respondents then face the food choice task (Behaviour 1, B1), after which they immediately face the charitable donation task (Behaviour 2, B2). To obtain the causal effect of the differently framed II interventions, another set of participants are randomly assigned to a control condition with no II intervention, but where they directly face the food choice task and then the charitable donations task (*Control-Food*). Comparing individual decisions in the food choice task across this control condition and the treatment conditions yields the direct causal effect of II interventions on vegetarian food choices. Comparing individual differences in behaviour in the charitable donations task between this control and the treatment conditions yields the spillover effect from being exposed to differently framed II interventions and making a food choice on donating, compared to making a food choice and then donating.

Comparing differences in donating behaviour between the treatment conditions and the control condition where participants directly face the donation task without facing any food choice task (*Control-Donation*) yields the spillover effect from being exposed to differently framed II interventions and making a food choice on donating, compared to simply donating (B2).

To summarise, we use a between-subjects longitudinal experimental design with five experimental conditions: one control condition where subjects undertake only the charitable donations task (*Control-Donation*; B2); another control condition where subjects undertake the food choice task and then the charitable donations task (*Control-Food*; B1 and then B2); and three treatment conditions where participants face one of the differently framed II interventions, followed by the food choice task and then the charitable donation task (*Personal, Planetary, Personal + Planetary*; II behavioural intervention followed by B1 then B2).

Afterwards, participants complete questions on past food consumption, donations and other everyday behaviours, socio-demographic characteristics, other control variables, and two manipulation checks.

In round two and three of the longitudinal design, subjects are asked to report on how many days they have been vegetarian over the past three days and one week respectively, along with some other past everyday behaviours.

The study complied with the university's Research Ethics Policy guidelines. We pre-registered the study in the Open Science Framework website (links for pre-registration here, and data and code here). To estimate the sample size per group, we assume a small effect size of Cohen's d = 0.23, based on similar figures from two meta-analyses of past experimental studies on nudges, implementation intentions, and food choices (Adriaanse et al., 2011; Cadario & Chandon, 2019). Since our main outcome of vegetarian food choice is a binary variable, we use z tests of difference between two independent proportions for the power analysis in G*Power 3.1 (Faul et al., 2007), which suggested a minimum number of n = 200 participants in each group. As participants were to be surveyed in two more rounds, an indicative 20% attrition rate was also factored in.

An online panel was recruited through Prolific Academic. The study was advertised as a "Study on everyday behaviours" and the experimental survey was hosted on the Qualtrics survey platform. To minimise attrition across the three rounds of the study, and to ensure good quality responses, participation was conditional on respondents being UK residents and having previously completed at least ten studies on Prolific Academic. Round one was made available on December 5, 2018, round two was launched three days later, and data for round three was collected two months later on February 6, 2019. All participants were paid £1 and £0.50 and £0.50 to complete rounds one, two and three respectively. On top of this, they could keep any earnings from a bonus gift voucher they could win for completing all three rounds. This bonus payment was also used to incentivise the food and donation tasks, as explained in the next section.

2.2. Implementation intention interventions

In round one, participants are randomly allocated to either a control condition, or to one of three interactive II interventions (see Fig. 1). In all the II conditions, participants see information about the health benefits from increasing plant-based foods and reducing red and processed meats. The information is framed in terms of: either personal health due to reductions in personal health risks (e.g. colorectal cancer, heart diseases: '*Personal*'); or planetary health due to reductions in climate change risks (e.g. agricultural deforestation, emissions and water pollution from livestock farming: '*Planetary*'); or reductions in both personal and climate change risks ('*Personal + Planetary*').

The following text introduces the planning prompt: '*Many people find it helpful to make an if-then plan to reduce red and processed meat in their diet*' and given the following example: '*If I am tempted to order a meat dish at a restaurant or café, then I will ask myself "do I really want to do this for my personal health?"*' (*Personal*).

Then, in our interactive II task, participants could make their own if-then plan by dragging and dropping their choice of two possible 'If statements' (E.g. *If I write down my groceries list before my shopping on the weekend; If I feel tempted to snack after a stressful day*) and 'Then statements' (E.g. *Then I will plan for a healthy vegetarian meal; Then I have to eat fruits, nuts or cut vegetables, for my own health*) into an 'If' and 'Then' box respectively. The 'If' statements are identical across groups, and only the 'Then' statements vary across conditions (e.g., *a healthy and environmentally friendly vegetarian meal; for my own health and the environment*).

After the II plans respondents face two sequential tasks: (i) choosing between vegetarian and non-vegetarian food items that they would receive for real if they won a bonus gift voucher in a subsequent lottery

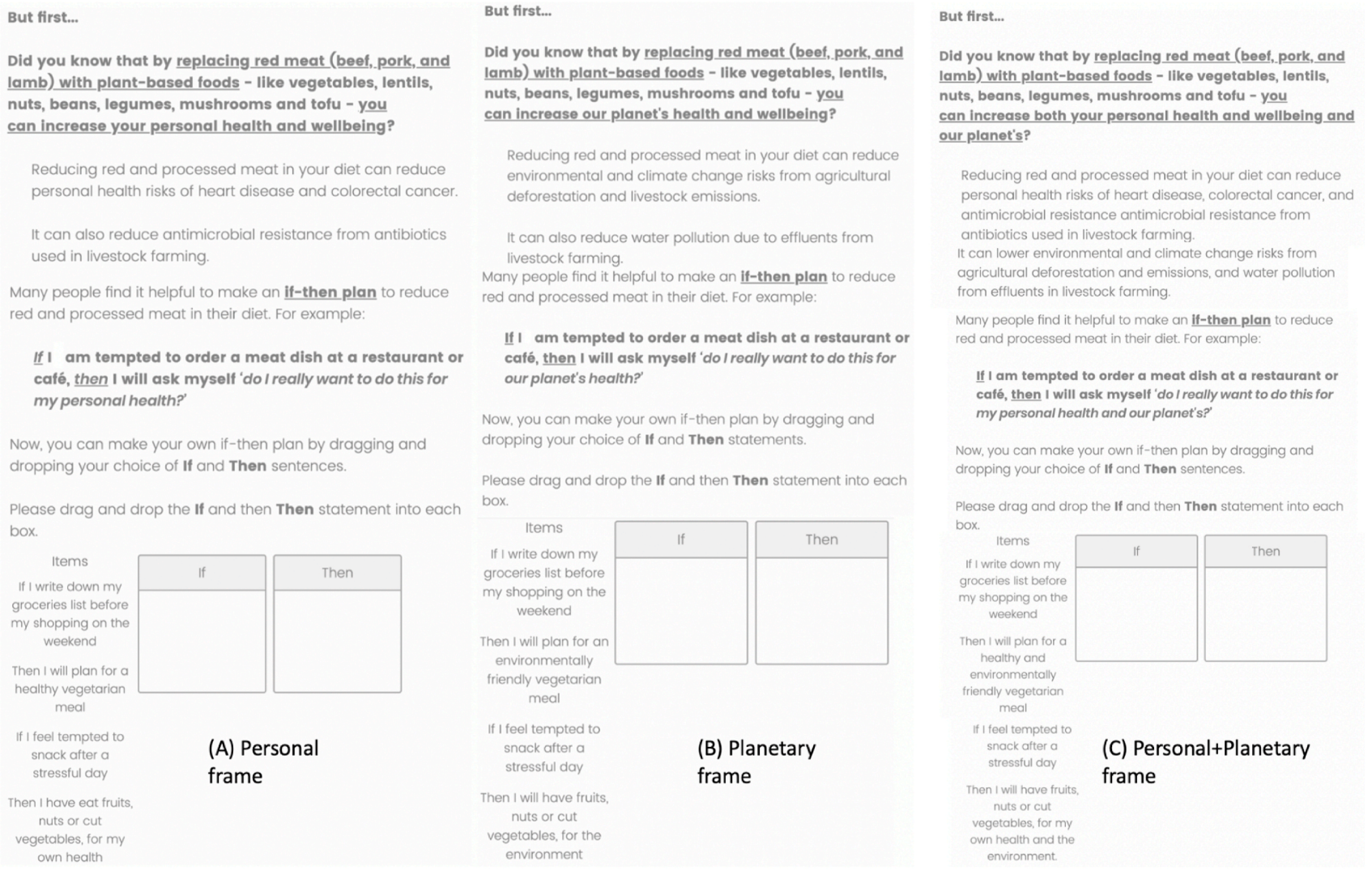

Fig. 1. Implementation Intentions intervention frames.

(direct effect, B1); and then (ii) donating real money up to £5, in £0.50 increments, to a charity of their choice from a pre-selected list including health, environmental and food charities (spillover effects, B2). In the control condition subjects face the food choice task without any intervention (*Control-Food*). While we do not expect that the act of choosing food before donating independently affect donation decisions, to unambiguously guard against this possibility we add a further control condition (*Control-Donation*) where participants face the charitable donation task without facing any behavioural intervention nor any food choice.

In the food choice task, participants are reminded that they have a one in 20 chance of winning a bonus gift voucher worth £15 from a leading top-tier chain of pizza restaurants in the UK for completing parts 1 and 2 of the study. They are informed that the selection of the winner would be determined through a random number generation. Then, they are asked to select which pizza they would prefer if they won the bonus gift voucher (B1). On the next page, they are given a selection of twelve pizzas taken directly from the menu of the popular restaurant chain, of which four are vegetarian, one is vegan, two are poultry-based, one is fish-based, and four are red meat-based. The direct effect dependent variable is vegetarian food choice, which takes the value of 1 if the participant chooses a vegetarian or vegan pizza, or 0 otherwise.

The charitable donation task (Behaviour 2, B2) is a modified dictator game with the charity as the recipient (with standard framing) (Carpenter et al., 2008). Participants are reminded that they also have a one in 20 chance to win a bonus payment of £5 for completing Part 1 and 2 of this study. They are then informed that they could choose to donate some of that £5, in £0.50 increments, to a charity of their choice from a pre-selected list. To raise the stakes of the donation task, they are told that any amount they choose would be multiplied by 10 and matched by the experimenter.

2.3. Measures

Dependent variables: Vegetarian food choice (B1) is the main binary dependent variable from the food choice task (the direct effect), which takes the value of 1 if the participant chooses a vegetarian or vegan pizza, or 0 otherwise. To assess the short-term carryover effects of the differently framed II interventions in Parts 2 and 3 of the study (3 days and 2 months after the interventions, respectively) subjects are asked to report on how many of days over the past 3 and 7 days, respectively they have eaten only vegetarian food, so that we code two count variables for number of days eating only vegetarian food, which take any value between a minimum of 0 and a maximum of 3 and 7, respectively. To measure the spillover effects, donations are the dependent variable, which could take a minimum amount of £0 and a maximum amount of £5.

Covariates: To measure past food behaviour, we ask participants to indicate the number of days where only vegetarian food has been consumed over the past 7 days (responses were 0 days–7 days). We ask them to identify what their typical diet is, where the response options are: omnivore, pescatarian, flexitarian, vegetarian, vegan, restricted diet. To measure past donations behaviour, we ask whether they have donated any money to charity in the past year (Yes, No). We also ask them to identify their gender (male, female, other), age and household income. In addition, we ask what their political leaning is (responses are leaning to the left or the right), whether they were currently a student (Yes, No).

Exclusions: Embedding verbal manipulation checks within an experiment has been criticised because they can interact with the experimental conditions (Hauser et al., 2018). We were particularly concerned that manipulation checks could affect subsequent responses (for e.g., by serving as a reminder) because we were collecting data over time in two subsequent rounds. We thus asked only two manipulation check questions to those in the II conditions, namely: (1) What was the central argument for reducing red meat in diets in the information text? Responses included personal health, planetary health, personal and planetary health, animal welfare, personal finances, and Brexit (the last three options were incorrect); (2) What type of plans do people find it useful to make to reduce red and processed meat in their diet? Responses included If-Then plans, Then-Why plans and What-How plans. We also checked if excluding the subset of participants identifying themselves as vegan or vegetarian affected our results. However, there are myriad public understandings of what constitutes a vegetarian (and vegan) diet (e.g. especially over the inclusion of insect-based, poultry and fish products) which can stem from cultural differences (Ruby et al., 2013). Thus, keeping in mind the issues about understanding of vegetarian diets and manipulation checks, and to ensure full transparency, in the main text we report and discuss all results for the whole sample, whereas we briefly comment in footnotes or in Appendix the results for the restricted sample, especially if different from the whole sample.

3. Results

3.1. Sample characteristics

Of our total sample, 64.52% of respondents report being female and 34.27% report being 25–34 years old, 47.09% report an annual household income of up to £29,999, and 84.72% report not being students (see Table 2). In comparison, according to the latest available census recordings, official statistics and projections by the Office for National Statistics (ONS) and by the Higher Education Statistics Agency (HESA), 50.6% of the UK population in 2011 are classified as female (Office for National Statistics, 2016); 17.5% of the UK adult population in 2020 is aged 25–34 years old (Office for National Statistics, 2019); and 5.24% of the UK adult population in 2020 are classified as higher education students (Office for National Statistics, 2019; Higher Education Statistics Agency, 2021), Moreover, according to the latest ONS statistics about the average household income in the UK, the median equivalised household disposable income in the UK in 2020 is £29,900 (Office for National Statistics, 2021). Compared to the general population in the UK, therefore, our sample of Prolific participants over-represents younger, female, and students respondents, and slightly over-represents higher-income respondents. Additionally, in our sample, 66.94% of respondents report to be politically left-leaning, 78.56% identify as having non-vegetarian diets, and 79.94% donated to a charity in the past year (Table 3). This is broadly in line with other studies documenting that samples from online platforms such as Prolific may not be fully representative of the general population (Chan et al., 2019; Palan & Schitter, 2018; Peer et al., 2017).

3.2. Influence of implementation intention interventions on vegetarian food choice

As it can be seen from Fig. 2, 33% of the participants select the vegetarian option in the *Control-Food* condition, whereas nearly half of the participants choose vegetarian options in the II treatments: more specifically 48.8%, 50% and 48.36% of the participants in the *Personal*, *Planetary* and *Personal + Planetary* conditions choose vegetarian options, respectively. Thus, the raw data indicates that participants exposed to the II interventions were more likely to choose a vegetarian option.

To formally test the hypothesised effects of the II intervention frames on vegetarian choice, we run a multiple logistic regression (with robust standard errors) with three dummy variables as predictors (for the *Personal*, *Planetary* and *Personal + Planetary* frames), the Control-Food group being used as a comparison condition.

The results from logistic regression analyses confirms that the II interventions are positive and significant predictors of vegetarian food choice. As can be seen in Table 4, the Model (1) $\chi 2$ is significant, suggesting that adding the predictors to the model significantly improves the fit compared to the model with only the constant. As hypothesised, the treated participants in all groups are twice more likely (based on the

Table 2
Descriptive statistics and balance on socio-demographic variables.

Variables	Category	Control-Donations	Control-Food	Personal	Planetary	Personal + Planetary	All
Age	18–24	12.96	17.93	12.4	14.92	17.21	15.08
	25–34	38.06	32.67	36.8	32.26	31.56	34.27
	35–44	21.86	24.7	20.8	23.39	26.64	23.47
	45–54	16.6	13.94	21.2	18.15	11.89	16.37
	55–64	7.69	8.76	5.6	7.26	9.43	7.74
	≥65	2.83	1.99	3.2	4.03	3.28	3.06
Gender	Male	38.87	30.68	33.6	38.71	34.43	35.24
	Female	61.13	69.32	66	61.29	64.75	64.52
	Other	0	0	0.4	0	0.82	0.24
Household	<£10,000	6.25	7.84	5.42	9.55	7.18	7.28
Income	£10,000-£15,999	9.62	8.82	8.37	9.09	10.77	9.32
	£16,000-£19,999	5.77	9.31	13.79	9.55	7.18	9.13
	£20,000-£29,999	20.67	23.53	13.3	23.64	25.64	21.36
	£30,000-£39,999	18.75	15.2	19.21	16.82	14.87	16.99
	£40,000-£49,999	13.94	17.16	18.23	10.91	13.85	14.76
	£50,000-£59,999	10.58	6.86	8.37	9.09	5.64	8.16
	£60,000-£69,999	5.77	1.47	4.93	4.55	6.15	4.56
	£70,000-£79,999	0.48	3.43	3.45	3.18	4.62	3.01
	£80,000-£89,999	1.92	1.96	3.45	0.45	0.51	1.65
	£90,000-£99,999	2.4	0	0.49	1.36	0.51	0.97
	£100,000-£149,999	2.4	3.92	0.49	1.82	2.05	2.14
	≥£150,000	1.44	0.49	0.49	0	1.03	0.68
Student status	Student	86.92	85.06	87.76	83.33	80.43	84.71
	Not student	13.08	14.94	12.24	16.67	19.57	15.29
Political	Left	62.75	70.12	71.2	64.11	66.39	66.94
orientation	Right	37.25	29.88	28.8	35.89	33.61	33.06
Sample size		249	251	250	248	244	1242

Note: p-values for Age, Gender and Household income from non-parametric Kruskal-Wallis tests and Student status and Political Orientation from Chi-Squared test.

Table 3
Descriptive statistics and balance on subgroup variables of past behaviour.

Variables	Measure/Category	Control-Donation	Control-Food	Personal	Planetary	Personal + Planetary	All
# Vegetarian days during	Mean	3.1	3.41	3.74	3.55	3.75	3.51
past week	S.D.	2.24	2.33	2.45	2.25	2.37	2.34
(Typical) Diet	Omnivore	72.29	66.14	64	62.9	62.3	65.54
	Flexi/Pesca-tarian	18.48	22.71	22.8	27.82	23.36	23.03
	Vegetarian/Vegan	6.82	9.16	12.4	7.66	12.71	9.75
	Other	2.41	1.99	0.8	1.61	1.64	1.69
Donated past year	Yes (%)	83.47	82.47	78.8	79.03	75.82	79.94

Note: p-values for Vegetarian days in the past week and Diets from Kruskal-Wallis test and for Past donations is from Chi-Squared test. When Kruskal-Wallis test is conducted for Control-Food, *Personal, Planetary* and *Personal + Planetary* conditions for Vegetarian days the past week, the p-value is 0.321.

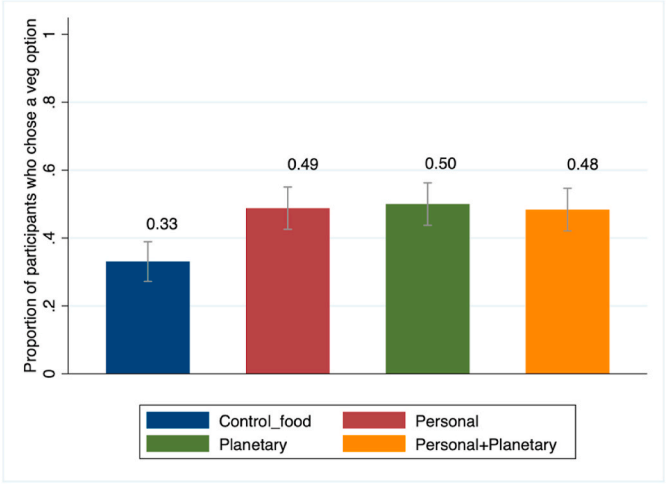

Fig. 2. Proportion of participants choosing vegetarian options.

odds ratio) to choose a vegetarian food item than participants in the control condition. Wald tests of the parameters of this model shows that the direct effect sizes on vegetarian choice are not statistically significantly different across the three II interventions ($\beta_{Personal}$ vs. $\beta_{Planetary}$ $\chi2 = 0.07$ and p-value = 0.789; $\beta_{Personal}$ vs. $\beta_{Personal + Planetary}$ $\chi2 = 0.01$ and p-value = 0.922; $\beta_{Personal + Planetary}$ vs. $\beta_{Planetary}$ $\chi2 = 0.13$ and p-value = 0.716).

To ensure robustness of these effects, in Model (2) we run the same logistic regression with the covariates added as predictors and restricting the sample to those respondents not identifying as vegetarian or vegan. The effects of all the II interventions compared to the control remains significant even controlling for the covariates in the restricted sample. Men are less likely to choose vegetarian options, but we find no evidence that political orientation, age, student status, or household income are associated to the vegetarian choice. As a further robustness check, we also restrict the sample firstly to just those who have passed the manipulation checks, and then to those who have passed these checks and do not identify as vegetarian and vegan (Appendix A, Table A1). We also replicate the analyses using a larger set of (pre-registered) covariates including Body Mass Index, self-reported hunger, and emotions such as feeling guilty, interested, happy and upset, measured via PANAS questions. None of these further control variables show statistically significant effects (Table A2). The main results

Table 4
Logistic regression of II intervention frames on vegetarian food choice: Direct effects, Part 1.

Model 1: without covariates							
Predictors	β (log odds)	Robust SE	z-value	Exp (β) Odds Ratio	p-value	[95% Confidence Intervals]	
Personal	0.657	0.185	3.560	1.929	<0.001	0.295	1.019
Planet	0.705	0.185	3.810	2.024	<0.001	0.343	1.067
Personal + Planetary	0.640	0.186	3.450	1.896	0.001	0.276	1.003
Constant	−0.705	0.134	−5.250	0.494	<0.001	−0.968	−0.442
Model 2: with covariates							
Predictor	**β (log odds)**	**Robust SE**	**z-value**	**Exp (β) Odds Ratio**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.830	0.239	3.480	2.293	0.001	0.362	1.298
Planetary	0.847	0.232	3.640	2.332	<0.001	0.391	1.302
Personal + Planetary	0.669	0.238	2.800	1.952	0.005	0.201	1.136
Hungry	−0.070	0.072	−0.970	0.932	0.334	−0.212	0.072
#Veg days past week	0.180	0.049	3.670	1.198	<0.001	0.084	0.277
Flexi/Pescatarian	0.474	0.208	2.280	1.607	0.023	0.066	0.882
Age	−0.042	0.068	−0.620	0.959	0.534	−0.175	0.091
Male	−0.467	0.176	−2.650	0.627	0.008	−0.813	−0.122
Income	−0.028	0.034	−0.830	0.972	0.407	−0.094	0.038
Student	0.118	0.243	0.490	1.125	0.627	−0.358	0.594
Political-right	−0.101	0.177	−0.570	0.904	0.569	−0.447	0.245
Constant	−1.122	0.387	−2.900	0.326	0.004	−1.881	−0.362

Notes: Model (1): Number of observations is 993, Wald chi2 (3) = 19.16, Prob > chi2 < 0.001 and Log pseudolikelihood = −673.411. Model (2): Number of observations is 717, Wald chi2 (3) is 67.40, Prob > chi2 is < 0.001 and Log pseudolikelihood is −444.618. The Odds Ratio (OR) is Exp (B) and value of 1 implies exposure does not affect odds of outcome, >1 implies higher odds, and <1 is lower odds of vegetarian food choice. Omitted categories: for Flexi/Pescatarian is Omnivore; Gender is Female + Other; Student status is Not Student; Political orientation is Left. Vegetarians, vegans and those with reporting other restricted diets omitted in model 2, along with those who preferred not to answer questions on covariates.

described above are similar across all these robustness checks.

3.3. Spillover effects on charitable donations

To explore spillover effects on charitable donations (behaviour 2), Figs. 3 and 4 present the *average donations* and the *proportion of participants donating* by condition. As expected, there are no significant differences in the average donation and in the likelihood of donating between the *Control-Food* and *Control-Donation* conditions (Appendix Table A3). So we pool their observations together into a combined control group (*Control*) as the omitted category.

Fig. 2 shows that the *average donations* are quite similar across groups, ranging from £2.11 (in the combined control condition) to £2.34 in the *Personal + Planetary* condition. Fig. 3 shows that a slightly *higher share of individuals* donate in the *Personal + Planetary* condition compared to the other groups (around 85% versus 77–80%). The raw data, therefore, suggests that the II interventions do not negatively impact donations compared to the control group.

To explore if any differences on the *average amount donated* are statistically significant, we regress the experimental conditions on donations in an ordinary least squares regression with robust standard errors, without restricting the sample. As it can be seen in Table 5, the Model (1) F-statistic is not statistically significant, suggesting that adding the predictors to the model does not significantly improve the fit compared to the model with only the constant. The results are similar when we restrict the sample to those respondents not identified as vegetarians or vegans, as well as those having passed the manipulation check questions (Table A5 in Appendix).

To check the robustness of these effects, we add covariates to the regression models in Model (2) in Table 5. We now observe that the participants in all the II groups – who do not identify as vegetarian/vegan – donate *more* (based on the OLS coefficients) than participants in the combined control condition (Model (2) F-statistic is statistically

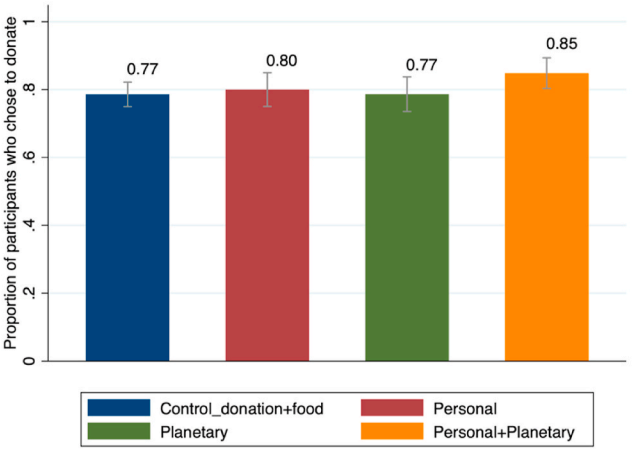

Fig. 4. Proportion of participants choosing to donate.

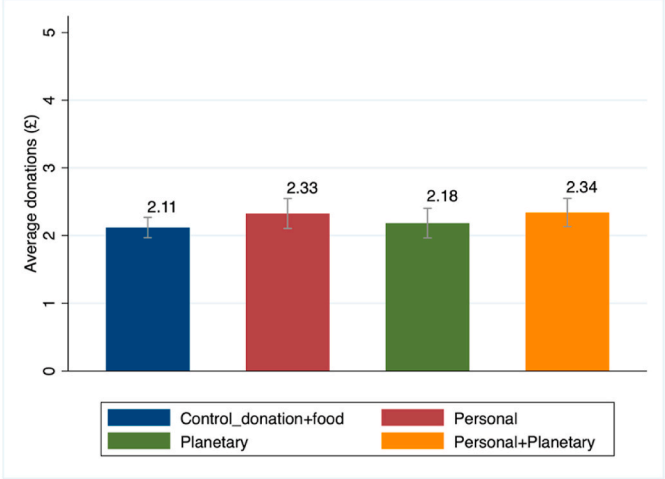

Fig. 3. Average donations.

Table 5
Ordinary Least Squares (OLS) regression of II intervention frames on donations: Spillover effects.

Model 1: Full sample						
Predictors	β	SE	t-value	p-value	[95% Confidence Intervals]	
Personal	0.207	0.136	1.520	0.129	−0.060	0.475
Planetary	0.065	0.136	0.480	0.630	−0.201	0.331
Personal + Planetary	0.222	0.131	1.700	0.090	−0.035	0.480
Constant	2.118	0.077	27.570	<0.001	1.967	2.269
Model 2: Sub-sample of those not identifying as vegetarian/vegan, with covariates						
Predictors	**β**	**SE**	**t-value**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.325	0.159	2.050	0.041	0.014	0.637
Planetary	0.288	0.152	1.890	0.058	−0.010	0.587
Personal + Planetary	0.286	0.150	1.910	0.056	−0.007	0.580
Donated, past year	−0.615	0.144	−4.280	<0.001	−0.898	−0.333
#Veg days, past week	0.035	0.035	0.990	0.322	−0.034	0.103
Flexi/Pescatarian	0.052	0.148	0.350	0.727	−0.239	0.342
Age	0.050	0.046	1.080	0.278	−0.040	0.140
Male	−0.001	0.122	−0.010	0.995	−0.240	0.239
Income	0.063	0.023	2.780	0.006	0.019	0.108
Student	0.104	0.170	0.610	0.541	−0.230	0.438
Political-Right	−0.210	0.116	−1.810	0.071	−0.438	0.018
Constant	2.262	0.282	8.020	<0.001	1.709	2.815
Model 3: Sub-sample of those passing checks and not identifying as vegetarian/vegan, with covariates						
Predictors	**β**	**SE**	**t-value**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.310	0.207	1.500	0.135	−0.096	0.716
Planetary	0.337	0.180	1.870	0.062	−0.017	0.692
Personal + Planetary	0.295	0.167	1.770	0.077	−0.033	0.622
Donated, past year	−0.722	0.160	−4.500	<0.001	−1.036	−0.407
#Veg days, past week	0.017	0.041	0.430	0.667	−0.062	0.097
Flexi/Pescatarian	−0.181	0.167	−1.080	0.280	−0.509	0.147
Age	0.080	0.053	1.520	0.130	−0.024	0.184
Male	−0.006	0.138	−0.040	0.965	−0.277	0.265
Income	0.061	0.025	2.410	0.016	0.011	0.110
Student	0.239	0.187	1.280	0.202	−0.128	0.605
Political-Right	−0.225	0.134	−1.680	0.093	−0.488	0.037
Constant	2.402	0.322	7.450	<0.001	1.769	3.035

Notes: Model (1): 1242 observations, F-statistic = 1.34, p-value = 0.260, R-squared = 0.003. Model (2): 902 observations, F-statistics = 4.1, p-value < 0.001, R-squared = 0.048. Model (3): 682 observations, F-statistic = 3.76, p-value < 0.001, R-squared = 0.058. Omitted categories: for Flexi/Pescatarian is Omnivore; Gender is Female + Other; Student status is Not Student; Political orientation is Left. Vegetarians, vegans and those with reporting other restricted diets omitted in model 2, along with those who preferred not to answer questions on covariates.

significant).[1] Wald tests of the parameters of this model shows that the spillover effect sizes on amount donated are not statistically significantly different across the three II interventions in either Model (2) or (3).

To examine the effect on the *likelihood of donating any amount*, we regress the experimental conditions on a binary variable capturing the decision to donate in logistic regression analyses (with robust standard errors). In Model (1) in Table 6, the coefficient on the *Personal + Planetary* condition is positive and significant at the 5% level. When we add covariates to the regression model, the results still show that participants in the *Personal + Planetary* condition are around 1.6 times more likely to donate than in the control condition. The results are similar when we restrict the sample (Table A5 and A6 in Appendix).[2]

In terms of covariates, those who have donated in the past are less likely to donate (and donated a lower amount) in the experiment, and so do those who identify with leaning to the right politically. Males are also less likely to make a donation. Finally, as expected, household income is positively associated with the amount donated. We find no statistically significant moderation effects of the covariates included in our sample (all the estimates are available on request). Apart from adding covariates, a range of robustness checks using alternative statistical models (including Tobit and Cragg-hurdle models) and restricted samples also replicate the main findings described above (Appendix Tables A4-A6).[3]

Overall, these results show a positive spillover effect from the combined *Personal + Planetary* treatment on the likelihood of donating, and little evidence of negative spillover from being exposed to personal health benefits.

3.4. Additional analyses of spillover effects on charitable donations

Following Galizzi and Whitmarsh (2019), we conceptualise spillover effects as changes in the second, non-target behaviour (i.e., donations) arising from exposure to the II interventions. This is different from the spillovers considered by Carrico et al. (2018) (and also by Maki et al., 2019) that focus on the changes in the second behaviour for those participants for whom the intervention "worked" to change the first target behaviour (i.e. choosing a veg option). To examine if our results are sensitive to this definitional difference, we restrict the sample to those respondents who chose the veg option (i.e., the targeted behaviour 1). Even focusing on this sub-sample of respondents, we find similar results to the ones discussed above, namely: no negative spillovers effects, a small positive effect of the *Personal + Planetary* framing condition on the

[1] Similarly, in Model (3) - when we restrict the sample to those not identifying as vegetarian/vegan and those passing the checks - the difference between the coefficients in the control group and the *Planetary* and *Personal + Planetary* condition is marginally significant at the 10% level.

[2] Similarly, when we add covariates to the sub-sample of those not identifying as vegetarians/vegans and also those who passed the checks, the coefficient on the *Personal + Planetary* condition remained stable and significant at the 5% level.

[3] The results are also robust when covariates controlling for the number of vegetarian days in the past week and for hunger are added (results are available on request).

Table 6
Logistic regression of II intervention frames on choice to donate: Spillover effects.

Model 1: without covariates							
Predictor	β (log odds)	Robust SE	z-value	Exp (β) Odds Ratio	p-value	[95% Confidence Intervals]	
Personal	0.085	0.192	0.440	1.089	0.657	−0.291	0.462
Planet	0.002	0.190	0.010	1.002	0.993	−0.370	0.373
Personal + Planetary	0.421	0.209	2.010	1.523	0.044	0.011	0.831
Constant	1.301	0.109	11.930	3.673	<0.001	1.087	1.515
Model 2: Sub-sample not identifying as vegetarian/vegan, with covariates							
Predictor	**β (log odds)**	**Robust SE**	**z-value**	**Exp (β) Odds Ratio**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.158	0.235	0.670	1.171	0.500	−0.302	0.618
Planetary	0.266	0.226	1.180	1.305	0.238	−0.176	0.708
Personal + Planetary	0.491	0.242	2.030	1.634	0.042	0.017	0.965
Donated, past year	−0.867	0.193	−4.490	0.420	<0.001	−1.245	−0.489
#Veg days, past week	−0.007	0.051	−0.140	0.993	0.889	−0.108	0.093
Flexi/Pescatarian	0.322	0.234	1.380	1.380	0.169	−0.136	0.780
Age	0.019	0.071	0.270	1.019	0.789	−0.120	0.158
Male	−0.463	0.174	−2.650	0.629	0.008	−0.805	−0.121
Income	0.036	0.034	1.060	1.036	0.290	−0.030	0.101
Student	0.199	0.285	0.700	1.220	0.485	−0.360	0.758
Political-Right	−0.173	0.176	−0.980	0.841	0.326	−0.519	0.172
Constant	2.199	0.412	5.330	9.012	<0.001	1.391	3.006
Model 3: Sub-sample passing checks and not identifying as vegetarian/vegan, with covariates							
Predictor	**β (log odds)**	**Robust SE**	**z-value**	**Exp (β) Odds Ratio**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.219	0.312	0.700	1.245	0.483	−0.393	0.831
Planetary	0.453	0.284	1.600	1.573	0.110	−0.103	1.009
Personal + Planetary	0.604	0.289	2.090	1.830	0.037	0.037	1.171
Donated, past year	−0.858	0.235	−3.660	0.424	<0.001	−1.318	−0.398
#Veg days, past week	−0.048	0.062	−0.770	0.954	0.440	−0.168	0.073
Flexi/Pescatarian	0.067	0.273	0.240	1.069	0.807	−0.468	0.601
Age	−0.001	0.083	−0.010	0.999	0.994	−0.164	0.163
Male	−0.453	0.207	−2.190	0.636	0.028	−0.858	−0.048
Income	0.049	0.039	1.250	1.050	0.211	−0.028	0.126
Student	0.403	0.334	1.210	1.497	0.227	−0.251	1.058
Political-Right	−0.234	0.208	−1.130	0.791	0.260	−0.641	0.173
Constant	2.345	0.497	4.720	10.432	<0.001	1.371	3.319

Notes: Model 1: 1242 observations, Wald chi2 (3) = 4.43, Prob > chi2 = 0.218, and Log pseudolikelihood is −617.207. Model 2: 902 observations, Wald chi2 (3) is 39.88, Prob > chi2 < 0.001, and Log pseudolikelihood is −331.41. Model 3: 682 observations, Wald chi2 (3) is 29.96, Prob > chi2 = 0.002, and Log pseudolikelihood is −331.41. Omitted categories for Past donor are Not past donor; Gender is Female + Other; Student status is Not Student; Political orientation is Left. In Models (2) and (3), vegetarians, vegans and those with reporting restrictions on diets is omitted, along with those who preferred not to answer questions on covariates.

likelihood of donating (OR = 2.32, p-value = 0.046, 95% CI [1.016, 5.312]), and a positive but not statistically significant effect amongst non-vegetarians (OR = 2.133, p-value = 0.112, 95% CI [0.838, 5.434]) (Table A7).

The framing of the interventions could induce within-domain spillovers (e.g., planetary framing may induce spillover effects onto other pro-environmental actions) or cross-domain spillovers (e.g., spillovers on actions in other domains like health or food) (Maki et al., 2019). For example, Carrico et al. (2018) found that participants in the health benefits condition for meat reduction were less likely to donate to an environmental charity relative to the control condition. To examine this possibility, we explore whether spillover effects matched the charity domain, that is, if II framing impacts the participant's choice to donate to a health, environmental or food charity (Tables A8-A10). We find no systematic effects on the likelihood of choosing environmental or food charity amongst the participants in the full sample, nor amongst the non-vegetarians.[4] Most non-vegetarian participants chose to donate to a health charity (53.72%) in the first place, followed by food and environmental charity (30.6% and 15.7% respectively; the ranking of charity choice being the same for the entire sample). It is possible that our framings, all of which appeal in terms of health, could have increased health-related donations, but it is difficult to empirically verify if this is the case within our data.

3.5. Persistence of effects on food choices over time

As can be seen from Fig. 5, the average number of days participants reported having vegetarian food three days after the intervention (in round two) is a little over one day in the *Personal*, and *Personal + Planetary* conditions, and a little under one day in the control and

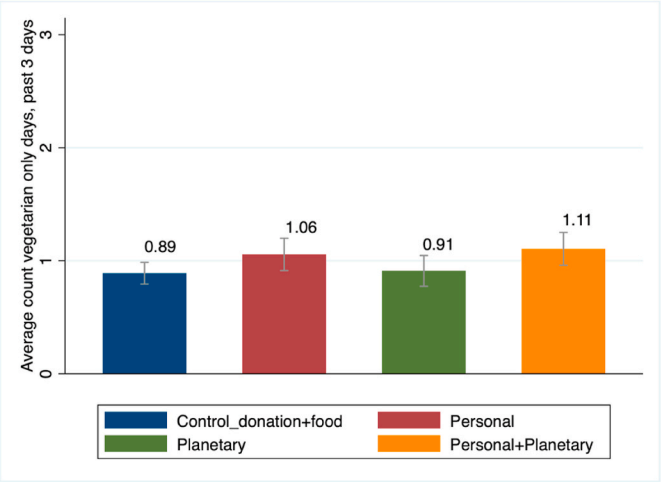

Fig. 5. Average number of vegetarian days over past three days (from round two).

[4] We find, however, that non-vegetarians show a marginally lower likelihood of choosing a health charity when exposed to the Planetary condition (OR = 0.732, p-value = 0.093; Table A8).

Planetary conditions.

To examine whether these differences are statistically significant, we run a logistic regression with three dummy variables as predictors, one for each of the II intervention frames, the combined control conditions being used as a comparison group. As can be seen in Table 7, the coefficients of the *Personal* + *Planetary* conditions are positive and significant at the 5% level.[5]

Finally, we look to see whether any effects emerged two months later, based on the data collected in round three. Fig. 6 shows that the average number of vegetarian days is very similar in all groups and is around 2 days (albeit marginally higher again the in the *Personal* and *Personal* + *Planetary* conditions). Results from a logistic regression reveal that these small differences are not statistically significant in the entire sample and in the sub-samples of those not identifying as vegetarian and those having passed attention checks - both without and with covariates (Table A12 in Appendix). Overall, this suggests that the effects of the II interventions do not persist over time.

4. Discussion and conclusion

In this pre-registered longitudinal study, we experimentally vary the framing of II plans to make salient either personal, or planetary, or personal and planetary health benefits, while keeping the domain of health constant. Our objective is to examine the effectiveness of framing benefits in terms of personal or planetary health, or both, on diet choices. We find that all interventions significantly increase consequential vegetarian food choices and do not cause negative spillovers on subsequent actual donations to charities. In fact, we find evidence of a positive spillover effect because participants are more likely to donate when exposed to the personal and planetary health framing.

In terms of practical implications, our findings confirm that policies or campaigns appealing to both personal and planetary health benefits, or to just personal health benefits, may be equally effective at changing vegetarian behaviour as appeals to planetary health benefits. This is relevant for the many informational campaigns and behavioural interventions which rely on a 'kitchen-sink' approach stating all the benefits from some behavioural change both to the individual and the society. Emphasising both environmental and health co-benefits in climate policy applications have been especially advocated in the context of changing food consumption (Tobler et al., 2011; Karlsson et al., 2020) and in the context of II interventions (Loy et al., 2016).

In terms of practical applications again, we have also developed a new set of interactive II tasks to prompt specific if-then plans for vegetarian eating, which can be easily embedded within digital platforms. Whereas II interventions have been traditionally designed and conducted in static face-to-face environments, we believe there is increasingly scope for the delivery of nudge-style behavioural interventions hosted on digital platforms, mobile apps and web-based services (e.g., noom.com), and innovative 'drag-and-drop' tasks could thus prove to be a useful device to engage respondents at scale in a low-cost way.

Importantly, unlike what may happen with appeals to monetary benefits, interventions appealing to personal and planetary health benefits, or to just personal health benefits, do not necessarily backfire nor curtail desirable positive spillovers. These results are broadly in line with a recent meta-analysis that finds that spillovers on actual behaviours are small (if they occur at all), and that spillovers are limited when two sequential behaviours have low similarity (as is arguably the case between food choices and donations) (Maki et al., 2019).

Our study leaves several open questions and directions for future research. Firstly, why don't we see any difference between the three types of framing on food choices? One possibility pertains to the type of public benefits framing we use, namely that of 'planetary health'. Although this type of framing has been increasingly used in the sustainability and public health literature (see for example the Lancet's *Planetary Health* journal), we are not aware of previous studies that have empirically examined this type of framing in relation to personal benefits. Past work, however, has pointed out that anthropomorphising the environment (e.g., 'Mother nature') has been shown to increase sustainable behaviours (Ahn et al., 2014; Tam et al., 2013). It is possible that by referring to the planet's 'health', we are also anthropomorphising the environment, and this may lead to an attenuation of the differences between the estimated treatment effect of the planetary and personal health conditions in our experiment. Future work can further investigate the effects of this type of framing.

It is also possible that emphasising both personal and planetary benefits to increase one-off vegetarian choices may induce positive spillover effects as well as carryover effects. The next step would be to take these interventions to naturalistic field settings and explore if this is actually the case. In addition, we also explored whether different framings induce cross-domain spillovers by impacting the choice of charity but did not find robust results. As the evidence to date on cross-domain behavioural spillovers is limited and mixed (Dolan & Galizzi, 2015; Galizzi & Whitmarsh, 2019), future work can further investigate when they occur and the psychological mechanisms driving them. In addition, the "planetary health" framing may prime people to donate more to health charities. In our sample most people indeed chose health charities, but we are not able to verify if this is the case because of priming. This can be the subject of future experimental inquiry.

There are few efforts to merge II interventions with benefits and motivations embedded in the if-then plans themselves. We frame self-interested and public benefits from the action, and it is possible that such framings have the potential of strengthening intrinsic motivations and intentions by linking intrinsic rewards with contextual cues. Future studies can investigate the potential mechanisms through which these plans work, such as via enhanced intrinsic motivations, intentions and identity, or via habit formation induced by behavioural repetition (Maki et al., 2019; van der Linden, 2015). These channels could also be beneficial in terms of spillover and carryover effects. Along these lines, for example, Maki et al. (2019)'s meta-analysis suggests that interventions that build on intrinsic motivation are more likely to result in positive behavioural spillovers. That said, we find that respondents in the *Personal* and *Personal* + *Planetary* conditions report being vegetarian for longer than in the control condition three days after being exposed to the intervention. While this suggests some potentially positive short-run carryover effects from interacting personal and planetary health benefits, we find that these effects do not persist two months later.

More broadly, why don't vegetarian habits hold? One possibility is that benefits are linked to the context – so incorporating context-specific benefits and rewards alongside cues in the if-then plan could be more effective than using general, relatively context-free, benefits. Another possibility is that, although our II task attempted to address both contextual cues (i.e., where and when) and benefits (i.e., personal and planetary benefits), it did not address behavioural repetition (i.e., how often), a crucial third component of habit formation (Wood & Neal, 2016). Since people can have pre-established routines for repeating their dietary choices at multiple times each day, it is possible that our II task was simply not sufficiently "strong" to change behaviour because it did not address these routines. Future studies can investigate how to address the repeated nature of dietary choices in interventions in several ways – for example, plans specifying the contextual cues, benefits, and

[5] However, when the sample is restricted to only those not identifying as vegetarian/vegan, the differences are not statistically significant, as seen from Model (2). When the sample is further restricted to those who have passed checks and those not identifying as vegetarian/vegan, the coefficient on the *Personal* + *Planetary* condition becomes marginally significant at the 10% level. To ensure robustness of these effects, we run the same logistic regressions with covariates and the results are similar i.e., the coefficient on the *Personal* + *Planetary* conditions is significant at the 5% level for the entire sample, but the p-value increases in the sub-sample of non-vegetarians and those having passed checks (Table A11 in Appendix).

Table 7
Poisson regression of II intervention frames on number of vegetarian days over the past three days (data from round two).

Model 1: Full sample							
Predictor	β (log count)	Robust SE	z-value	Incidence rate ratio	p-value	[95% Confidence Intervals]	
Personal	0.084	0.044	1.930	1.088	0.054	−0.001	0.170
Planetary	0.011	0.044	0.240	1.011	0.808	−0.076	0.098
Personal + Planetary	0.108	0.043	2.480	1.114	0.013	0.023	0.193
Constant	0.637	0.026	24.690	1.890	<0.001	0.586	0.687
Model 2: Sub-sample not identifying as vegetarian or vegan							
Predictor	**β (log count)**	**Robust SE**	**z-value**	**Incidence rate ratio**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.053	0.045	1.180	1.054	0.236	−0.035	0.141
Planetary	0.022	0.045	0.500	1.022	0.618	−0.065	0.110
Personal + Planetary	0.068	0.044	1.530	1.070	0.127	−0.019	0.155
Constant	0.540	0.026	21.030	1.716	<0.001	0.490	0.590
Model 3: Sub-sample passing checks and not identifying as vegetarian or vegan							
Predictor	**β (log count)**	**Robust SE**	**z-value**	**Incidence rate ratio**	**p-value**	**[95% Confidence Intervals]**	
Personal	0.029	0.057	0.500	1.029	0.616	−0.083	0.141
Planetary	0.020	0.053	0.370	1.020	0.713	−0.085	0.124
Personal + Planetary	0.084	0.051	1.650	1.088	0.098	−0.016	0.183
Constant	0.540	0.026	21.020	1.716	<0.001	0.490	0.590

Notes: Robust standard errors clustered at the subject level in parentheses. Model 1: 865 observation, Wald chi2 (3) is 3.56, Prob > chi2 is 0.31, and Log pseudolikelihood is −2592.72. In Model 2, number of observations is 933, Wald chi2 (3) is 8.56, Prob > chi2 is 0.036, and Log pseudolikelihood is −1423.66. In Model 3, number of observations is 770, Wald chi2 (3) is 0.68, Prob > chi2 is 0.88, and Log pseudolikelihood is −2029.43. The Poisson regression coefficient can be interpreted as follows: for a one-unit change in the predictor variable, the difference in the logs of expected counts is expected to change by the respective regression coefficient (given other predictors in the model are held constant).

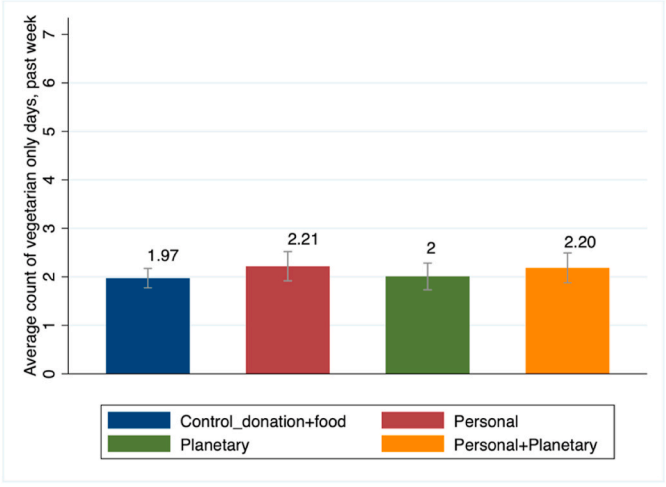

Fig. 6. Average number of vegetarian days over past seven days (from round three).

frequency; asking people to personalise the plans around their routines; using text reminders to make their plans and benefits salient over time and at pre-set times, and so on.

How generalisable are our results? Clearly, our findings are based on a one-off exposure to an intervention in a specific sample and context, and responses are recorded in incentivised tasks in non-representative sample who were paid to participate. So, we do not know how long effects endure in the real world, how generalisable these effects are, and whether impacts are similar when participants are unobtrusively observed in natural field settings (ecological validity). That said, even under these conditions, we found effects three days after in the *Personal + Planetary* group, in line with findings that being surveyed can later change behaviour (Zwane et al., 2011). Whereas there are doubts about the long-term sustainability of these II interventions to change dietary choices, we reckon that rigorously testing if different messages yield persistent impact - and do not backfire in other contexts – would require a replication using a different design and actual behavioural data from naturally occurring settings (e.g., a longitudinal natural field experiment such as Allcott & Rogers, 2014, or Ferraro et al., 2011).

Furthermore, behavioural responses may depend on underlying individual differences, such as intentions, past behaviour, identity, moral values, beliefs, mental representations, cognitive biases, and political ideology (Camilleri et al., 2019; Goldsmith et al., 2016; Hornsey et al., 2016; Markowitz & Shariff, 2012). In our experiment we do not find that behavioural responses significantly differ on the accounts which we control for, and for which we test moderation effects (i.e., age, gender, income, student status, political orientation). Nonetheless, future research could further investigate the potentially heterogeneous effects of identity, cognition, values, personality traits and preferences on interventions to affect vegetarian choices, as well as their potential moderating effects on changes in eating behaviour (Lauren et al., 2017; Schultz et al., 2016, 2016; Sintov et al., 2019; Whitmarsh & O'Neill, 2010). Importantly, it is possible that these interventions are more impactful for those participants who already have the intention to change their behaviours in the first place.

Finally, while our II behavioural interventions are not coercive and are relatively easy and uncontroversial to implement, they should not pre-empt the scope for broader, more comprehensive - and arguably more effective - policy tools, including carbon taxes (Hagmann et al., 2019; Werfel, 2017).

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2021.101710.

Author statement

Ganga Shreedhar: conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, writing – original draft. Matteo M Galizzi: conceptualisation, investigation, methodology, writing – original draft.

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