ENVIRONMENTAL MESSAGES PROMOTE PLANT-BASED FOOD CHOICES: AN ONLINE RESTAURANT MENU STUDY

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EXECUTIVE SUMMARY

Highlights

- Food-related greenhouse gas emissions have been estimated to contribute up to 37 percent of global annual total emissions, with animal-based foods contributing twice the amount of plant-based foods (Xu et al. 2021).
- Shifting consumer demand away from animal-based foods and toward plant-based alternatives is critical for reducing food-related climate change impacts as well as resource use and biodiversity loss (Dalin and Outhwaite 2019; Hayek et al. 2020; Searchinger et al. 2019; Willett et al. 2019).
- Behavioral science has begun to explore strategies to encourage and empower consumers to make more sustainable dietary choices through a variety of behavioral economics-based “nudge” interventions. Although research on sustainability labels and icons has proliferated in recent years, relatively little attention has been paid to descriptive consumer messaging presented at the point of purchase.
- This working paper details the methodology and results from an online survey-based randomized trial assessing the impact of 10 uniquely themed sustainability messages on consumers’ restaurant menu selections.

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Suggested Citation: Blondin, S., S. Attwood, D. Vennard, and V. Mayneris. 2022. “Environmental Messages Promote Plant-Based Food Choices: An Online Restaurant Menu Study” Working Paper. Washington, DC: World Resources Institute. Available online at <https://doi.org/10.46830/wriwp.20.00137>.

- Results suggest that descriptive sustainability messages presented in a simulated restaurant menu choice scenario increase the percentage of vegetarian dishes selected compared to a control group receiving no message. Further research is needed to determine whether and how this type of messaging is effective across other contexts in real-world settings.

Context

Shifting consumers away from resource-intensive animal-based foods and toward plant-based alternatives is critical for sustainably feeding a growing global population and mitigating climate change. Recent estimates suggest that the world's food supply will need to increase by up to 62 percent (from 2010) to meet increasing demand (van Dijk et al. 2021). As climate change intensifies, demand-side solutions are urgently needed to complement supply-side efforts to produce more food on limited available land. In fact, if the 2 billion people currently consuming high amounts of ruminant meat limited their intake to 1.5 servings per week (or about 50 calories per person per day), this dietary shift alone would reduce agricultural land demand and nearly eliminate the need for further deforestation (a prerequisite for holding global warming below 1.5–2°C), even while feeding 10 billion people by 2050 (Searchinger et al. 2019). Identifying cost-effective and easily scalable consumer behavior-change strategies is critical.

About This Working Paper

This working paper adds to the evidence base on strategies for effectively communicating the different environmental impacts of food choices, with the intention of shifting consumers toward plant-based options by assessing how descriptive messages influence behavior. A wide variety of icons, symbols, and labeling schemes based on third-party certifications or life cycle assessment data have emerged in recent years to communicate the environmental impacts of specific food and food products to consumers. However, such strategies are limited by data availability and accuracy,

consumer (mis)interpretation and confusion, and comprehensiveness. Little attention has been given to the potential of descriptive messages that communicate the benefits of plant-based foods in a qualitative way, either as a stand-alone or complementary strategy. This working paper takes a preliminary step toward filling this research gap.

The Research Problem

Deeply rooted in human culture, meat eating is a behavior that has been historically encouraged and revered, and one that played a central role in the evolution of the human species. However, in recent years, the benefits traditionally associated with meat consumption have been accompanied by a growing recognition of serious costs. High meat consumption, especially of ruminant meat, is responsible for detrimental impacts on human health and the environment. As a result, convincing people who consume high amounts of meat to eat less of it has become a pressing task. To this end, many behavioral science-based tools have been tested for their effectiveness in reducing meat consumption (Harguess et al. 2020), with varying degrees of success. Though consumers appear to be responsive to informational interventions, the most effective means of communicating the benefits of plant-based options remains elusive.

Summary of Our Approach

This working paper details the methodology and results from two online survey-based randomized trials assessing the impact of descriptive messages describing the benefits of plant-based foods on consumers' hypothetical menu choices. The 10 messages presented to participants each communicated a unique (combination of) benefit(s) to consumers, including taste/flavor, environmental impact, health/performance, and generosity/altruism. The first trial randomized participants to receive one of 10 uniquely themed messages and asked them to choose between a

vegetarian and meat dish in eight cuisine-based menu dish pairings (e.g., bean burrito versus beef burrito). The second trial randomized participants to receive one of the five top-performing messages from the first trial and select one dish from each of two hypothetical restaurant menus, each featuring eight dishes (six meat based, two plant based). The percentage of vegetarian dishes selected by participants in each of the two trials was compared to that of participants randomized to a control group who received no message. Sociodemographic and psychological explanations for consumers' menu choices were also explored.

Research Findings and Key Insights

Results from these two randomized trials suggest that displaying thoughtfully framed environmental messages on restaurant menus can help to nudge diners to order more vegetarian entrees when eating out. Of the five messages displayed in the simulated menu ordering trial, four performed better than the control (no message), with the two best-performing messages roughly doubling the percentage of vegetarian orders. The following key insights can be gleaned from these findings:

- Messages communicating the benefits of plant-based dishes to consumers when choosing among restaurant menu options effectively influence selection patterns toward more sustainable options.
- The results in this study demonstrate that presenting environmental messages to study participants prior to choosing a menu item from a simulated online menu can result in up to a doubling of the number of plant-based options, which could have a substantial impact if findings generalize to real-world settings at scale.
- The messages tested in this study are examples of the types of messages that could be adapted and tailored to a wide variety of food retail contexts.
- Adding descriptive messages communicating the diverse benefits of plant-based food choices is a flexible and low-cost intervention that requires minimal time investment and is therefore a scalable approach to behavior change.

1. CURRENT PATTERNS AND IMPACTS OF MEAT CONSUMPTION

Ruminant meat consumption, especially beef, is especially high in industrialized Western countries, with the United States positioned as a global leader in per capita meat consumption (Figure 1) (Ritchie and Roser 2017).

Despite a steady downward trend in per capita beef consumption observed since the 1970s in the United States, consumption actually increased by 6 percent from 2015 to 2017 (Figure 2). This uptick has been attributed to

recovering consumer income after the 2007–09 economic recession and stable and/or declining retail red meat prices (Bentley 2019). Meanwhile, consumption of meat from other sources has either remained relatively constant or, in the case of poultry, increased, leaving total per capita meat consumption near an all-time high.

With recent evidence suggesting that food systems contribute more than one-third of global greenhouse gas (GHG) emissions globally (Xu et al. 2021),¹ the environmental impacts of food production and consumption cannot be overlooked.

Figure 1 | Per Capita Meat Consumption by Type and Country, 2017

Note: Data refer to meat "available for consumption." Actual consumption may be lower after correction for food wastage.

Source: Ritchie and Roser 2017.

Figure 2 | United States Per Capita Meat Consumption by Type and Cumulative, 2017

Source: Bentley 2019.

In recent years, a plethora of media reports, news coverage, and research has highlighted the impact of consumer dietary patterns on climate change, raising awareness among the general public. Ruminant animal meat (Box 1) has drawn special attention, as its production contributes disproportionately to GHG emissions, water and land use, and biodiversity loss. In fact, beef production requires 20 times more land and emits 20 times more GHG emissions per gram of edible protein than common plant-based protein sources such as beans, peas, and lentils (Searchinger et al. 2019). Despite these impacts, a wide variety of meats (Box 1) remain popular and play a central role in many global cuisines, with per capita meat consumption generally increasing as incomes rise (Marques et al. 2018).

In addition to the unsustainable impacts of ruminant meat production, red meat consumption is associated with an increased risk of chronic disease, including cardiovascular disease, cancer, type 2 diabetes, and obesity, as well as mortality (Guasch-Ferré et al. 2019; Schlesinger et al. 2019; Schwingshackl et al. 2017; Zeraatkar et al. 2019; Zheng et al. 2019).

BOX 1 | Dietary Definitions

- **Animal-based foods:** Includes all types of meat, fish, and products derived from animals (e.g., milk, eggs, cheese, etc.).
- **Plant-based foods:** Includes foods from plants and fungi (e.g., fruits and vegetables, beans, grains, legumes, mushrooms, nuts and seeds, plant oils, herbs, and spices).
- **Processed meat:** Includes sausages, bacon, ham, deli meats such as salami, pâtés, canned meat, and sliced luncheon meats (including chicken and turkey).
- **Red meat:** Includes beef, lamb and mutton, pork, veal, venison, and goat.
- **Ruminant meat:** Includes beef, venison, lamb, and mutton.
- **White meat:** Includes chicken, turkey, duck, goose, game birds, and rabbit.

Source: Attwood et al. 2020b; NHS 2021.

2. BEHAVIORAL NUDGES TO SHIFT DIETARY CHOICES

Multiple strategies for reducing the environmental footprint of ruminant meat have been proposed across the supply chain—from adopting more efficient production methods to curtailing farm-based methane emissions to reducing consumer wastage. One important strategy is to shift population-level dietary patterns that are high in animal-based foods toward plant-based foods (Box 1). These dietary shifts are a critical component of limiting global warming to 1.5°C above preindustrial levels (Searchinger et al. 2019).

Finding effective and efficient means of positively shifting consumers' food choices is an active area of research and policy interest (Reisch et al. 2021). Of the myriad strategies available, ranging from meat taxes to consumer education, behavioral “nudges” have emerged as a set of particularly promising approaches. As defined by Thaler and Sunstein (2008), “A nudge is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting fruit at eye level counts as a nudge. Banning junk food does not.”

The concept of nudging originates in the field of behavioral economics, a branch of economics recognizing the apparent irrationality behind people's decision-making processes. The observed deviations from behavior predicted by classic economics result from inherent biases, rules of thumb, and the social and environmental contextual factors that influence human behavior. Examples of nudge interventions include reminders, warnings, labeling, priming (using subtle, often subconsciously perceived environmental cues to influence behavior), default choices, and consumer messaging. Of the myriad behavioral strategies for shifting consumers' dietary choices, priming, information disclosure, social norms, and defaults have been applied most frequently in behavior change intervention research (Reisch et al. 2021).

Although some approaches that aim to influence conscious dietary choices, such as self-monitoring and individual counseling (Bianchi et al. 2018), may reduce meat demand

and encourage long-term behavior change transferable across settings, these approaches require substantial effort and resources and rely upon diners' willingness to change. Conversely, nudge-based interventions offer food service providers, retailers, and policymakers a suite of easy-to-implement, low-cost, and scalable interventions that do not entail regulation, economic incentives, or restrictions on consumer choice (Reisch et al. 2021).

This distinction between unconscious and conscious decision-making has been described by behavioral science researchers as a process that involves two types of thinking: one that is automatic and the other reflective (Kahneman 2011; Thaler and Sunstein 2008). Automatic thinking is characterized as effortless, fast, and instinctual. Reflective thinking, on the other hand, is characterized as effortful, slow, and controlled (Hansen and Jespersen 2013). Corresponding to these two types of thinking are two types of nudges aimed at influencing automatic and reflective thinking.

A further distinction can be made between transparent and nontransparent nudges, with the intention and means of influence being apparent to the nudge recipient in the case of transparent nudges. Examples of transparent nudges used to influence food choices include traffic-light nutrition labeling, caloric content of meals displayed on restaurant menus, point-of-purchase prompts or messages, and carbon and water footprint labeling. Examples of nontransparent nudges include removing trays from cafeterias, serving smaller plates and bowls, changing the order and/or location of foods on a buffet line, and increasing the ratio of plant- to animal-based dishes (Attwood et al. 2020b).

Messaging Approaches and Sustainable Food Choices

Various types of nudges have been used to shift consumers toward more sustainable dietary choices. Particular interest has been directed toward exploring how best to communicate the environmental impacts of different food choices to consumers via menus, packaging, signs, posters, or marketing copy.

There are multiple reasons for this interest in increasing transparency around the environmental impact of food. Firstly, messaging is already widely used by many food providers and manufacturers; hence, it is a familiar and easy-to-execute means of communicating to consumers. Secondly, research suggests that consumers generally appreciate food labels that communicate environmental information, either on its own or in combination with health/nutrition information (Tobi et al. 2019). Thirdly, market research also suggests that consumers believe food manufacturers, retailers, and providers should make more effort to guide consumers in their purchasing decisions (Minchin 2021). Finally, as a transparent nudge, sustainability messaging does not involve unconscious influence and, therefore, raises few ethical concerns.

Symbolic environmental messaging

To date, most research exploring questions related to environmental messaging has focused on symbols or logos. Such “ecolabels” have taken many different forms, including third-party certifications (e.g., fair trade, organic, Rainforest Alliance) presented as icons or symbols to indicate a product meets specified criteria, or carbon footprint metrics to characterize or categorize products on a sustainability spectrum.

In a recent review of 76 interventions (reported across 56 studies) assessing the impact of environmental labels on consumer food choices, researchers reported that 60 had a positive effect on selection, with not enough evidence to determine whether any one label type had a greater effect than others (Potter et al. 2021).

However, there is also reason to be cautious. In particular, consumers often have very little understanding of the environmental metrics underlying a given label (Rondoni and Grasso 2021; Sánchez-Bravo 2021). Existing research shows, for example, that few shoppers have sufficient knowledge to accurately comprehend the meaning or relevance of indicators such as kilogram reductions in GHG emissions or to understand environment-specific, technical concepts such as biodiversity or land-use footprints (Grunert et al. 2014). As a result, it is possible that including sustainability labels, logos, and/or quantitative metrics on food items could confuse consumers, limiting their capacity to act upon the information presented (Brown et al. 2020). Consistent with these limitations, a recent review of 38 research articles on consumers’ attitudes toward carbon footprint

labels reported that individuals with a higher income and education level are generally more positively disposed toward and more likely to pay more for products with carbon labeling (Rondoni and Grasso 2021).

Overall, research shows that environmental symbols tend to elicit smaller-than-anticipated influences on decision-making in real-world food choice environments, ranging from 5 to 10 percent (Brunner et al. 2018; Osman and Thornton 2019; Vlaeminck et al. 2014), likely as a result of low consumer comprehension. Moreover, food purchasing environments are replete with competing visual stimuli, where labels on many products are all vying for consumer attention and where choices are made very quickly and intuitively (Hornibrook et al. 2015). To this point, research suggests that consumers are willing to pay less for an item when both carbon and third-party labels are presented simultaneously (Rondoni and Grasso 2021), possibly due to cognitive overload. Although every reduction helps, researchers have cautioned against relying on sustainability labeling alone to sharply reduce demand for high-impact foods (Brown et al. 2020).

Descriptive environmental messaging

An alternative approach to environmental messaging that has potential to overcome barriers associated with poor comprehension is to describe the environmental credentials of plant-based foods in a more descriptive way. For example, instead of asking shoppers and diners to independently interpret the meaning of abstract symbols, businesses could use simple phrases or words to communicate the fact that plant-based foods are better for the environment.

As previous research indicates, descriptive messaging can influence food choices by activating sets of associated positive mental representations that consumers already have regarding the labeled product. For example, consumers have been shown to rate foods described as “eco-friendly” as tastier and of better quality than identical products without these descriptions (Sörqvist et al. 2015). Research also shows that options considered to be more environmentally friendly tend to be judged as fresher and healthier, regardless of whether or not they are in reality (Siegrist et al. 2015). Hence, one of the major benefits of descriptive messaging over symbolic messaging is the potential to influence choice indirectly through associated positive attributes.

The “green halo” that descriptive environmental messaging evokes has the potential to catalyze the desired shift toward more plant-based diets. Indeed, initial research in this area shows that referencing the lower environmental impact of plant-based foods boosts their selection compared to more conventional “vegetarian” labeling. For example, in one recent study by Krpan and Houstsma (2020), labeling vegetarian main courses listed in an online menu as “Environmentally Friendly Main Courses for a Happy Planet” led to a 73 percent relative increase in their selection compared to when the same dishes were designated as “Vegetarian Main Courses” (Krpan and Houstsma 2020). Further exploration by researchers revealed that environmental messaging boosted diners’ expectations that they would enjoy their chosen meal but had no influence on their sense of environmental responsibility.

Similarly, in another recent study comparing the impact of descriptive messaging about diet-related environmental impacts, the authors found this approach was *more* effective than no messaging in reducing meat intake and as effective as comparative health messaging. Again, the environmental messages in this study had no significant influence on participants’ personal identity in relation to the environment (Wolstenholme et al. 2020), evoking our question of how environmental messages influence plant-based food choices.

Building on earlier research (Sparkman and Walton 2017) and through a series of four studies, Sparkman et al. (2020) tested the impact of dynamic norms messages compared to no messages on the number of meat versus vegetarian dishes selected in both online and field settings (e.g., “We’ve noticed customers are starting to choose more meatless dishes. From Lunch to Late Night, we make sure to offer you a variety of dishes to choose from.”). Dynamic norms influenced consumers in the desired direction in three of these four studies, with the strongest impact found when customers had a greater connection to the referent group (e.g., fellow university affiliates). However, a more recent study failed to replicate these findings (Aldoh et al. 2021).

Together, previous studies suggest that descriptive consumer messaging is a promising strategy to encourage more sustainable food choices. However, given the nuanced results present in existing literature, further research is needed to understand the optimal way to frame these messages to encourage the greatest possible shift toward more plant-based diets and away from meat.

Environmental messaging—knowledge gaps

Although research suggests that descriptive environmental messaging is a promising strategy for shifting consumers toward plant-based options, clarity is needed regarding the best way to implement this approach. These are a few of the key questions that remain unanswered:

- Does highlighting the environmental credentials of plant-rich foods actually boost sales of labeled items compared to products or menu options featuring alternative message frames or no messaging at all?
- If effective, how should environmental benefits be communicated to consumers?
- How does this type of messaging influence decision-making? For example, do environmental messages encourage consumers to weigh the carbon or other footprints of plant- versus meat-based items and change their choices accordingly, or—as behavioral theory would dictate—are they exerting a more automatic effect on consumer decision-making?

3. STUDY DESIGN AND METHODOLOGY

The aim of the present study was to understand the relative impact of different types of environmental messages on food choices—the ultimate goal being to offer the food service and retail sectors clearer guidance on how to apply this approach to boost sales of plant-rich options and reduce consumption of ruminant meat from high levels.

The primary research question that we address here is whether descriptive environmental messages work to encourage consumers to choose plant-based options over meat-based options. Secondly, and assuming an affirmative response to the primary question, we explore which type(s) of environmental message(s) are most effective and through which pathway(s) do descriptive environmental messages work to influence consumer choices.

Methods

The process used to answer these research questions occurred in two phases (Figure 3). In Phase 1, we generated a series of differentially framed descriptive environmental messages. In Phase 2, we tested the message performance across a series of two randomized controlled trials. Trial 1 subjected the long list of messages that were generated in Phase 1 to a prioritization process using a large-scale online survey. This allowed us to short-list the five top-performing messages to take forward to Trial 2—a randomized controlled trial to determine which messages resulted in the largest increase in plant-based food selections from two online menus.

Figure 3 | **Message Development and Message Testing Phases of the Study**

Source: Authors.

Phase 1: Message Development

To generate a range of descriptive environmental messages to take forward to subsequent testing phases, World Resources Institute (WRI) researchers and staff worked with a team of marketing consultants using a structured creative process. As part of the initial briefing for this work, the consultants were supplied with a document laying out key instructions and parameters for message development, based on the requirements of our two research questions.

- **Length:** All messages must be no longer than a few sentences (i.e., similar in format and scope to the types of promotional messages typically included on food packaging, menus, signs, or labels).
- **Content:** All messages needed to refer to the concept of plant-based foods and to the concept of the climate/environment (or synonymous terms, such as *planet*).

Phase 1 proceeded in a series of four steps as depicted in Figure 4 and described in detail below.

Step 1: Inspiration gathering

In this initial step, WRI staff members and consultant teams gathered a range of example messages to use as inputs for Step 2. This involved reviewing websites, existing plant-based and broader sustainable brand campaigns, restaurant menus, and academic research on message framing. The latter aimed to identify the key parameters that have so far been tested in past messaging research. Examples include messages that were structured according to prevention versus promotion, local versus global, impact now versus impact in the future, financial versus health implications, impact on self versus impact on others, descriptive versus factual language, and natural versus technical frames.

Step 2: Ideation

WRI staff members and consultant teams (seven participants in total) completed an online ideation session using Miro software. The session was structured as follows: initial introduction to the challenge, reviewing goals of the meeting, and an overview of the agenda. This was followed by the team reflecting on inputs

Figure 4 | Environmental Message Development Process

Source: Authors.

gathered in Step 1 and working in subgroups to generate as many messages as possible during the remainder of the session. At the end of the session, the workshop coordinator compiled and recorded the ideas that were generated by the team.

Step 3: Message refinement

Following the ideation session, the workshop coordinator and marketing consultants worked on clustering the messages into broad themes; 10 unique areas were identified. These themes, and associated messages that were grouped under each, were then reviewed by all team members and edited as required. After refining the themes

and messages, aiming for the most compelling phrasing and maximal divergence between themes to avoid overlap, participants then voted for their favorite messages, leaving a total of 28 across the 10 themes (Table 1).

Step 4: Message selection

In this final step, the 28 short-listed messages were programmed into an online survey, with team members asked to rank them from most to least preferred. The top 10 messages according to survey results were taken forward for inclusion in the subsequent online prioritization survey.

Table 1 | **Ten Environmental Messages and Associated Themes Generated in Phase 1**

THEME	MESSAGE
Health and environment	You will be surprised how much positive impact plant-based food can have on both the planet and your health. Choose plant-based dishes to lower your carbon footprint and improve nutrition. It's about goodness for you and the planet.
The altruistic choice	Plant-based dishes are a win-win for you and the planet. They help you feel alive and full of energy. And they are kinder to the planet, with less impact on the climate. Plant-based dishes: do good and feel great.
Joining a movement	90% of Americans are making the change to eat less meat. Join this growing movement and choose plant-based dishes that have less impact on the climate and are kinder to the planet.
The aspirational choice	Movie stars and fashion icons around the world are waking up to the urgent challenge of climate change. Cutting down on meat and choosing more plant-based food is one of the ways they are reducing their impact. Join the in-crowd to make a change for a cooler planet.
A sustainable future	Choosing plant-based food is the best way to feed a growing population while protecting our planet's climate for generations to come. A greener future for our children starts on your plate.
Small changes, big impact	Each of us can make a positive difference for the planet. Swapping just one meat dish for a plant-based one saves greenhouse gas emissions that are equivalent to the energy used to charge your phone for two years. Your small change can make a big difference.
Performance benefits	Plant-based dishes take their energy from vegetables grown with the power of the sun and soil. They are a source of vibrant goodness for your body that also helps the planet's climate stay cool. Power your body with green energy.
Taste benefits	Plant-based dishes are stacked with fresh vegetables and flavorful herbs and spices, making them a delicious meal that is also kinder to the climate than meat-based dishes. Savor food that saves the planet.
Connecting with nature	Plant-based dishes are made with natural field-grown vegetables that are freshly harvested at their peak. Wholesome plant-based food is not only kinder to the climate but also full of natural good taste.
Planet, health, taste	Plant-based dishes are made with delicious ingredients that are better for your health and the climate than meat. Plant-based dishes are free from compromise: great taste, good for your health, and help the planet.

Sources: AIIIB 2021.

Our goal was not to ensure even coverage across all possible themes; rather, we intended to identify the strongest messages to be taken forward for subsequent testing. Hence, some thematic categories have no messages taken forward to Phase 2. Prior to this, each message was subjected to final editing and refinement.

Phase 2: Message Selection and Menu Message Testing Trials

After finalizing the 10 climate messages, the next phase of the study entailed, first, narrowing the list down to the 5 top-performing messages (Trial 1) and, second, determining which of the remaining messages were most effective in nudging respondents to select vegetarian dishes in a simulated online menu ordering survey (Trial 2).

Participants

Participants were recruited via Prolific (www.prolific.co), an online study subject recruitment platform, in January and February 2021. Prescreeners were applied via Prolific to limit recruitment of participants to current U.S. residents, fluent English speakers, and those who had no dietary restrictions and were not adhering to any specific diet. Participants were presented with a study consent form, explaining the purpose and expectations of the research and the voluntary nature of their participation, which was signed prior to participating in the survey (Appendix A).

Sample size estimates were calculated using a multiarm clinical trial sample size calculator (Grayling and Wason 2020), specifying 80 percent power ($\beta = 0.8$), a 5 percent significance level ($\alpha = 0.05$), and a 7 percent effect size, based on previous findings from a menu study conducted by Attwood et al. (2020a). We created sample target quotas for specific sociodemographic characteristics based on 2010 U.S. census data for ethnicity (about 60 percent white, 40 percent nonwhite) and gender (about 50 percent male, 50 percent female). Age groups (20–35 and 36+ years) were created based on typical market-based target audiences (roughly millennials and Generation X+). Target sample sizes for each gender, race/ethnicity/age group are listed in Appendix B.

Online survey development and administration

All surveys were designed and administered via Qualtrics software (Provo, Utah). In each of the two trials, participants were randomized to receive one of the 10 environmental messages or no message (control) in conjunction with the dish selection (Trial 1) or menu ordering (Trial 2) task.

The selection/ordering task was followed by a series of supplemental questions exploring decision-making drivers, dietary habits, climate change concern, and sociodemographic characteristics (see Appendix C for complete survey). Responses to the decision driver question (Appendix C, first question block) was intended to assess which, if any, contextual or psychological factors influenced consumers' menu decisions.

A single question asking participants to write in their favorite fruit was used as a quality control check, along with Qualtrics' reCAPTCHA score, both used to detect potential survey fraud. Each of the surveys was estimated to take approximately five minutes. Participants were paid US\$0.08 per minute (\$9.60 per hour), consistent with Prolific's midlevel payment spectrum.

Trial 1: Message selection

The message selection survey consisted of a series of eight paired entrees (i.e., main meals) from which participants were asked to select one. The menu items selected for the pairings were meant to be familiar to a mainstream American consumer base; therefore, we did not include esoteric ingredients or food products that might only be recognizable to a niche subgroup (e.g., meat substitutes, such as tofu or seitan, or branded meat alternatives, such as Impossible or Beyond burgers).

Six of the pairings consisted of one meat dish and one vegetarian dish. The meat-veg dish pairings were selected from popular cuisines in the United States and were intended to be comparable in terms of value, appeal, and satiety. The two remaining pairings consisted of one "double veg" pairing (i.e., two vegetarian dishes) and one "double meat" pairing (i.e., two meat dishes).

These double pairings were intended to reduce social desirability bias (i.e., participants figuring out the goal of the study and modifying their choices accordingly) among participants. See Appendix D for a complete list of cuisine types and corresponding dish pairings.

Figure 5 depicts the environmental message and dish pairings as presented to participants in Qualtrics. The same message was repeated on each dish pair selection screen, so that each participant only ever saw one message, and the ordering of dish pairings and dishes within pairings were presented in random order.

Trial 2: Menu testing

The menu-testing survey consisted of two menus (one lunch and one dinner menu), each with eight entrees: six containing meat and two vegetarian (Figure 6). The lunch menu consisted of assorted soups and sandwiches, and the dinner menu featured a variety of typical American entree dishes (see Appendix E for a complete list of menu options). As with Trial 1, menu items were selected for their recognizability and familiarity to a general American

Figure 5 | Screenshots of the Environmental Message and Dish Pairing Selection as Displayed in Qualtrics, Trial 1

Source: Authors.

audience. Figure 6 depicts the environmental message and menu pairings as presented to participants in Qualtrics. The same message was repeated on each menu screen, and the ordering of menus and dishes within each menu were presented in random order.

Data analysis

Data were analyzed using Stata statistical software, version 14.2 (StataCorp 2015). Descriptive statistics were used to characterize the sample and test for baseline differences in sociodemographic characteristics by message group. Analysis of variance was used to determine the percentage of vegetarian dishes selected (Trial 1) and menu orders (Trial 2) in each message group compared to the control group and compared to the other

message groups. Gender, race, income, age, and education were tested as effect modifiers. Tukey’s method was used to adjust for multiple comparisons.

Additionally, for Trial 2, logistic regression was used to calculate the odds ratio of ordering a vegetarian menu item by message group. Finally, the following 10 decision drivers were tested as potential mediators (i.e., factors that explain the relationship between message type and dish choice) using the ldecomp package to parse out the model’s direct and indirect effects (Buis 2010): healthier, more filling, more appealing/tasty, new or different, more familiar, better for animal welfare, more environmentally friendly, met dietary needs, better for human welfare, and more commonly ordered by others.

Figure 6 | Screenshots of Lunch and Dinner Menus as Displayed in Qualtrics, Trial 2

90% of Americans are making the change to eat less meat. Join this growing movement and choose plant-based dishes that have less impact on the climate and are kinder to the planet.		90% of Americans are making the change to eat less meat. Join this growing movement and choose plant-based dishes that have less impact on the climate and are kinder to the planet.	
<div>BLT Sandwich</div> <div>☐ Classicly layered bacon, lettuce, and tomato with mayonnaise on grilled rye bread</div>	<div>Mediterranean Veggie Sandwich</div> <div>☐ Roasted bell peppers, crumbled feta, cucumbers, spring greens, tomatoes, red onions, and pine nut hummus on herbed bread</div>	<div>Chicken Pasta</div> <div>☐ Blackened chicken and diced tomatoes with spinach tortellini in alfredo sauce</div>	<div>Baby Back Ribs</div> <div>☐ Tender ribs with smoky mesquite BBQ sauce, served with coleslaw and corn bread</div>
<div>Vegetable Beef Soup</div> <div>☐ Ground beef simmered with diced red potatoes, corn, green beans, and carrots in a tomato vegetable broth</div>	<div>Creamy Potato Ham Soup</div> <div>☐ Diced potatoes, ham, chopped carrots and onion cooked in creamy cheese</div>	<div>Pacific Veggie Pizza</div> <div>☐ Caramelized onions, roasted red peppers, black olives, mushrooms, and spinach over shredded mozzarella</div>	<div>Sirloin Steak</div> <div>☐ Pan-seared sirloin steak, served sweet potato fries</div>
<div>Turkey Chili</div> <div>☐ Turkey, garbanzo beans, black beans, and kidney beans, slow cooked in a tomato base</div>	<div>Ten Vegetable Soup</div> <div>☐ Tomatoes, red peppers, corn, carrots, celery, spinach, onion, and garlic in vegetable stock with chickpeas and quinoa</div>	<div>Chicken Pot Pie</div> <div>☐ Shredded chicken, carrots, onions, mushrooms and peas with a creamy herb sauce in a flaky pie crust</div>	<div>Butternut Squash Quinoa Bowl</div> <div>☐ Roasted butternut squash, sliced avocado, toasted chickpeas, and pumpkin seeds over quinoa, with a roasted red pepper sauce</div>
<div>Roast Beef Sandwich</div> <div>☐ Roast beef topped with a spiced BBQ sauce, lettuce, and tomato on sesame bun</div>	<div>Crispy Chicken Sandwich</div> <div>☐ Crispy white meat chicken breast topped with lettuce, pickles and spicy mayonnaise on a toasted bun</div>	<div>BBQ Chicken Pizza</div> <div>☐ Diced chicken, red onion, smoked Gouda cheese and fresh mozzarella with BBQ sauce</div>	<div>Classic Meatloaf</div> <div>☐ Thick sliced ground beef slow-baked in a classic tomato sauce with onions, served with roasted vegetables, mashed potatoes and gravy</div>

Source: Authors.

Participants were excluded from the analytic sample if their recorded Prolific identification was incorrectly specified or was entered multiple times; they did not enter a favorite fruit for the quality control question or had a reCAPTCHA score of less than 0.5; did not consent to participate or finish the survey; or fell into the 1st or 99th percentile for completion time. Participants who identified as vegan, vegetarian, or pescatarian; reported rarely/never eating meat or only eating meat several times per year; excluded beef and/or red meat from their diet; or last consumed meat more than a month ago were also excluded because they would likely choose a vegetarian dish regardless of message receipt.

4. RESULTS

Trial 1

Sociodemographics

After excluding ineligible participants, data from 6,374 participants were included in the analysis for Trial 1. Sociodemographic characteristics of the respondents are displayed in Table 2. There were no statistically significant differences in sociodemographic characteristics between the control and message groups, so results are presented in aggregate.

Table 2 | **Trial 1 Sample Sociodemographic Characteristics**

	n = 6,374	%
Race		
White	4,098	64.3
Black/African American	595	9.3
Hispanic/Latino	466	7.3
Asian	932	14.6
Other	283	4.4
Gender		
Female	3,180	49.9
Male	3,162	49.6
Other/NA	32	0.5
Income		
≤ US\$39,999	1,976	31.0
≥ US\$40,000	4,398	69.0
Age		
≤ 35 years	3,461	54.3
> 35 years	2,913	45.7
Education		
≤ High school	908	10.3
Some college/associate's degree	1,606	34.0
Bachelor's degree	2,433	38.2
> Bachelor's degree	1,121	17.6

Note: NA = not applicable.

Sources: Authors.

The majority of participants were white (64.3 percent) and roughly equally divided between genders (49.9 percent female) and the two age brackets (54.3 percent were 35 years old or younger). Most had earned a bachelor's or higher degree (55.8 percent) and made at least \$40,000 (for reference, from 2015 to 2019 the median per capita income was \$34,103) (U.S. Census Bureau 2019).

Message influence

Figure 7 displays the five top-performing messages ranked in order from highest to lowest percentage increase in vegetarian dishes selected. All of the messages performed statistically significantly better than no message (control group), though none of the messages performed statistically significantly better than the other messages. The impact of the message on ordering behavior did not differ by race, gender, age, education, or income.

Figure 7 | **Percentage of Vegetarian Dishes Selected Compared to the Control Group among Five Top-Performing Messages from Trial 1**

Sources: Authors.

Trial 2

Sociodemographics

After excluding ineligible participants, data from 2,902 participants were included in the analysis for Trial 2 where messages were added to food menus.

Sociodemographic characteristics of the respondents are displayed in Table 3. As in Trial 1, the majority were white, above median income level, 35 years old or younger, had obtained a bachelor's or higher degree, and made \$40,000 or more per year.

Table 3 | Trial 2 Sample Sociodemographic Characteristics

	n = 2,902	%
Race		
White	2,009	69.2
Black/African American	203	7.0
Hispanic/Latino	214	7.4
Asian	358	12.3
Other	118	4.1
Gender		
Female	1,329	45.8
Male	1,565	53.9
Other/NA	8	0.3
Income		
≤ US\$39,999	900	31.0
≥ US\$40,000	2,002	69.0
Age		
≤ 35 years	1,621	55.9
> 35 years	1,281	44.1
Education		
≤ High school	327	11.3
Some college/associate's degree	990	34.1
Bachelor's degree	1,082	37.3
> Bachelor's degree	503	17.3

Note: NA = not applicable.

Sources: Authors.

Message influence

Of the five messages tested in Trial 2, all but the “sustainable future” message performed statistically significantly better than the control (no message) (Figure 8). As with Trial 1, the “small changes, big impact” message increased the percentage of vegetarian meals the most, and none of the messages performed statistically significantly better than the others. The impact of the message on ordering behavior did not differ by race, gender, age, or education. The “small changes, big impact”

message was less effective among low-income participants when compared to high-income participants ($p = 0.02$), but only by one percentage point. Results from logistic regression models yielded the same findings when it came to the likelihood of ordering a vegetarian dish from both menus; participants receiving the “small changes, big impact” and “joining a movement” messages were also more likely to report that they would choose a vegetarian dish the next time they ate out (Appendix F).

Figure 8 | **Percentage of Vegetarian Dishes Selected Compared to the Control Group among the Five Top-Performing Messages from Trial 1**

Sources: Authors.

Decision drivers

In analyzing participants’ decision-making drivers (i.e., what factors caused a message to influence choices), results suggest that health concerns, perceptions of heartiness, and perceptions of the taste/appeal of the dish were most commonly ranked among the top three factors influencing selection (Table 4). Dietary needs/restrictions, concern for human welfare, and the popularity of the dish ranked last.

Our analysis demonstrated that none of the proposed decision drivers explained the relationship between the message received and the menu item selected. For example, we did not observe that the “taste benefits” message increased participants’ taste/appeal drive, which in turn influenced their menu choice. Hence, messages appear to affect food choices via pathways of influence that are not solely related to the content of the message itself.

Table 4 | **Decision Drivers Ranked as Most Influential in Determining Menu Selection**

DECISION DRIVER	PERCENTAGE RANKING AMONG TOP 3
Health	85.5
Heartiness	49.3
Taste/appeal	45.1
Novelty	31.2
Familiarity	26.5
Animal welfare	20.9
Environment	15.5
Dietary needs	11.5
Human welfare	8.9
Socially normative	5.8

Sources: Authors.

5. DISCUSSION

Results from the two trials presented here suggest that displaying thoughtfully framed environmental messages on restaurant menus can help to nudge diners to order more vegetarian entrees when eating out. Of the five messages displayed in the simulated menu ordering trial, four performed better than the control (no message), with the corresponding increase in the percentage of vegetarian orders roughly doubling for the two best-performing messages. These changes could make a big difference when it comes to reducing food-related environmental impacts if realized on a population scale, particularly the most influential messages. However, further research is needed to determine whether similar results are obtained across populations of varying socioeconomic status and country contexts and, most importantly, in real-world settings.

Top-Performing Messages

The largest shift toward plant-based dishes and away from meat occurred in the group receiving the “small changes, big impact” message, where the percentage of vegetarian orders more than doubled compared to the control group (25.4 percent versus 12.4 percent). This message translated the environmental cost of what might be perceived as a small, everyday decision into conceptual cost (cell phone charging time). Although it is not uncommon for food-related environmental impact metrics to be converted from standard units of GHG emissions, energy use, land area, and water investments into conceptual equivalents (e.g., number of miles driven/cars on the road, bathtubs/swimming pools filled, cubic feet of ice caps melted), the impact of such messages on consumer behavior have not been rigorously assessed. This strategy has been applied in the field of nutrition to translate the caloric content of dishes into the equivalent number of miles needed to expend the same amount of energy (either in terms of miles or minutes of walking), with some evidence of effectiveness (Antonelli and Viera 2015; Daley et al. 2020; Dowray et al. 2013). However, to our knowledge, ours is the first study to test the impact of such translations on consumer behavior at the point of decision-making.

The “joining a movement” message also resulted in a near doubling of vegetarian dishes selected (from 12 percent in the control group to 23 percent). This message included a descriptive social norm message (“90% of Americans are making the change to eat less meat”) followed by a call to action (“Join this growing movement and choose plant-based dishes that have less impact on the climate and are kinder to the planet”). These findings support and add to previous research in the field of pro-environmental behavior change highlighting that the use of social norms works to positively influence consumers’ choices in a variety of domains, including dietary choices (Abrahamse 2020; Cialdini et al. 2021; Salmivaara et al. 2021; Yamin et al. 2019).

Study Limitations and Future Directions

Although the findings from this study are promising, further research is needed to test the impact of descriptive messaging in a real-world setting (where diners must pay for and consume their selected meals) and across different countries and decision-making contexts (e.g., restaurants versus online menus versus supermarkets, United States versus other high meat-consuming populations). Recruiting study participants with sociodemographic characteristics that more closely represent the wider population of interest is also crucial for generalizing results beyond the study sample.

Further exploration of why and how descriptive environmental messages affect consumers’ automatic and/or reflective thinking processes, thereby influencing their behavior, is also deserving of attention. None of the decision drivers measured in this study (Table 4) were both influenced by the message and, in turn, influencers of dish selection—for several possible reasons. First, previous research in the field of psychology suggests that people are not necessarily the most accurate sources when it comes to explaining their own behavior (Gantman et al. 2017), making self-reported explanations less reliable. For example, previous research suggests that consumers may not perceive the extent to which social norms influence

their behavior (Nolan et al. 2008) and would, hence, be unable to report its impact. Second, it is possible that the messages elicited an emotional response—for example, the “warm glow” associated with prosocial behavior or guilt associated with choosing a meat dish—which was not measured in this study. Regardless of the explanation, understanding the cognitive processes at work allows for better prediction of the types of messages that best resonate with consumers.

Future studies should also consider whether and how variations in message content within the top-performing themes influence consumers’ choices. For example, is there something particularly poignant about translating the environmental impact of a dish into cell phone charges, or could other variations on this theme work equally as well or better? It would also be worthwhile to explore how climate messages might interact with other nudge approaches to behavior change, such as the order in which menu items are presented, how they are named, and/or the ratio of meat versus vegetarian options available.

Conclusion

In conclusion, presenting environmental messages to consumers when making food decisions is a potentially effective way to encourage plant-based choices. The messages tested in this study are examples of the types of messages that could be adapted and tailored to a wide variety of retail and food service contexts. A key insight for food service providers and retailers is that the approach is scalable and easy to implement. Although additional research is needed to substantiate and expand upon the evidence base, the results from this study suggest that nudging consumers via climate messaging in the context in which consumers make diet-related decisions is a promising, scalable strategy for encouraging more sustainable dietary choices.

APPENDIX A: PARTICIPANT CONSENT FORM

The following information about this survey is provided to help you decide whether or not to participate in this study.

What data will be collected?

The purpose of this survey is to better understand how people make decisions when reading restaurant menus. If you take part, you will be shown some text and then asked to make a choice between eight pairs of dishes from a menu. This will be followed by some questions asking you about your normal diet and some other personal information, such as race/ethnicity, income, place of residence, height and weight, and education, among others.

How will the data be used?

Data collected from this survey will be used for research purposes to understand how different types of dishes on menus should be marketed to increase their appeal to diners.

How will the data be stored and for how long?

Data will be stored in a password-protected secured drive for up to two years after the study (anonymously without Prolific ID numbers).

How will you maintain the anonymity of responses?

The first survey question will request your Prolific ID number so that we can link and compare data collected by Prolific. Once data have been downloaded, Prolific ID numbers will be deleted from our database and replaced with a randomly generated ID so nobody will be able to link you to the data we have stored.

Will data be made available to other researchers online at some point?

Anonymized data may be made available to researchers outside of the World Resources Institute in conjunction with corresponding publications.

How can I withdraw from the study if I choose?

Participation in this study is voluntary. You may withdraw from the survey by discontinuing to answer questions at any time. Data from incomplete surveys will be discarded and not included in our analysis.

Under which legal framework will my data be held?

This survey will be administered by researchers at the World Resources Institute, whose institutional privacy policies and data ethics standards will be upheld. No names, addresses, email addresses, phone numbers, or any other data that has the potential to reverse engineer that information will be collected. Data will be stored in a secure, password-protected file and only accessed via WRI-issued computers. Passwords will be updated quarterly, and a limited number of study staff members will have access to data files.

By checking one of the boxes below, please indicate whether you would like to participate in this study. Your consent implies that you have read and understood the above information.

- ☐ I consent to participate in this study.
- ☐ I do not wish to participate in this study.

APPENDIX B: PARTICIPANT SOCIODEMOGRAPHIC CHARACTERISTICS

Table B1 | Target Participant Recruitment Sociodemographic Characteristics and Target Sample Sizes for Trials 1 and 2

GENDER	RACE/ETHNICITY	AGE	TRIAL 1 SAMPLE SIZE	TRIAL 2 SAMPLE SIZE
Female	Nonwhite	36+	800	400
Female	White	36+	1200	600
Female	Nonwhite	20–35	800	400
Female	White	20–35	1200	600
Male	Nonwhite	36+	800	400
Male	White	36+	1200	600
Male	Nonwhite	20–35	800	400
Male	White	20–35	1200	600

- ☐ healthier
- ☐ more filling
- ☐ more appealing/tasty
- ☐ new or different
- ☐ more familiar
- ☐ better for animal welfare
- ☐ more environmentally friendly
- ☐ better for my diet (e.g., gluten-free, low carb, Kosher, Halal, etc.)
- ☐ better for human welfare
- ☐ more commonly ordered by others

To what extent did the message at the top of the menu influence your subsequent choice among the dishes?

Next time you order from a restaurant menu, how likely are you to choose a vegetarian meal?

	Very likely	Somewhat likely	Neither likely nor unlikely	Somewhat unlikely	Very unlikely
Likelihood	☐	☐	☐	☐	☐

Before the onset of COVID-19, how often did you usually dine out or get takeout from any retail food establishment?

	Daily	Several times per week	Several times per month	Several times per year	Rarely or never
Frequency of eating out pre-COVID	☐	☐	☐	☐	☐

Supplemental Dietary Questions

When was the last time you consumed meat of any kind?

	Today	Yesterday	Within the past week	Within the past 2–3 weeks	Within the past month	More than a month ago	Not applicable
Most recent meat consumption	☐	☐	☐	☐	☐	☐	☐

In general, how often do you consume meat of any kind?

	Daily	Several times per week	Several times per month	Several times per year	Rarely or never
Typical meat consumption frequency	☐	☐	☐	☐	☐

Please indicate which of the following dietary patterns best describes yours:

- ☐ None in particular
- ☐ Vegetarian
- ☐ Pescatarian
- ☐ Vegan

Other (or specify/clarify options above, e.g., vegetarian no eggs): _____

Comments: _____

Which of the following foods do you exclude entirely from your diet (if any)? Please select all that apply.

- ☐ Beef
- ☐ Pork (including ham and bacon)
- ☐ Red meat
- ☐ Chicken
- ☐ Turkey
- ☐ Fish
- ☐ Shellfish
- ☐ Eggs
- ☐ Cow's milk

☐ Yogurt (dairy)

☐ Cheese

Other or specify foods in categories above: _____

☐ None

What is your favorite kind of fruit? _____

Please indicate your willingness to reduce the amount of meat you typically consume:

	Very unwilling	Somewhat unwilling	Neither willing nor unwilling	Somewhat willing	Very willing
Willingness to reduce meat consumption	☐	☐	☐	☐	☐

Climate Change

How much do you think human activity contributes to global climate change?

	Not at all	0	1	2	3	4	5	A great deal
Human contribution								

To the best of your knowledge, which of the following is the most effective way of reducing humans' impact on the environment?

☐ Eating less meat

☐ Buying locally produced food

☐ Buying organic food

How important is climate change to you, personally?

	Not important	0	1	2	3	4	5	Very important
Importance								

Demographics

What is your permanent state of residence?

Alabama ... Wyoming ▼

What is your 5-digit zip code? _____

What is the highest level of school you have completed or the highest degree you have received?

- ☐ Less than high school degree
- ☐ High school graduate (high school diploma or equivalent, including GED)
- ☐ Some college but no degree
- ☐ Associate's degree in college (2-year)
- ☐ Bachelor's degree in college (4-year)
- ☐ Master's degree
- ☐ Doctoral degree
- ☐ Professional degree (JD, MD)

What is your race/ethnicity?

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Pacific Islander
- ☐ Hispanic or Latino

Other _____

- ☐ Prefer not to answer

What was your pre-COVID-19 household income before taxes?

- ☐ Less than \$10,000
- ☐ \$10,000 to \$39,999
- ☐ \$40,000 to \$79,999
- ☐ \$80,000 to \$159,999
- ☐ \$160,000 to \$249,999
- ☐ \$250,000 or more

What is your year of birth? _____

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to answer

What is your current height?

Feet: _____

Inches: _____

What is your current weight?

Pounds (lbs): _____

APPENDIX D: TRIAL 1 MENU PAIRINGS

Table D1 | Cuisine Types and Menu Pairings Presented to Participants in Trial 1

CUISINE	MEAT	VEG
Italian	Spaghetti and meatballs Beef meatballs, red peppers, basil, and onion in marinara over penne pasta	Eggplant Parmesan Lightly breaded eggplant sautéed in olive oil and baked with marinara and melted Parmesan
Mexican	Beef burrito 12-inch flour tortilla filled with seasoned grilled beef, rice, beans, salsa, cheese, fajita veggies, and sour cream	Bean and cheese burrito 12-inch flour tortilla filled with seasoned black beans, shredded lettuce, salsa, fajita veggies, cheese, and sour cream
Mexican (double veg)	Nacho platter Refried beans, salsa, jalapeños, melted jack cheese, and sour cream atop crispy corn tortilla chips	Enchiladas Soft corn tortillas stuffed with pinto beans, grilled veggies, and melted jack cheese; baked and topped with salsa
Middle Eastern	Lamb kebab Grilled lamb and vegetables served on a bed of spiced basmati rice	Falafel wrap Grilled chickpea falafel served in hot pita bread with lettuce, tomatoes, onions, and hummus
American—burgers	Beef burger 100% Angus beef patty on a toasted bun with lettuce, tomato, and onion; served with fries	Black bean burger Seasoned black bean patty on a toasted bun with lettuce, tomato, pickles, and onion; served with fries
Chinese (double meat)	General Tso's chicken Battered, deep-fried chicken tossed in a sweet and spicy sauce with a side of steamed broccoli and rice	Kung pao chicken Stir-fried diced chicken and roasted peanuts with onion, bell peppers, and carrots in a spicy chili pepper sauce
American—sandwich	Roast beef sandwich Thinly sliced roast beef with caramelized onions, provolone cheese, and horseradish sauce on a sesame seed bun	Caprese sandwich Sliced mozzarella, tomato, basil, and herbed olive oil dressing on a ciabatta roll
Italian—pizza	Classic pepperoni Pepperoni with mozzarella and marinara sauce on a deep-dish crust	Veggie supreme Roasted bell peppers, mushrooms, olives, and onions with mozzarella on a deep-dish crust

APPENDIX E: TRIAL 2 MENUS

Figure E1 | Trial 2 Lunch Menu

Roast Beef Sandwich

Roast beef topped with a spiced BBQ sauce, lettuce, and tomato on sesame bun

BLT Sandwich

Classically layered bacon, lettuce, and tomato with mayonnaise on grilled rye bread

Crispy Chicken Sandwich

Crispy white meat chicken breast topped with lettuce, pickles, and spicy mayonnaise on a toasted bun

Vegetable Beef Soup

Ground beef simmered with diced red potatoes, corn, green beans, and carrots in a tomato vegetable broth

Turkey Chili

Turkey, garbanzo beans, black beans, and kidney beans, slow cooked in a tomato base

Creamy Potato Ham Soup

Diced potatoes, ham, chopped carrots, and onion cooked in creamy cheese

Ten Vegetable Soup

Tomatoes, red peppers, corn, carrots, celery, spinach, onion, and garlic in vegetable stock with chickpeas and quinoa

Mediterranean Veggie Sandwich

Roasted bell peppers, crumbled feta, cucumbers, spring greens, tomatoes, red onions, and pine nut hummus on herbed bread

Figure E2 | Trial 2 Dinner Menu

Butternut Squash Quinoa Bowl

Roasted butternut squash, sliced avocado, toasted chickpeas, and pumpkin seeds over quinoa, with a roasted red pepper sauce

Pacific Veggie Pizza

Caramelized onions, roasted red peppers, black olives, mushrooms, and spinach over shredded mozzarella

Classic Meatloaf

Thick-sliced ground beef slow baked in a classic tomato sauce with onions, served with roasted vegetables, mashed potatoes, and gravy

Sirloin Steak

Pan-seared sirloin steak served with sweet potato fries

Baby Back Ribs

Tender ribs with smoky mesquite BBQ sauce, served with coleslaw and corn bread

Chicken Pot Pie

Shredded chicken, carrots, onions, mushrooms, and peas with a creamy herb sauce in a flaky pie crust

Chicken Pasta

Blackened chicken and diced tomatoes with spinach tortellini in alfredo sauce

BBQ Chicken Pizza

Diced chicken, red onion, smoked Gouda cheese and fresh mozzarella with BBQ sauce

APPENDIX F. TRIAL 2 LOGISTIC REGRESSION RESULTS

Table F1 | Likelihood of Choosing a Vegetarian Entree from Both Menus in Trial 2 in Each Message Group Compared to Control

MESSAGE	ODDS RATIO	P-VALUE	95% CONFIDENCE INTERVAL	
Small changes, big impact	2.69	<0.0001	1.68	4.31
Joining a movement	2.50	<0.0001	1.55	4.03
Health and environment	1.91	0.01	1.17	3.14
Taste benefits	1.68	0.046	1.01	2.78
A sustainable future	1.27	0.37	0.75	2.15

Table F2 | Likelihood (Self-Reported) of Being Somewhat or Very Likely to Choose a Vegetarian Dish at Next Restaurant Ordering Occasion in Each Message Group Compared to Control

MESSAGE	ODDS RATIO	P-VALUE	95% CONFIDENCE INTERVAL	
Small changes, big impact	1.79	<0.0001	1.32	2.43
Joining a movement	1.54	0.006	1.13	2.11
Health and environment	1.28	0.13	0.93	1.77
Taste benefits	1.27	0.14	0.92	1.76
A sustainable future	1.19	0.29	0.86	1.64

Note: Participants responded to the following question: "Next time you order from a restaurant menu, how likely are you to choose a vegetarian meal?" Responses fell on a five-point Likert scale from very unlikely to very likely.

ENDNOTES

- 1 Sources of food systems-related GHG emissions include land-use change, farmland management, livestock, and post-farm-gate activities (e.g., manufacturing, processing, transportation, etc.) (Xu et al. 2021).

REFERENCES

- Abrahamse, W. 2020. "How to Effectively Encourage Sustainable Food Choices: A Mini-Review of Available Evidence." *Frontiers in Psychology* 11 (November). <https://doi.org/10.3389/fpsyg.2020.589674>.
- Aldoh, A., P. Sparks, and P.R. Harris. 2021. "Dynamic Norms and Food Choice: Reflections on a Failure of Minority Norm Information to Influence Motivation to Reduce Meat Consumption." *Sustainability* 13 (15): 8315. <https://doi.org/10.3390/su13158315>.
- Antonelli, R., and A.J. Viera. 2015. "Potential Effect of Physical Activity Calorie Equivalent (PACE) Labeling on Adult Fast Food Ordering and Exercise." *PloS One* 10 (7): e0134289. <https://doi.org/10.1371/journal.pone.0134289>.
- Attwood, S., S.J. Chesworth, and B.L. Parkin. 2020a. "Menu Engineering to Encourage Sustainable Food Choices When Dining Out: An Online Trial of Priced-Based Decoys." *Appetite* 149 (June). <https://doi.org/10.1016/j.appet.2020.104601>.
- Attwood, S., P. Voorheis, C. Mercer, K. Davies, and D. Vennard. 2020b. *Playbook for Guiding Diners toward Plant-Rich Dishes in Food Service*. Washington, DC: World Resources Institute. https://files.wri.org/d8/s3fs-public/19_Report_Playbook_Plant-Rich_Diets_final.pdf.
- Bentley, J. 2019. "U.S. Per Capita Availability of Red Meat, Poultry, and Seafood on the Rise." U.S. Department of Agriculture Economic Research Service, December 2. <https://www.ers.usda.gov/amber-waves/2019/december/us-per-capita-availability-of-red-meat-poultry-and-seafood-on-the-rise/>.
- Bianchi, F., E. Garnett, C. Dorsel, P. Aveyard, and S.A. Jebb. 2018. "Restructuring Physical Micro-environments to Reduce the Demand for Meat: A Systematic Review and Qualitative Comparative Analysis." *Lancet Planetary Health* 2 (9): e384–97. [https://doi.org/10.1016/S2542-5196\(18\)30188-8](https://doi.org/10.1016/S2542-5196(18)30188-8).
- Brown, K.A., F. Harris, C. Potter, and C. Knai. 2020. "The Future of Environmental Sustainability Labelling on Food Products." *Lancet Planetary Health* 4 (4): e137–e38. [https://doi.org/10.1016/S2542-5196\(20\)30074-7](https://doi.org/10.1016/S2542-5196(20)30074-7).
- Brunner, F., V. Kurz, D. Bryngelsson, and F. Hedenus. 2018. "Carbon Label at a University Restaurant— Label Implementation and Evaluation." *Ecological Economics* 146 (April): 658–67. <https://www.sciencedirect.com/science/article/pii/S0921800917301404>.
- Buis, M.L. 2010. "Direct and Indirect Effects in a Logit Model." *Stata Journal* 10 (1): 11–29. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3314333/>.
- Cialdini, R.B., and R.P. Jacobson. 2021. "Influences of Social Norms on Climate Change-Related Behaviors." *Current Opinion in Behavioral Sciences* 42 (December): 1–8. <https://doi.org/10.1016/j.cobeha.2021.01.005>.

- Daley, A.J., E. McGee, S. Bayliss, A. Coombe, and H.M. Parretti. 2020. "Effects of Physical Activity Calorie Equivalent Food Labelling to Reduce Food Selection and Consumption: Systematic Review and Meta-analysis of Randomised Controlled Studies." *Journal of Epidemiology and Community Health* 74 (3): 269–75. <https://doi.org/10.1136/jech-2019-213216>.
- Dalin, C., and C.L. Outhwaite. 2019. "Impacts of Global Food Systems on Biodiversity and Water: The Vision of Two Reports and Future Aims." *One Earth* 1 (3): 298–302. <https://doi.org/10.1016/j.oneear.2019.10.016>.
- Dowray, S., J.J. Swartz, D. Braxton, and A.J. Viera. 2013. "Potential Effect of Physical Activity Based Menu Labels on the Calorie Content of Selected Fast Food Meals." *Appetite* 62 (March): 173–81. <https://doi.org/10.1016/j.appet.2012.11.013>.
- Gantman, A.P., M.A. Adriaanse, P.M. Gollwitzer, and G. Oettingen. 2017. "Why Did I Do That? Explaining Actions Activated Outside of Awareness." *Psychonomic Bulletin & Review* 24 (5): 1563–72. <https://doi.org/10.3758/s13423-017-1260-5>.
- Grayling, M.J., and J.M.S. Wason. 2020. "A Web Application for the Design of Multi-arm Clinical Trials." *BMC Cancer* 20 (January): 1–12. <https://doi.org/10.1186/s12885-020-6525-0>.
- Grunert, K.G., S. Hieke, and J. Wills. 2014. "Sustainability Labels on Food Products: Consumer Motivation, Understanding and Use." *Food Policy* 44 (February): 177–89. <https://doi.org/10.1016/j.foodpol.2013.12.001>.
- Guasch-Ferré, M., A. Satija, S.A. Blondin, M. Janiszewski, E. Emlen, L.E. O'Connor, W.W. Campbell, F.B. Hu, W.C. Willett, and M.J. Stampfer. 2019. "Meta-analysis of Randomized Controlled Trials of Red Meat Consumption in Comparison with Various Comparison Diets on Cardiovascular Risk Factors." *Circulation* 139 (15): 1828–45. <https://doi.org/10.1161/CIRCULATIONAHA.118.035225>.
- Hansen, P.G., and A.M. Jespersen. 2013. "Nudge and the Manipulation of Choice: A Framework for the Responsible Use of the Nudge Approach to Behaviour Change in Public Policy." *European Journal of Risk Regulation* 4 (1): 3–28. <https://doi.org/10.1017/S1867299X00002762>.
- Harguess, J.M., N.C. Crespo, and M.Y. Hong. 2020. "Strategies to Reduce Meat Consumption: A Systematic Literature Review of Experimental Studies." *Appetite* 144 (January): 104478. <https://doi.org/10.1016/j.appet.2019.104478>.
- Hayek, M.N., H. Harwatt, W.J. Ripple, and N.D. Mueller. 2020. "The Carbon Opportunity Cost of Animal-Sourced Food Production on Land." *Nature Sustainability* 4 (September): 21–24. <https://doi.org/10.1038/s41893-020-00603-4>.
- Hornibrook, S., C. May, and A. Fearn. 2015. "Sustainable Development and the Consumer: Exploring the Role of Carbon Labelling in Retail Supply Chains." *Business Strategy and the Environment* 24 (4): 266–76. <https://doi.org/10.1002/bse.1823>.
- Kahneman, D. 2011. *Thinking, Fast and Slow*. New York: Macmillan.
- Krpan, D., and N. Houtsmä. 2020. "To Veg or Not to Veg? The Impact of Framing on Vegetarian Food Choice." *Journal of Environmental Psychology* 67 (February): 101391. <https://doi.org/10.1016/j.jenvp.2020.101391>.
- Marques, A.C., J.A. Fuinhas, and D.F. Pais. 2018. "Economic Growth, Sustainable Development and Food Consumption: Evidence across Different Income Groups of Countries." *Journal of Cleaner Production* 196 (September): 245–58. <https://doi.org/10.1016/j.jclepro.2018.06.011>.
- Minchin, J. 2021. "Survey Reveals Consumers Becoming More Eco-focused When Shopping." *New Food*, April 22. <https://www.newfoodmagazine.com/news/145145/consumer-sustainability/>.
- NHS (National Health Service). 2021. "Eat Well: Meat in Your Diet." July 13. <https://www.nhs.uk/live-well/eat-well/meat-nutrition/>.
- Nolan, J.M., P.W. Schultz, R.B. Cialdini, N.J. Goldstein, and V. Griskevicius. "Normative Social Influence Is Underdetected." *Personality and Social Psychology Bulletin* 34 (7): 913–23. <https://doi.org/10.1177/0146167208316691>.
- Osman, M., and K. Thornton. 2019. "Traffic Light Labelling of Meals to Promote Sustainable Consumption and Healthy Eating." *Appetite* 138 (July): 60–71. <https://doi.org/10.1016/j.appet.2019.03.015>.
- Potter, C., A. Bastounis, J. Hartmann-Boyce, C. Stewart, K. Frie, K. Tudor, F. Bianchi, et al. 2021. "The Effects of Environmental Sustainability Labels on Selection, Purchase, and Consumption of Food and Drink Products: A Systematic Review." *Environment and Behavior* 53 (8): 0013916521995473. <https://doi.org/10.1177/0013916521995473>.
- Reisch, L.A., C.R. Sunstein, M.A. Andor, F.C. Doebbe, J. Meier, and N.R. Haddaway. 2021. "Mitigating Climate Change via Food Consumption and Food Waste: A Systematic Map of Behavioral Interventions." *Journal of Cleaner Production* 279 (January): 123717. <https://doi.org/10.1016/j.jclepro.2020.123717>.
- Ritchie, H., and M. Roser. 2017. "Meat and Dairy Production." Our World in Data. <https://ourworldindata.org/meat-production>.
- Rondoni, A., and S. Grasso. 2021. "Consumers Behaviour towards Carbon Footprint Labels on Food: A Review of the Literature and Discussion of Industry Implications." *Journal of Cleaner Production* 301 (June): 127031. <https://doi.org/10.1016/j.jclepro.2021.127031>.
- Salmivaara, L., C. Lombardini, and L. Lankoski. 2021. "Examining Social Norms among Other Motives for Sustainable Food Choice: The Promise of Descriptive Norms." *Journal of Cleaner Production* 311 (August): 127508. <https://doi.org/10.1016/j.jclepro.2021.127508>.

- Sánchez-Bravo, P., E. Chambers V, L. Noguera-Artiaga, E. Sendra, E. Chambers IV, and Á.A. Carbonell-Barrachina. 2021. "Consumer Understanding of Sustainability Concept in Agricultural Products." *Food Quality and Preference* 89 (April): 104136. <https://doi.org/10.1016/j.foodqual.2020.104136>.
- Schlesinger, S., M. Neuenschwander, C. Schwedhelm, G. Hoffmann, A. Bechthold, H. Boeing, and L. Schwingshackl. 2019. "Food Groups and Risk of Overweight, Obesity, and Weight Gain: A Systematic Review and Dose-Response Meta-analysis of Prospective Studies." *Advances in Nutrition* 10 (2): 205–18. <https://doi.org/10.1093/advances/nmy092>.
- Schwingshackl, Lukas, Georg Hoffmann, Anna-Maria Lampousi, Sven Knüppel, Khalid Iqbal, Carolina Schwedhelm, Angela Bechthold, Sabrina Schlesinger, and Heiner Boeing. 2017. "Food Groups and Risk of Type 2 Diabetes Mellitus: A Systematic Review and Meta-analysis of Prospective Studies." *European Journal of Epidemiology* 32 (5): 363–75. <https://doi.org/10.1007/s10654-017-0246-y>.
- Searchinger, T., R. Waite, C. Hanson, and J. Ranganathan. 2019. *Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050*. Washington, DC: World Resources Institute. <https://files.wri.org/d8/s3fs-public/wrr-food-full-report.pdf>.
- Siegrist, M., V.H.M. Visschers, and C. Hartmann. 2015. "Factors Influencing Changes in Sustainability Perception of Various Food Behaviors: Results of a Longitudinal Study." *Food Quality and Preference* 46 (December): 33–39. <https://doi.org/10.1016/j.foodqual.2015.07.006>.
- Sörqvist, P., A. Haga, L. Langeborg, M. Holmgren, M. Wallinder, A. Nörtl, P.B. Seager, and J.E. Marsh. 2015. "The Green Halo: Mechanisms and Limits of the Eco-label Effect." *Food Quality and Preference* 43 (July): 1–9. <https://doi.org/10.1016/j.foodqual.2015.02.001>.
- Sparkman, G., and G.M. Walton. 2017. "Dynamic Norms Promote Sustainable Behavior, Even If It Is Counternormative." *Psychological Science* 28 (11): 1663–74. <https://doi.org/10.1177/0956797617719950>.
- Sparkman, G., E. Weitz, T.N. Robinson, N. Malhotra, and G.M. Walton. 2020. "Developing a Scalable Dynamic Norm Menu-Based Intervention to Reduce Meat Consumption." *Sustainability: Science Practice and Policy* 12 (6): 2453. <https://doi.org/10.3390/su12062453>.
- StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp.
- Thaler, R.H., and C.R. Sunstein. 2008. *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Vol. 293. New Haven, CT: Yale University Press.
- Tobi, R.C.A., F. Harris, R. Rana, K.A. Brown, M. Quaife, and R. Green. 2019. "Sustainable Diet Dimensions. Comparing Consumer Preference for Nutrition, Environmental and Social Responsibility Food Labelling: A Systematic Review." *Sustainability: Science Practice and Policy* 11 (23): 6575. <https://doi.org/10.3390/su11236575>.
- U.S. Census Bureau. 2019. "Quick Facts: United States." <https://www.census.gov/quickfacts/fact/table/US/SEX255219>.
- van Dijk, M., T. Morley, M.L. Rau, and Y. Saghai. 2021. "A Meta-analysis of Projected Global Food Demand and Population at Risk of Hunger for the Period 2010–2050." *Nature Food* 2 (7): 494–501. <https://doi.org/10.1038/s43016-021-00322-9>.
- Vlaeminck, P., T. Jiang, and L. Vranken. 2014. "Food Labelling and Eco-friendly Consumption: Experimental Evidence from a Belgian Supermarket." *Ecological Economics: The Journal of the International Society for Ecological Economics* 108 (December): 180–90. <https://doi.org/10.1016/j.ecolecon.2014.10.019>.
- Willett, W., J. Rockström, B. Loken, M. Springmann, T. Lang, S. Vermeulen, T. Garnett, et al. 2019. "Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems." *The Lancet* 393 (10170): 447–92. [https://doi.org/10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4).
- Wolstenholme, E., W. Poortinga, and L. Whitmarsh. 2020. "Two Birds, One Stone: The Effectiveness of Health and Environmental Messages to Reduce Meat Consumption and Encourage Pro-environmental Behavioral Spillover." *Frontiers in Psychology* 11 (October): 577111. <https://doi.org/10.3389/fpsyg.2020.577111>.
- Xu, X., P. Sharma, S. Shu, T.-S. Lin, P. Ciais, F.N. Tubiello, P. Smith, N. Campbell, and A.K. Jain. 2021. "Global Greenhouse Gas Emissions from Animal-Based Foods Are Twice Those of Plant-Based Foods." *Nature Food* 2 (September): 1–9. <https://doi.org/10.1038/s43016-021-00358-x>.
- Yamin, P., M. Fei, S. Lahlou, and S. Levy. 2019. "Using Social Norms to Change Behavior and Increase Sustainability in the Real World: A Systematic Review of the Literature." *Sustainability: Science Practice and Policy* 11 (20): 41. <https://doi.org/10.3390/su11205847>.
- Zeraatkar, D., B.C. Johnston, J. Bartoszko, K. Cheung, M.M. Bala, C. Valli, M. Rabassa, et al. 2019. "Effect of Lower versus Higher Red Meat Intake on Cardiometabolic and Cancer Outcomes: A Systematic Review of Randomized Trials." *Annals of Internal Medicine* 171 (10): 721–31. <https://doi.org/10.7326/M19-0622>.
- Zheng, Y., Y. Li, A. Satija, A. Pan, M. Sotos-Prieto, E. Rimm, W.C. Willett, and F.B. Hu. 2019. "Association of Changes in Red Meat Consumption with Total and Cause Specific Mortality among US Women and Men: Two Prospective Cohort Studies." *British Medical Journal* 365 (June). <https://doi.org/10.1136/bmj.l2110>.

ACKNOWLEDGMENTS

The authors thank the following individuals for reviewing and providing helpful input on draft versions of this publication: Anne Bordier, Mindy Hernandez, Micaela Karlsen, Gerard Pozzi, Lucia Reisch, Anna Twomlow, and Richard Waite.

The authors thank Lauri Scherer for copyediting, LSF Editorial for proofreading, and Jenna Park for publication layout and design.

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.