Title: Food Swaps to Improve the Healthfulness and Reduce the Carbon Footprint of Grocery Purchases
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Study Principal Investigator:

Anna H. Grummon
Stanford University
email: agrummon@stanford.edu

Introduction

The goal of the analyses described here is to use data we collected through an online randomized trial to examine consumer responses to receiving health, climate, or health and climate swap recommendations while grocery shopping. This analysis plan pre-specifies the analyses before collecting data and therefore serves as our ex-ante planned analysis.

Study Protocol

Participants will complete an online randomized trial. Participants will complete 3 online study visits, each separated by ~1 week. For all 3 study visits, participants will complete a shopping task in a naturalistic online grocery store and respond to survey questions. In the first study visit (baseline), participants will provide electronic informed consent and then complete the shopping task with no modifications to the store. At the end of the first visit, participants will be randomized to 1 of 4 trial arms: 1) health swaps, 2) climate swaps, 3) combined health and climate swaps, or 4) control. For the second and third study visit, participants will complete the shopping task in their randomly assigned trial arm, then respond to survey questions.

In the shopping task, participants will be instructed to shop as they usually would for items in the following food groups: beverages, boxed and frozen meals, dairy and dairy alternatives, meat and meat alternatives, soups, and sweets and snacks. They will be given a budget of $50. To checkout, participants need to have spent between 0.5 and 1.5 times this budget (i.e., $25 to $75), but otherwise will be free to shop as they wish. To incentivize participants to behave as they would in a real store, we will inform them that 25 will be randomly chosen to have their selections delivered to them, plus the remainder of the shopping budget as an electronic gift card. At the end of the study, we will debrief participants that those who were selected for delivery would instead receive an electronic gift card for $50.

Statistical Considerations

General Principles

We will use a two-sided critical alpha of 0.05 to conduct all statistical tests. All confidence intervals presented will be 95% and two-sided. Unless otherwise noted, analyses will be intent-to-treat, examining all participants in their randomized groups (regardless of the extent of the study they complete after randomization).

Co-Primary Outcomes

There are two co-primary outcomes:

1. The first co-primary outcome is the healthfulness of participants' selections, operationalized as the average Ofcom Nutrient Profiling Model score of the products the participants select in the shopping task.
2. The second co-primary outcome is the carbon footprint of participants' selections, operationalized as the average carbon footprint (in CO_2-equivalents) of the products the participants select in the shopping task.

Secondary Outcomes

The secondary outcomes are:

- Selection outcomes:
    3. Calorie density, kcal per 100g
    4. Sugar density, g per 100g
    5. Sodium density, mg per 100g
    6. Saturated fat density, g per 100g
    7. Fiber density, g per 100g
    8. Protein density, g per 100g
    9. Total spending, USD ($)
- Psychological outcomes
    10. Thinking about health
    11. Thinking about climate impact
    12. Thinking about taste
    13. Negative emotions while shopping
    14. Positive emotions while shopping
    15. Injunctive norms to buy healthy foods
    16. Descriptive norms to buy healthy foods
    17. Injunctive norms to buy foods with low climate impact
    18. Descriptive norms to buy foods with low climate impact

Other Outcomes

The other outcomes are:

19. Perceived helpfulness of nutrition labels
20. Perceived helpfulness of climate labels
21. Perceived helpfulness of health swap recommendations
22. Perceived helpfulness of climate swap recommendations
23. Liking of nutrition labels
24. Liking of climate labels
25. Liking of health swap recommendations
26. Liking of climate swap recommendations
27. Acceptability of nutrition labels
28. Acceptability of climate labels
29. Acceptability of health swap recommendations
30. Acceptability of climate swap recommendations

Statistical Methods

1. We will describe participant characteristics by trial arm. We will use means and standard deviations to characterize continuous variables. We will use frequencies and percentages

to characterize categorical variables. We will also describe the number of swaps offered and proportion of swaps accepted in the intervention arms.

2. Analyses of the co-primary outcomes:
    a. We will use mixed effects linear regression to evaluate the effects of the interventions on the healthfulness and carbon footprint of participants' selections. In separate models for healthfulness and carbon footprint, we will regress the outcomes on indicator variables for trial arm (excluding the control arm as the reference category), an indicator variable for time period (baseline vs. follow-up) and the interaction between trial arm and time period. We will treat the intercept as random to account for repeated measures within participants. The treatment effects are given by the coefficients on the interaction terms. We will test whether each intervention arm (i.e., Health Swaps, Climate Swaps, or Combined Health + Climate Swaps) affects healthfulness and carbon footprint of participants' selections compared to the control arm. We will also test whether the effects of the 3 intervention arms on the healthfulness and carbon footprint of participants' selections differ from one another using Wald tests.
    b. We will test whether the effects of the interventions on the healthfulness and carbon footprint of participants' selections are moderated by age group (young adult ages 18-25 vs. older adult ages 26 and older), health consciousness (average responses to 4 items adapted from prior studies,[1,2] treated continuously), and environmental consciousness (average responses to the GREEN scale,[3] treated continuously). To test for moderation, we will add to the primary model indicators for the moderator, interactions between the moderator and trial arm, interactions between the moderator and time period (baseline vs. follow-up), and three-way interactions (i.e., difference-in-difference-in-differences) between the moderator, trial arm, and time period. We will use separate models for each co-primary outcome (healthfulness and carbon footprint) and moderator. We will test the joint significance of the difference-in-difference-in-differences interaction terms. If the primary analyses do not reveal differences between the three intervention arms, we may collapse across these arms for the moderation analyses.
    c. We will test whether the effects of the intervention on the co-primary outcomes differ between first and second exposure using mixed effects linear regression. Similar to the main model, we will regress the outcome on indicator variables for trial arm (excluding the control as the referent), week of data collection (i.e., week 2 or week 3, excluding week 1 [the baseline week] as the referent category), and the interactions between trial arm and week of data collection. We will use the model to estimate effects of the interventions on the outcomes during week 2 (vs. baseline) and week 3 (vs. baseline) and to test whether these effects differed from one another. If the analyses described above do not reveal differences between the three intervention arms, we may collapse across these arms for this analysis.

3. Analyses of secondary outcomes:
    a. We will use a similar mixed effects regression approach to evaluate the effect of the interventions on the secondary outcomes (e.g., calorie density, thinking about health).
4. Analyses of other outcomes
    a. We will descriptively report participants' responses to the perceived helpfulness, liking, and acceptability outcomes.

Sample Size Needs

We used G*Power to estimate sample size needs.[4] We estimated sample size needs to detect an effect of each intervention (health, climate, and combined) vs. the control of d=.15. This effect is considered small[69] and is conservative based on prior studies.[31,70,71] Assuming a two-tailed critical alpha of 0.05 and a correlation among repeated measures of 0.4, a sample size of 904 (226 per group) would yield 90% power to detect an effect of this size or larger. To account for potential missing data, we aimed to recruit a sample of 1,200 (300 per group).

Exclusions

In week 1, we will exclude participants who do not complete the survey. These participants will not be randomized and will not be invited to complete the remaining weeks of the study.

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