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Can episodic future thinking affect food choices?

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ABSTRACT
Episodic future thinking, defined as the ability to project oneself into the future, has proven useful to pre-experience the future consequences of present actions. We investigate how episodic future thinking influences the food choices of normal weight, overweight, and obese individuals. In doing so, we conduct a controlled laboratory experiment in which participants are presented with representations of weight-increased and weight-reduced modified images of themselves before performing a food choice task. This allows subjects to vividly imagine the future consequences of their actions. We also test the effect of providing health-related information on food choices to compare with the episodic future thinking effect. Our results suggest that while providing health-related information increases the number of lite snack choices of overweight and obese individuals, engaging in episodic future thinking has a positive impact on the food choices of the obese only. These findings are supported by eye-tracking data showing how visual attention and emotional arousal (measured by pupil size) impact individuals' food choices.

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1. Introduction

Economists and psychologists commonly believe that an individual’s sense of connection with his future self—or lack thereof—plays a key role in driving myopic behavior today (Schelling, 1984; Thaler and Shefrin, 1981). Charles Dickens’s depiction of Ebenezer Scrooge in A Christmas Carol motivates our work in the present paper. Scrooge is a cruel person who is given a chance to redeem himself through the intervention of ghosts from his past, present, and future. The ghosts of the past and present make him melancholic, but ultimately do not succeed in changing his behavior. It is not until the visit from the Ghost of Christmas Yet-to-Come that Scrooge changes his present behavior:

“Ghost of the Future!” [exclaimed Scrooge], “I fear you more than any spectre I have seen. But as I know your purpose is to do me good, and as I hope to live to be another man from what I was, I am prepared to bear you company, and do it with a thankful heart.” Charles Dickens (1843)
Related to this story is the notion that an individual’s degree of connection with his self-image today, and possibly in the future, might affect his decisions in the present. Indeed, researchers believe there is a gap or misunderstanding between how an individual may feel in the future and his discounted decisions taken in the present (Loewenstein et al., 2003). In this regard, Loewenstein (1996) argues that more vivid visual imagery of the future consequences of today’s actions might amplify the visceral emotions related to processing those actions. These heightened emotional states might help increase the saliency of the future consequences associated with a decision in the present. For instance, nutritionists’ extensive exposure to obesity and diabetes acts to charge their emotions against chronic disease, which in turn drives them toward healthier diets (Wardle et al., 2000).

A strategy that has proven useful in helping individuals intensify the connection with their future and reduce the perceived distance between the future and the present is “episodic prospection” or “episodic future thinking” (Atance and O’Neill, 2005). Episodic future thinking (EFT) refers to an individual’s ability to project himself into the future in order to pre-experience an event (Atance and O’Neill, 2001; Schacter et al., 2007). EFT has proven to be a useful instrument for reducing temporal discounting by helping individuals consider the potential future rewards or punishments of their actions (O’Donnell et al., 2017; Stein et al., 2017; Schacter et al., 2017; Wu et al., 2017; Chiou and Wu, 2016; Daniel et al., 2016; Kaplan et al., 2016; Liu et al., 2013; Van Gelder et al., 2013; Cheng et al., 2012; Kurth-Nelson et al., 2012; Benoit et al., 2011; D’Argembeau et al., 2011; Herschfield et al., 2011; Peters and Büchel, 2010; Ernser-Hershfield et al., 2008). In addition, research shows that engaging in EFT reduces impulsive behaviors such as overeating, alcohol consumption, and smoking (Stein et al., 2018; Bulley and Gullo, 2017; Sze et al., 2017; Dassen et al., 2016; O’Neill et al., 2016; Stein et al., 2016; Snider et al., 2016; Bromberg et al., 2015; Daniel et al., 2015; Sze et al., 2015; Daniel et al., 2013a; 2013b).

Building on the literature linking episodic future thinking and temporal discounting, we investigate whether interacting with images of “weight-reduced” and “weight-increased” representing potential future selves can motivate people to make better food choices in the present. The closest study to ours is Kuo et al. (2016), who allow participants to interact with a weight-reduced representation of themselves using a virtual environment. The authors find a significant effect of episodic prospection in reducing calorie consumption. However, they are unable to identify whether the magnitude of the episodic prospection effect differs across individuals with different Body Mass Indices (BMI). Our study not only addresses this research gap but also combines the elements of food-related visual temptation and body weight to examine the mechanism through which EFT affects current food choices. This is an important issue given the high obesity rates around the world (Amlung et al., 2016).

The main goal of the present study is to examine the effect of episodic future thinking on current food choices. However, in order to test whether food-related decisions are affected by a lack of connection with the future self, we differentiate between the effect of EFT and immediate health-related thinking. This also allows us to examine whether the effect of EFT would differ from more traditional health information intervention programs that have been popularly tested in previous studies (Rusmevichientong et al., 2014; Escarón et al., 2013; Horgen and Brownell, 2002). In contrast to previous studies (Kuo et al., 2016; Daniel et al., 2013b; 2013a), we assess the differences in the magnitude of the EFT effect across BMI status (i.e., normal weight, overweight, and obese). More importantly, our study is unique in combining eye-tracking technology with economic methods to improve the understanding of the relationship between episodic future thinking and food decision-making.

To perform our analysis, we conduct a controlled laboratory experiment in which participants are induced with health-related thoughts and image self-representations projecting the future benefits and costs of physical changes prior to performing an incentivized food choice task. We randomly assign subjects to three conditions. In the first treatment, referred to as the EFT condition, subjects have the opportunity to interact with digitally modified pictures representing a “weight-reduced” and a “weight-increased” version of themselves for 2 minutes. This facilitates the self-visualization of the future benefit and cost of their current actions (i.e. food choices). The second treatment, referred to as the health information condition, presents subjects with a 2-min video focusing on the benefits of dieting and exercising along with the costs of eating unhealthy foods. Subjects in the control condition receive no information prior to performing the tasks and simply wait 2 minutes before proceeding to the next phase of the experiment.

We find that providing information about the benefits and costs associated with healthy and unhealthy habits increases the number of lite snack choices (i.e. low-calorie snacks with nutrient claims) of overweight and obese individuals. However, exposure to episodic future thinking has a positive impact on the food choices of the obese only. Our behavioral findings are supported by two eye-tracking metrics, total visit duration and pupil dilation, which reveal that the treatments affect individuals’ visual attention and emotional arousal toward the snacks. While EFT increases arousal toward food among overweight and obese individuals, it also increases their attention toward the lite alternatives. On the contrary, the provision of health-related information is effective in decreasing the arousal levels toward food exhibited by all subjects, regardless of their weight status.

Our study provides several contributions to the literature. First, we provide a direct test of the effect of episodic future thinking on food choices in a real (non-hypothetical) economic environment. Second, we provide evidence that the EFT effect on food choices has heterogeneous effects for different BMI categories. In this regard, we highlight the importance of designing policy interventions that are tailored to the specific health characteristics of individuals for setting effective health-related goals. This opens the door to a new research agenda that could help explain why overweight and obese individuals often fail to stick to health-related intervention programs. Finally, we contribute to the literature by introducing eye tracking metrics that may help explain the mechanisms underlying the relationship between EFT and food-related decision making.
2. Literature review

A number of studies have examined the impact of episodic future thinking (EFT) on decision-making and preferences (Rung and Madden, 2018; Bulley and Gullo, 2017; Wu et al., 2017; Kuo et al., 2016; Stein et al., 2016). Episodic future thinking, one of several forms of prospective thinking, involves vivid mental simulation or visualization of possible future events, which activates brain regions involved in prospective thinking (Antice and O’Neill, 2001), thereby inducing a future orientation (Cheng et al., 2012; Chiu and Wu, 2016).1 One of the research domains in which episodic future thinking has been previously utilized is inter-temporal choices or temporal discounting (Benoit et al., 2011; Peters and Büchel, 2010). Temporal discounting refers to the evaluation that individuals place on larger future rewards in favor of smaller immediate rewards, which often leads to impulsive choices in favor of the smaller reward option (Mischel and Ebbesen, 1970). In EFT studies, participants are typically instructed to imagine realistic events at several future times. Cues for the imagined future events are subsequently embedded in a delayed discounting task and participants are asked to think about their events during each inter-temporal choice (Daniel et al., 2013b). The results from these studies suggest that EFT increases patience by helping individuals consider the potential future rewards/punishments of their actions (Daniel et al., 2013b; Peters and Büchel, 2010).

The effects of episodic future thinking on delayed gratification have been extended to the domain of eating behavior, where engaging in EFT is shown to reduce the dietary biases toward the immediate satisfaction of food intake and increase the value of long-term health goals. For example, Daniel et al. (2013b) show that when overweight and obese women vividly imagine the future through EFT, they consume fewer calories in a subsequent ad libitum eating task. Similar effects have been found among overweight children (Daniel et al., 2015) and female students (Dassen et al., 2016). In addition, the effectiveness of EFT in reducing energy intake has been found in natural field settings (i.e. food court) (O’Neill et al., 2016), weight loss intervention programs (Sze et al., 2015), and online experiments (Sze et al., 2017).

One issue in the aforementioned literature is that individuals often fail to identify with their future selves due to lack of imagination (Schelling, 1984; Parfit, 1971), impairing the level of self-control exerted in subsequent decisions. In fact, there is evidence that individuals use similar processes to make decisions for their future selves as those used to make decisions on behalf of strangers (Pronin et al., 2008). It is almost as if the lack of connection between “me-today” and “me-in-the-future” drives people to see “me-in-the-future” as a complete stranger. In this regard, studies have shown that the EFT effect on discounting-related behavior is more pronounced when the vividness or concreteness of the future simulated event is enhanced (O’Donnell et al., 2017; Hershfield, 2011; Bartels and Rips, 2010). For example, Hershfield et al. (2011) shows that allowing people to interact with age-progressed renderings of themselves made them allocate more financial resources into the future. Similarly, Van Gelder et al. (2013) show that people who interact with realistic digital portraits of their future selves are less likely to cheat in a subsequent task. On that basis, we present subjects with altered digital images representing a weight-reduced and weight-increased image of themselves in order to facilitate their self-visualization of the future benefits and costs of their actions, before making their food choices. This idea of having a more vivid future representation has previously been applied to a food-related context. Kuo et al. (2016) allow participants to interact with weight-reduced self-representations in a virtual environment prior to observing their temporal and food decisions. The authors find a positive EFT effect in reducing discounting rates and calorie intake, and increasing participants’ preferences for smaller amounts of sugar in a reward drink.

In summary, laboratory and field experiments indicate that episodic future thinking helps reduce delay discounting and calorie consumption. Relatively few studies on EFT have examined heterogeneous treatment effects, but the evidence available suggests that these effects do not differ for sub-populations (Daniel et al., 2013a). Our study not only measures the magnitude of the distributional effects of episodic future thinking across BMI categories, but it also combines the elements of food-related visual attention and body weight to examine whether EFT affects current food choices.

3. Hypotheses

The above discussion motivates the following three hypotheses, which we test in a laboratory experiment using individuals with heterogeneous (BMI) weight status.

**Hypothesis 1. Interventions inducing future self-image thoughts increase the number of lite snack choices.**

Hypthesis 1 is in line with research suggesting that episodic future thinking reduces discounting and calorie intake (Kuo et al., 2016; Daniel et al., 2013b). We expect the EFT treatment to increase the value of delayed outcomes (i.e. make subjects more patient) since it allows individuals to pre-experience the reward of a future better appearance, which will steer them toward choices with long-term effects (e.g., lower calorie consumption in the present). That is, we expect them to put more weight on their expected future appearance relative to their satisfaction from current food consumption.

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1 Four types of future thinking or prospection have been recently distinguished: simulation, prediction, intention, and planning (Szpunar et al., 2014). Empirical studies mainly focus on episodic future thinking or simulation, in which the words thinking and simulation are used interchangeably. See Schacter et al. (2007) for a review.
Hypothesis 2. Interventions focusing on the consequences of healthy and unhealthy habits increase the number of lite snack choices.

We expect that providing information about the benefits and costs of healthy/unhealthy dietary habits will make subjects more patient and decrease their temptation toward unhealthy (i.e. more calorie-dense) food. The health-related video might motivate subjects to change their current dietary habits toward a healthier lifestyle. However, it is conceivable that thinking about the consequences of unhealthy behaviors (e.g., stress, tiredness) might overwhelm them, causing an opposite, backfire effect (Hershfield, 2011). Moreover, we believe that this treatment effect might not be as strong as that from the EFT condition since subjects might not feel connected with their future self-image, hindering them from acting more future-oriented.

So far, the proposed mechanisms to decrease calorie intake in previous literature have focused on the assumption that there is no heterogeneity across individuals with different health characteristics. We expect the magnitude of the treatment effects to differ across BMI status (normal weight, overweight, and obese).

Hypothesis 3. There are heterogeneous treatment effects on food choices by BMI.

To date, only two studies have addressed the effect of episodic future thinking on delayed gratification differentiating individuals by BMI (Daniel et al., 2015; 2013a); however, both studies differ from ours in terms of the sample and experimental task used. Daniel et al. (2015) show that episodic prospecting reduces food intake in overweight/obese children; however, the treatment effect is not differentiated between BMI categories (i.e. overweight and obese). Although the second study finds a positive effect of episodic prospecting in reducing delay discounting, this effect is similar for normal-weight and overweight/obese women (Daniel et al., 2013a). Moreover, this study focuses on the impact of episodic future thinking on discounting of money, not food choices, which is our main outcome measure of interest. Because the study of EFT on individuals with different BMI status is limited, priors regarding the size or magnitude of the treatment effects by BMI status should be drawn with caution. Overall, we hypothesize that, in the absence of a treatment, overweight and obese individuals will place a higher value on the immediate pleasure of eating unhealthy (high calorie) food. On the contrary, we expect overweight and obese subjects to choose more lite snacks after engaging in EFT.

4. Methods

4.1. Experimental design

The experiment consists of a between-subject design in which participants are randomly assigned to one of three experimental conditions: i) the episodic future thinking (EFT) condition, ii) the health information condition, and iii) the control condition. Specifically, subjects in the EFT condition are exposed to two digitally altered pictures of themselves for a period of 2 min: a weight-reduced image and a weight-increased image. Contrary to previous studies (Kuo et al., 2016), we present subjects with both their weight-reduced and weight-increased selves in order to induce thoughts on the future benefits of becoming healthier as well as the future costs of becoming unhealthier. Subjects are told that these pictures represent their potential future selves and are asked to retain their self-image representations for the remainder of the experiment. The order in which the two images are presented is randomized across subjects; that is, half of the subjects observe the weight-reduced image first, followed by the weight-increased image, and the other half observe the two images in the opposite order. We use a computer algorithm to alter the images to represent about a 15% increase (cost) and decrease (benefit) in BMI relative to the participant’s current BMI; the proportional change was mild in order to represent somewhat realistic goals comparable across participants (Foster et al., 1997). Subjects in the health information condition watch a 2-min video that induces them with thoughts related to the health benefits of dieting and exercising and the costs, in terms of calorie intake, of eating unhealthy food. In this way, participants are engaged in imagery of immediate health-related thoughts rather than pre-experiencing future events, as in the EFT condition. The transcript of the video presented to subjects in this condition is available in Appendix A. In the control condition, subjects receive no information and simply wait 2 min before starting the experiment to avoid differential incentive structures.

4.2. Participants

The sample consists of 332 students from a large university in the United States. We recruit students as subjects since they are relatively homogeneous in terms of demographic and socio-economic characteristics (Cason and Wu, 2017), allowing us to make treatment comparisons across BMI categories. Participants are recruited using bulk emails and receive a show-up compensation fee of $20 for participating in the experiment. The experimental sessions are conducted one person at a time during different times of the day (from 8:00 am to 8:00 pm) in order to minimize time-of-day effects. Each session

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2 Examples of the modified self-images can be found in the Appendix. The images are modified using a computer algorithm available at http://www.webtouch.ca/weightmirror/.

3 We control for demographic and socio-economic characteristics in the regression models.

4 Environmental factors and subjects’ emotional/visceral states may vary depending on the time of day in which the session is conducted, affecting decision-making differently. Thus, the time at which the sessions are conducted is randomized across conditions.
lasted around 60 minutes. To qualify for the study, subjects have to be at least 18 years old, without a history of eating disorders or food allergies. Participants are instructed to refrain from eating for at least three hours prior to their assigned experimental session. The food deprivation period is set up in order to mimic the hunger state that most people experience between meals and to ensure a similar state of hunger across participants. To further check participants’ compliance with the fasting requirement, the time since their last meal is collected in the demographic/behavioral questionnaire given after the experimental tasks. They also report on a scale from 1 to 9 (1 = not hungry at all, and 9 = extremely hungry) how hungry they are at the beginning of the session (Ashton, 2015). On average, subjects fast for 6 hours (SD = 4.5) prior to the session and report facing a mild state of hunger at the beginning of the experiment (M = 4.7). The study is approved by the Institutional Review Board.

4.3. Experimental procedure

Upon arriving to the lab, participants receive a unique identification number and sign a written informed consent. They are then seated in front of the computer station and their eye movements are calibrated for eye tracking purposes prior to initiating the experimental tasks. All tasks are computerized. After finishing the 2-min manipulation in their assigned treatment, they complete an incentivized food choice task. The food task presents subjects with 20 binary choice sets. Each choice set starts with a fixation point slide (2 s), followed by a stimulus (two food product images; 8 s), a choice decision (no time restriction), and an inter-stimulus slide (0.75 s) (see Appendix Fig. A1). The stimulus comprises two food images representing a ‘regular’ and a ‘lite’ version of the same snack, with the main difference between the two snacks being the number of calories and the nutrient content claim displayed on the labels (e.g. original vs. light Yoplait vanilla yogurt). For instance, we refer to ‘lite’ snacks as those containing nutrient content claims that describe the level of a nutrient in the product using terms such as free, low, reduced, lite, etc. On the contrary, ‘regular’ snacks are referred to those products containing labels without nutrient claims that use terms such as original, classic, traditional, etc. To characterize food products as ‘lite’ or ‘regular’, we follow the FDA Nutrition Labeling and Education Act (NLEA). All lite snacks contain fewer calories compared to the regular snacks. The lite and regular snacks are ready-to-eat items that were carefully selected to be similar in terms of price, brand, packaging, and flavor (see Appendix Fig. A2). However, the food choices give participants a menu of options to choose from in order to appeal to a variety of food snacks. In each choice set, the stimulus is presented on the screen for 8 s, after which subjects are asked to choose which of the two snacks they would prefer to eat. The order in which the two snacks are presented on the screen is randomized across choice sets; that is, half of the choice sets display the lite snack on the right-hand side of the screen and the regular snack on the left-hand side, and the other half present the two food images in the opposite order. In order to incentivize the food choice task, one of the 20 choice sets is randomly chosen at the end of the session as binding. The binding decision is randomly determined by the participants using a bingo cage containing 20 balls numbered 1–20, and they are required to eat their selected product in the binding choice set before receiving their payment and leaving the lab. The list of the products used in the food task is available in Appendix Table A1.

Following the food choice task, participants fill out a demographic and behavioral survey. Finally, the actual weight and height of each participant are collected using a calibrated digital scale and measuring tape. These measurements are taken by two trained experimenters to ensure accuracy. The body mass index (BMI) is calculated using the standard formula: kg/m², and it is used to classify subjects as either normal weight (≤ 24.9), overweight (25–29.9), or obese (≥ 30). Before leaving the lab, subjects are required to eat the product they have chosen in the binding decision of the food choice task, after which they receive their payment and are escorted out of the experiment. All experimental materials are available in Appendix A.

During the food choice task, subjects’ visual attention to the food products is recorded using a stationary non-invasive Tobii TX300 eye tracker (Tobii, 2014). The eye-tracking device is embedded in the computer screen and tracks gaze position at a sampling rate of 120 Hz (i.e. 120 observations per second). A nine-point calibration procedure is used to ensure the accuracy of the eye-tracking metrics. Two eye tracking metrics, total visit duration and pupil dilation, are used to assess objective visual attention and emotional arousal experience by participants while performing the food choice task. Visual stimuli are presented using the iMotions software platform (iMotions, 2014). The eye tracking specifications are described in Appendix B.

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5 In the EFT condition, the experimenter takes a picture of the subject (face and full body) using a white background wall before continuing with the experimental tasks.
6 Eye tracking is collected throughout the entire experimental session; however, we report eye tracking metrics only for the food choice task as it is the main objective of this paper.
7 Participants also complete a time preference task following the food choice task. Results from the time preference task are not reported in this paper.
8 Available at: https://www.fda.gov/food/LabelingNutrition/ucm111447.htm (accessed 02.25.19).
9 Another way of incentivizing food choices is to present subjects with the product prices (holding prices constant across each pair of snacks) and deducting the price of the chosen product from their participation fee. Since our interest is in the trade-off between the two snacks, we incentivize consumption while holding the price at zero.
10 To classify subjects by BMI, we follow the National Institute of Health guidelines. https://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm (accessed 01.29.19).
Table 1
Balance test across treatment groups.

| Variable | Description                  | Mean (Std. Err.) | Mean (Std. Err.) | Mean (Std. Err.) | Kruskal–Wallis Test |
|----------|-------------------------------|------------------|------------------|------------------|---------------------|
|          |                               | Control          | EFT              | Health Information |
| BMI      | Measured BMI, kg/m²²         | 26.60 (0.56)     | 26.71 (0.56)     | 26.52 (0.55)     | p-value = 0.92      |
| Hunger   | Hunger level, 1–9            | 4.57 (0.22)      | 4.89 (0.22)      | 4.74 (0.23)      | p-value = 0.60      |
| Age      | Age in years, 18–57 years    | 24.22 (0.65)     | 25.75 (0.69)     | 25.10 (0.75)     | p-value = 0.03      |
| Male     | DV = 1 if male, 0 otherwise | 0.47 (0.05)      | 0.51 (0.05)      | 0.48 (0.05)      | p-value = 0.87      |
| Asian    | DV = 1 if Asian, 0 otherwise| 0.27 (0.04)      | 0.30 (0.04)      | 0.37 (0.05)      | p-value = 0.39      |
| White    | DV = 1 if White, 0 otherwise| 0.50 (0.05)      | 0.44 (0.05)      | 0.38 (0.05)      | p-value = 0.32      |
| Hispanic | DV = 1 if Hispanic, 0 otherwise | 0.19 (0.04) | 0.14 (0.03) | 0.16 (0.04) | p-value = 0.77 |
| Other    | DV = 1 if African American or 'other' race, 0 otherwise | 0.04 (0.02) | 0.13 (0.03) | 0.09 (0.03) | p-value = 0.55 |
| Income   | Yearly income                | 51061.65 (3747.86) | 45370.13 (3898.53) | 41891.69 (3787.47) | p-value = 0.06 |
| N        |                               | 113              | 108              | 111              |

Notes: The hypotheses are tested using Kruskal–Wallis rank test. Other race includes subjects identifying themselves as African American and ‘other’ race.

Table 2
Panel Logit regressions on healthy food choices by BMI.

| Dependent Var. | Probability of choosing the lite snack |
|----------------|----------------------------------------|
|                | Normal (1) | Normal (2) | Overweight (3) | Overweight (4) | Obese (5) | Obese (6) |
| EFT            | −0.062 (0.109) | −0.069 (0.112) | 0.195 (0.134) | 0.188 (0.131) | 0.263** (0.155) | 0.320** (0.164) |
| HEALTH INFORMATION | 0.147 (0.110) | 0.111 (0.114) | 0.453*** (0.141) | 0.469*** (0.129) | 0.531*** (0.153) | 0.537*** (0.149) |
| Hunger         | −0.017 (0.021) | −0.019 (0.027) | −0.019 (0.009) | −0.006 (0.009) | 0.016 (0.006) | 0.023 (0.006) |
| Age            | −0.006 (0.011) | −0.006 (0.009) | −0.006 (0.009) | −0.002 (0.009) | −0.002 (0.009) | −0.002 (0.009) |
| Male           | −0.084 (0.092) | −0.357*** (0.113) | −0.166 (0.144) | −0.166 (0.133) | −0.357*** (0.168) | 0.283* (0.129) |
| Hispanic       | 0.103 (0.121) | 0.300*** (0.144) | 0.174 (0.174) | 0.174 (0.174) | 0.326* (0.176) | 0.283* (0.176) |
| Male           | 0.034 (0.201) | 0.018 (0.171) | 0.018 (0.171) | 0.018 (0.171) | 0.251 (0.251) | 0.251 (0.251) |
| Income         | −0.000 (0.000) | −0.000 (0.000) | −0.000 (0.000) | −0.000 (0.000) | −0.000 (0.000) | −0.000 (0.000) |
| Constant       | 0.011 (0.078) | 0.302 (0.305) | −0.000 (0.090) | 0.374 (0.325) | −0.255** (0.121) | −0.461* (0.241) |
| N Choices      | 3160 | 3060 | 1880 | 1880 | 1600 | 1600 |
| N Subjects     | 158 | 153 | 94 | 94 | 80 | 80 |
| Log-Likelihood | −2178.84 | −2108.87 | −1281.95 | −1274.91 | −1096.55 | −1091.62 |

Notes: Standard errors in parentheses are clustered at the individual level; ***p < 0.01, **p < 0.05, and *p < 0.10; Normal category (in columns 1 and 2) corresponds to a bmi ≤ 24.99. Overweight category (in columns 3 and 4) corresponds to 25 ≤ bmi ≥ 29.99. Obese category (in columns 5 and 6) corresponds to a bmi ≥ 30.

5. Results

5.1. Descriptive analysis

Table 1 describes the sample and provides a balance check across treatments. Around half the sample is male (49%), with an average age of 25 years and an average family income of $46,144. On average, 43.7% identify themselves as White, 31%
as Asians and 16.6% as Hispanic. The average BMI of the sample is 26.6, which corresponds to overweight status. Of the 332 participants, 158 are normal weight, 94 are overweight, and 80 subjects are obese (see Appendix Table A2). Due to random assignment of the treatments, the distribution of weight status is balanced across treatments, with a larger number of normal-weight individuals in all treatments. Moreover, there are no differences in the proportions of male, Asians, White, Hispanics, and individuals of ‘other’ race across treatments (p > 0.10 for all Kruskal–Wallis rank tests). Recall that subjects are asked to fast for at least three hours prior to the experimental session. Self-reported hunger levels are collected in the demographic/behavioral survey using a rating scale from 1 to 9 (1 = not hungry at all, and 9 = extremely hungry). Using Kruskal–Wallis rank tests, we find no differences in the reported level of hunger across weight categories (p = 0.49) or across treatments (p = 0.60), which indicates that all subjects experienced a similar mild state of hunger upon arriving at the lab (M = 4.7).

In the food choice task, participants have to choose between a regular and a lite version of the same snack for 20 different choice sets. Recall that each pair of products in a choice set are carefully chosen to be identical in most aspects—including brand, price, packaging and flavor—except for the number of calories and nutritional claim. Hypotheses 1 and 2 state that the treatments will have a positive effect on the number of lite choices. Although we expect providing information on the benefits and costs of healthy/unhealthy lifestyles to increase the number of lite snacks chosen, based on hypothesis 1 we argue that the representation of weight-related self-images in the future will have a stronger positive effect on the number of lite snacks chosen. In the results presented below, unless stated otherwise, the reported p-values are derived by Wilcoxon rank-sum tests.

**Result 1.** Relative to the control and EFT conditions, individuals in the health information treatment make more lite snack choices.

Fig. 1 plots the number of lite snack choices by treatment. We find that participants in the health information condition have a higher number of lite choices compared to the control and the EFT condition (p < 0.01 for both tests). Overall, there is no difference in the number of lite choices between the control and the EFT condition (p = 0.30). Although the general sample results do not support hypothesis 1, as explained later, there are significant treatment (EFT) effects for different BMI categories.

**Result 2.** There are heterogeneous treatment effects on food choices by participants’ BMI categories.

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11 Of the remaining 8.7%, 2.7% identify themselves as African American and the other 6% as other than Asian, White, and Hispanics.
12 Although several recruiting methods are implemented, there are persistent difficulties in recruiting obese subjects. A potential solution would be to use in-person recruiting with an obese experimenter approaching potential participants. This might create a more comfortable environment for obese subjects, which in turn might increase their participation rate.
13 We find statistical differences in age and income across treatments, which we control for in the regression models in Table 2.
14 All the hypotheses are tested using Wilcoxon rank-sum tests and are supported by multiple hypothesis testing (List et al., 2016). Results from the multiple hypothesis testing are available in the online supplementary material.
15 Recall that the order in which the weight-increased and weight-reduced images are presented in the EFT condition is randomized across subjects. We test for ordering effects and found no differences in the average number of lite choices (p > 0.10, Wilcoxon rank-sum test).
16 We also test for the effect of subjects’ hunger level on the number of lite choices. We separate subjects based on the median hunger level (above or below 5), with 181 subjects being above the median. Using Wilcoxon rank-sum tests, we find no differences in the number of lite choices between the two hunger levels or across treatments (p > 0.10 for all tests).
Fig. 2 breaks down the results by BMI category. Compared to the control condition, overweight and obese subjects choose more lite snacks after watching the health-related video in the health information condition ($p < 0.01$ for overweight and obese subjects). This result suggests that inducing thoughts about the consequences of healthy and unhealthy habits in overweight and obese subjects encourages them to choose healthier snacks. Contrary to previous studies (Daniel et al., 2013b), we find that the number of lite choices in the EFT condition remains unchanged for normal, overweight, and obese subjects compared to the control ($p > 0.10$ for all tests). Notice however that the EFT effect among obese subjects is very close to being significantly different from the control effect at the 10% level ($p = 0.12$). Estimates from bootstrap sampling (with 1000 replications) sometimes result in significant $p$-values at the 10% level.\(^{17}\) Given the slight imbalance across treatments in relation to age and income, we further explore the treatment effects across BMI categories using panel regression models.

More formally, we investigate the treatment effects on food choices using panel logit specifications and present the results in Table 2. In the food choice task, subjects are asked to make 20 binary choices between two products differing mainly in the number of calories. Other than that, the products have identical attributes; hence there are no product specific covariates. The food choices are modeled as

$$Y_{ihs} = \beta_0 + \beta_1 \text{EFT}_i + \beta_2 \text{Health}_i + \beta_3 X_{ni} + \epsilon_{ihs}$$

where the dependent variable is an indicator variable of whether the individual chooses the lite alternative. The variables \text{EFT}_i and \text{Health}_i are treatment dummies (\text{Control}_i is the excluded baseline category); $X_i$ is a vector of socio-demographic and behavioral characteristics, and $\epsilon_{ihs}$ is an i.i.d logistic-distributed error term. The standard errors are clustered at the individual level. The specifications in columns (1) and (2) represent the specifications for normal-weight individuals, columns (3) and (4) for overweight individuals, and columns (5) and (6) for obese individuals.

The results of the panel logit regressions show that the treatment effects differ depending on the BMI of the participants. First, the estimates of the EFT condition show that the probability of choosing the lite alternative significantly increases only for obese individuals and has no effect on overweight subjects. Second, the health information condition has a positive and significant effect for overweight and obese individuals, meaning that after watching the video regarding the consequences of healthy and unhealthy habits, their probability of choosing the lite snack increased. In the case of normal weight individuals, none of the treatments have an effect on their food choices. All results hold with and without control variables.\(^{18}\) These findings highlight the importance of setting health-related goals customized for specific health characteristics, such as BMI.

\(^{17}\) It is important to note that the number of observations for the obese in the EFT condition is the lowest compared to other groups. Although several recruiting methods are used, we have persistent difficulties getting obese individuals to participate. Furthermore, data collection was paused due to the coronavirus (COVID-19) crisis.

\(^{18}\) A potential concern is whether subjects perceive the difference in healthiness between the pair of snacks. We conjecture that if some subjects indeed perceived the lite snacks to be less healthy than they should be, then the significant treatment effects found on the number of lite choices among overweight and obese subjects could be considered as a lower bound. That is, if the difference in perceived healthiness between some pair of products had been greater, then it is more likely that overweight and obese subjects would have chosen a higher number of lite snacks.
5.2. Visual attention and arousal toward food

To analyze possible mechanisms underlying food decision-making more extensively, we utilize two eye-tracking metrics: total visit duration and pupil dilation. These metrics allow us to examine whether individuals’ visual attention and arousal toward the snacks have an impact on their food choices. First, we measure visual attention as the difference in total visit duration (ms) between lite and regular snacks (Fig. 3). A negative value indicates higher attention toward the regular snacks, while a positive value implies higher attention toward lite products. This difference, also known as gaze dwell time bias, has been previously used as an index of maintained attention on food-related stimuli (Werthmann et al., 2011; Castellanos et al., 2009). The results presented in Fig. 3 show that subjects in the EFT condition spend more time looking at the lite snacks compared to the control; however, this effect is significant for obese individuals only (p = 0.01). This finding aligns well with the food choices made by the obese in this condition. Being exposed to EFT helps obese participants make healthier food choices by increasing their visual attention toward the lite alternatives. Compared to the control, the health information condition shifts the attention of normal weight and obese subjects toward lite snacks but has an opposite effect for overweight participants (p = 0.08 for obese, and p > 0.10 for normal weight and overweight subjects). Although these find-
ings show heterogeneous treatment effects by BMI category, only the effects among the obese are found to be significant. Therefore, we use a second eye tracking metric to explore whether subjects exhibit overall arousal toward the food products.

The second eye-tracking metric we use to support our behavioral findings is pupil dilation, which has been linked to higher emotional engagement or arousal (Bradshaw, 1967; Hess and Polt, 1960). An increase in pupil size is related to higher approach toward the stimuli, regardless of the hedonic valence of the stimuli (Bradley et al., 2008). For example, Partala and Surakka (2003) find larger pupil diameter to both positive (baby laughing) and negative (baby crying) auditory stimuli. Kimble et al. (2010) report increased arousal (larger pupils) in veterans with higher post-traumatic stress disorder (PTSD) symptoms when exposed to threatening stimuli. The relationship between pupil response and arousal has been found even in infants (i.e., younger than 1 year of age), whose pupil size increased in response to arousal exhibited when viewing novel stimuli (Jackson and Sirois, 2009) or unusual events (Gredebäck and Melinder, 2010). In the present study, average pupil size or changes in pupil dilation are used as an indicator of the emotional arousal exhibited by participants while looking at the snacks in the food choice task. It is clear from Fig. 4 that the average pupil size is significantly lower for subjects in the health information condition compared to those in the control and EFT conditions (p < 0.01 for both tests). In other words, inducing health-related thoughts is proven to be effective at lowering engagement or arousal toward the snacks. The opposite effect is found among subjects in the EFT condition who exhibit higher arousal levels toward the food products compared to the control and health information conditions (p < 0.01 for both tests). These results are further explored by treatment and by BMI category.

Fig. 5 plots average pupil size by treatment and BMI. For normal-weight individuals, there is a significant decrease in the average pupil size in the health information condition compared to the control (p < 0.01). This result is indicative of an attentional shift from regular to lite food products for normal weight individuals after receiving the health-related information. In the case of overweight individuals, the level of arousal toward the snacks in the EFT treatment is significantly higher compared to that in the control and the health information condition (p < 0.01 for both tests). The absence of an EFT effect on food choices among overweight subjects may be linked to the high arousal levels they exhibit toward the snacks after being exposed to EFT. Lastly, the results show that obese subjects exhibit lower levels of arousal toward the snacks in the health information condition compared to the control and the EFT condition (p = 0.06 for control and p < 0.01 for EFT). Although being exposed to EFT increases the overall arousal toward food among the obese, their visual attention is directed particularly toward lite snacks and translate to final healthier food choices.

6. Conclusions

In summary, episodic future thinking influences individuals’ current food choices. However, the results suggest that these effects depend on the subjects’ BMI. For instance, while exposing obese individuals to images representing weight-increased and weight-reduced versions of themselves increases the number of their lite food choices, no effect is found for overweight and normal weight individuals. While previous studies have shown a positive impact of EFT on decision-making among individuals with high BMI (O’Neill et al., 2016; Daniel et al., 2013a), we find no impact on the food choices of overweight individuals. A potential explanation for the absence of an EFT effect among overweight participants is that they might not be highly motivated to change their appearance as they can hide their weight through the use of clothing in order to be perceived as normal weight individuals (Faries and Bartholomew, 2015). In fact, there is evidence that overweight individuals tend to self-report similar levels of body surveillance as those classified as normal weight, suggesting that they watch their
body as frequently to ensure they match up to perceived body-related standards (Faries and Espie, 2016). It is also possible that self-consciousness about appearance may play a role in their motivation—or lack thereof—for having healthy lifestyles. This explanation is supported by self-determination theory (Deci and Ryan, 1985; 2002), which proposes that goal adoption and behavioral change are more likely to occur when individuals have intrinsic and autonomous motives (internalization within the self and personal importance) for goal striving. That is, overweight individuals may not feel motivated since the magnitude of the “benefits” and “costs” associated with the changes in the self-images are less drastic as those for the obese. A third explanation is provided by neuroscience findings suggesting that being overweight is associated with lower blood flow to the prefrontal cortex and anterior cingulate cortex (Willeumier et al., 2011). Deficits in these brain regions have been linked to a decreased effectiveness of the episodic future thinking effect (Peters and Büchel, 2010). Lastly, we cannot rule out the artifact of where the breakdown between weight categories is made. We categorize subjects based on their BMI as it is the standard practice in social sciences; however, it is possible that individuals along the border lines (above or below) do not differ in the way they respond to the treatments.

Although the main goal of our study is to examine the effect of episodic future thinking on decision-making, we also analyze the effect of health-related information on subjects’ food choices. In this regard, we find that the provision of information about the consequences of healthy/unhealthy lifestyles has a positive impact on the number of lite food choices of overweight and obese individuals. This finding is encouraging given the fact that numerous studies have found health information provision to be an ineffective approach to improve diet (Guthrie et al., 2015; Wisdom et al., 2010; Downs et al., 2009). It is possible that presenting the information through a video, rather than text format, elevate the salience of the consequences of unhealthy lifestyles. This suggests that in order to lead to desirable changes in eating behavior, health information should be provided in the right form.

Our behavioral findings are supported by eye-tracking data showing how individuals’ emotional arousal toward the food impact their ultimate food choices. Overall, the findings show that the provision of health-related information is effective at reducing the engagement or emotional arousal toward snacks. When looking at distributional effects, we find that the emotional arousal of normal-weight subjects toward food is reduced after receiving the health information treatment; however, this effect has no impact on their current food choices. In the case of overweight individuals, engaging in EFT increases the arousal level toward snacks, resulting in no impact on their food choices. For obese individuals, being exposed to the consequences of healthy and unhealthy habits not only lowers their overall arousal toward food but also increases the number of lite snacks chosen. Furthermore, while EFT increases overall arousal toward food among the obese, it directs their visual attention toward lite snacks, which translates into healthier food choices.

These results can inform obesity intervention programs. For example, the distributional effects in health-related policy interventions and nudges have been overlooked by policy makers (Sunstein, 2016) and under explored by researchers (Allcott and Kessler, 2019; Thunström et al., 2018; Roberts, 2017). In this regard, our findings highlight the importance of creating customized programs and interventions targeting particular groups according to their specific health characteristics for setting achievable and realistic health-related goals. We conclude that a one-size-fits-all approach for health-related interventions may not be effective for all individuals. In fact, our results could imply that realistic and tangible gains can be useful in producing significant increases in obese individuals’ motivation and engagement to keep up with an intervention program. For example, individuals who receive immediate feedback on their performance are better able to adjust their efforts and strategies of goal striving (Locke and Latham, 1990). Fitness-tracking applications designed to provide participants with short-term feedback about their progress in terms of caloric consumption, weight loss (changes in BMI and percentage of body fat), exercising, and sleeping habits could prove useful. Importantly, individuals are able to set their own (realistic) goals and share their progress with other participants, which might help increase their motivation toward the goal (Exley and Naecker, 2016). Furthermore, by customizing programs to individual specific health characteristics, programs can appeal to different priorities and goal setting. Tailoring realistic targets can keep individuals engaged and translate into better outcomes. For instance, while using education about the consequences of healthy and unhealthy habits works well for overweight and obese individuals, based on the results of the EFT treatment, we believe that long-term rewards could work poorly for overweight subjects, who might require more tangible or immediate results. Previous research has shown that self-regulatory breakdowns can occur as a result of unrealistic or incorrect goal setting (Leventhal et al., 2008).

The findings from this study open the door to a new research agenda that could help explain why overweight and obese individuals often fail to stick to their dietary and fitness programs. The goals of this research agenda should include exploring different behavioral approaches that can boost individuals’ motivation toward health-related goal achievement. A natural extension would be to test the use of more real environments, such as virtual reality, to induce future health-related thoughts in situations that require self-control exertion. To date, only one study has utilized virtual reality to test whether allowing subjects to interact with weight-reduced representations of themselves affect their calorie consumption and time preferences (Kuo et al., 2016). However, this method has not been previously used in incentivized economic experiments. In addition, future research could examine the effect of using weight-increased and weight-reduced self-images in EFT separately; this will allow us to understand whether the costs or benefits associated with the physical image changes have a stronger effect on the food choices of sub-populations (normal weight, overweight, and obese). Finally, an interesting question raised by one of the referees relates to the dynamics of choices over time. We find differences in food choices between the first 10 and last 10 choice sets, with a higher proportion of lite snack choices in later decisions (p < 0.01, Wilcoxon rank-sum test). There could be several explanations for this effect, including potential guilt exhibited by subjects after making several unhealthy choices, the presence of learning effects, or simply higher attraction toward the last alternatives. We
tried to reduce these potential effects by randomly selecting only one of the 20 choices as binding. This is a question that merits further research.

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**Declaration of Competing Interest**

None.

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**Appendix A. Experimental instructions**

*Note: Prior to completing the tasks, subjects in the treatments receive the respective manipulation. Subjects in the control simply waited 2 minutes and started the experiment.*

**Video transcript for health information condition**

We all know we feel better when we eat right and exercise, but anyone who makes the habit to go to the gym or being physically active knows the rewards of exercise extend far beyond sliming down or adding muscle tone. Fitness expert is here to talk about the immediate improvements you will see when you start to eat right and you exercise regularly.

Regular exercise and obviously eating healthy are going to do lots of benefits, not just your weight loss or your muscle gain, but there are also not so obvious benefits.

1. Boosts immunity. You can boost your immune system by eating the right food and exercising regularly. By boosting your immune system you are going to get sick less, which means less work that you would miss, some more productivity. But also you are fighting off major diseases like your risk to heart diseases, osteoporosis, even cancer.

2. Improve your entire circulation over a period of time. The healthy diet is going to make your blood flow your body easier, and the exercise is going to make your heart muscle grow. The stronger your heart is, the more is go being to be able to pump that blood, so absolutely your circulation is going to improve.

3. Self-confidence. Your physical appearance changes so your confidence changes with that too. It is a major confidence booster. Your physical appearance is one thing, but also taking charge of your life by eating something as simply as choosing a glass of water over a calorie loaded soda or drink, that is going to give you a little of a confidence boost knowing that you made the right choice.

**Table A1**

List of products used in food choice task.

| Regular Snacks                          | Lite Snacks                                      |
|-----------------------------------------|-------------------------------------------------|
| Classic Lays potato chips (160 cal.)    | Oven-baked Lays potato chips (120 cal.)          |
| Original Fiber One chewy bar (140 cal.)| 90 Calorie Fiber One chewy bar (90 cal.)         |
| Original Jell-O gelatin (70 cal.)       | Low calorie Jell-O gelatin (10 cal.)             |
| Original Sargento string cheese (80 cal.)| Reduced fat Sargento string cheese (50 cal.)    |
| Original Pringles potato chips (150 cal.)| Fat free Pringles potato chips (70 cal.)        |
| Original Yoplait yogurt (150 cal.)      | Light Yoplait yogurt (90 cal.)                   |
| Original Snack Pack pudding (110 cal.)  | Sugar free Snack Pack pudding (70 cal.)          |
| Traditional Oikos Greek yogurt (150 cal.)| Non-fat Oikos Greek yogurt (120 cal.)           |
| Original Cheez-It baked crackers (150 cal.)| Reduced fat Cheez-It baked crackers (130 cal.)  |
| Original Jif peanut butter (250 cal.)   | Reduced fat Jif peanut butter (250 cal.)        |
| Original Gatorade beverage (80 cal.)    | Low calorie Gatorade beverage (30 cal.)         |
| Original Quaker chewy bar (140 cal.)    | Low fat Quaker chewy bar (90 cal.)               |
| Original Ritz crackers (80 cal.)        | Whole wheat Ritz crackers (70 cal.)              |
| Traditional Lipton green tea (100 cal.) | Diet Lipton green tea (0 cal.)                   |
| Original Great Value ice cream sandwich (160 cal.)| 97% fat free Great Value ice cream sandwich (110 cal.)|
| Xtreme butter ACI II popcorn (160 cal.) | 94% fat free ACI II popcorn (130 cal.)           |
| Original BelVita biscuits (230 cal.)    | Soft baked BelVita biscuits (190 cal.)           |
| Original Jell-O swirls pudding (110 cal.)| Reduced calorie Jell-O swirls pudding (60 cal.) |
| Original Dole peaches (70 cal.)         | No sugar added Dole peaches (25 cal.)            |
| Classic coca cola can (90 cal.)         | Zero calorie coca cola can (0 cal.)              |
Fig. A1. Example of one of the 20 food choice sets.
Fig. A2. Example of a snack pair presented in the food choice task.

You vs. Fast Food
Guess how long you would need to exercise to lose the junk food!
Burrito (Chipotle - 1,200 cal.) vs. push-up = 140 min
Big Mac (MacDonals - 530 cal.) vs. lunges = 57 min
Whopper (Burger King - 650 cal.) vs. curl-up = 89 min

Example of weight-reduced image for EFT condition
Note: Subjects are told that the images represent their future selves following an increase or decrease in weight. For example, for the ‘actual weight’ (picture a) they are told: “This is how you currently look like”. Then, they are shown the weight-reduced image (picture b) and are told: “This is how you would look like in the future if you lose x number of pounds”.

Screen 1
WELCOME!
Thank you for participating in today’s session. The session will proceed in several stages.
Stage 1: Food Choice Task
Stage 2: Time Preference Task
Stage 4: Receive Payment and Product
Press Enter to continue...
Food Choice Task
This stage will proceed as follows:
1. This stage consists of 20 choice situations.
2. In each trial, you will be presented with two food products.
3. You need to choose which of the products you would prefer to eat.
Press Enter to continue?

4. Your decisions are real. At the conclusion of the experiment, one decision will be randomly selected to be binding.
5. You will receive one single unit of the food product you chose and will have to eat it at the end of today’s session.
Press Enter to continue...

Time Preference Task
This stage will proceed as follows:
1. You will be presented with 15 alternatives that include economic decisions.
2. Each alternative involves a choice between two payment Options.
3. Please choose your preferred payment option for each alternative.
Press Enter to continue...

4. At the end of the experiment, one alternative will be chosen, and you will be given a 10% chance of being paid according to the payment option you chose for this alternative.
5. To facilitate the delivery of the payment, the experimenter will get your email address and transfer the payment to your bank account.
6. The payment amount and delivery date will depend on the option chosen by you in the binding alternative.
Press Enter to continue...

Demographic/Behavioral survey
1. Please enter your ID number.
2. How often do you exercise? (Include only periods of exercise longer than 20 min).
   Never
   Once a month
   Once a week
   2–3 times per week
   4–6 times per week
   Once a day
   More than once a day
3. Do you currently smoke cigarettes?
   Yes
   No
4. Do you consume alcohol?
   Yes
   No
5. How many hours did you sleep last night?
   6. How many days per week do you eat breakfast?
   0 days
1 day
2 days
3 days
4 days
5 days
6 days
7 days
7. At what time did you consume your last meal today?
8. Rate on the scale from 1 to 9, how hungry were you feeling at the beginning of the session (1 = Not at all; 9 = Extremely hungry).
9. Do you currently have a serious health issues?
Yes
No
10. Please indicate your age in years.
11. Please indicate your Major by Department.
12. Please indicate your current academic year.
Freshman
Sophomore
Junior
Senior
Masters
Ph.D.
13. Please indicate your gender.
Male
Female
14. Please indicate your race.
Asian/Pacific Islander
African American
Caucasian/White
Native American/Indigenous
Hispanic
Other
15. Please indicate your household yearly income for 2015. (Include all forms of income, including salary, interest and dividend payments, tips, scholarship support, student loans, parental support, and allowance)
Less than $30,000
$30,000 - $39,999
$40,000 - $49,999
$50,000 - $59,999
$60,000 - $59,999
$70,000 - $79,999
$80,000 - $89,999
$90,000 - $99,999
$100,000 - $149,999
$150,000 or more

Appendix B. Eye tracking specifications

Participants’ eye movements are recorded using a desk-mounted Tobii TX300 eye tracker (Tobii, 2014), which uses the “dark pupil” tracking technique to determine eye position. The eye tracker device is embedded in the computer screen and operates at a (binocular) sampling rate of 120 Hz and gaze accuracy of about 0.4°. The experiment is conducted in a controlled laboratory environment with constant illumination. To ensure gaze accuracy, the distance between the eye tracker and the subject’s eyes is kept at 50–80 cm, and a 9-point calibration procedure is conducted prior to the experimental tasks. The stimuli are presented on a 23” monitor with a screen resolution of 1920 x 1080 pixel and a reaction time of 5 ms. To quantify visual attention, we define non-overlapping static Areas of Interest (AOIs) on the food images (see Fig. A3). All AOIs are consistent in terms of size (width and height) and shape (rectangular). The AOIs are used to determine the amount

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19 Dark pupil eye tracking technique places the illuminator away from the optical axis, causing the pupil to appear black; for more information see https://www.tobiipro.com/siteassets/tobii-pro/product-descriptions/tobii-pro-tx300-product-description.pdf.
20 Variations in the illumination of the environment or the luminance of the stimuli might affect the size and shape of the pupil; thus, impairing gaze accuracy and precision.
of time (based on fixations) subjects spend on each food image. To calculate pupil dilation, we take an average between the pupil size of subjects’ left and right eye (in millimeters) while performing the food choice task.

Appendix C. Additional analysis

Table A2
Balance test across treatment and BMI.

| Variable | Control Mean (Std. Err.) | EFT Mean (Std. Err.) | Health Info Mean (Std. Err.) |
|----------|--------------------------|----------------------|-------------------------------|
|          | Normal                   | Overweight           | Obese                         |
|          |                         |                      |                               |
| Hunger   | 4.93 (0.30)              | 4.28 (0.43)          | 4.20 (0.45)                   |
|          | 0.26                     | 5.19 (0.33)          | 4.67 (0.39)                   |
|          |                          | 4.63 (0.50)          | 0.61 (0.31)                   |
|          |                          | 4.60 (0.31)          | 4.76 (0.43)                   |
|          |                          | 5.00 (0.53)          | 0.76 (0.67)                   |
| Age      | 22.69 (1.42)             | 25.31 (1.42)         | 25.93 (1.74)                  |
|          | 0.37                     | 23.83 (0.56)         | 25.00 (0.97)                  |
|          |                          | 30.71 (2.28)         | 0.03 (1.71)                   |
|          |                          | 23.91 (1.83)         | 26.48 (1.90)                  |
| Male     | 0.46 (0.07)              | 0.48 (0.09)          | 0.47 (0.09)                   |
|          | 0.99                     | 0.46 (0.07)          | 0.53 (0.07)                   |
|          |                          | 0.58 (0.08)          | 0.67 (0.08)                   |
|          |                          | 0.45 (0.08)          | 0.54 (0.08)                   |
|          |                          | 0.83 (0.10)          |                               |
| Asian    | 0.33 (0.06)              | 0.21 (0.08)          | 0.20 (0.07)                   |
|          | 0.49                     | 0.38 (0.07)          | 0.25 (0.08)                   |
|          |                          | 0.21 (0.08)          | 0.43 (0.09)                   |
|          |                          | 0.48 (0.09)          | 0.21 (0.08)                   |
|          |                          | 0.31 (0.08)          | 0.10 (0.09)                   |
| White    | 0.43 (0.07)              | 0.55 (0.09)          | 0.57 (0.09)                   |
|          | 0.47                     | 0.29 (0.07)          | 0.58 (0.08)                   |
|          |                          | 0.50 (0.08)          | 0.06 (0.10)                   |
|          |                          | 0.25 (0.09)          | 0.59 (0.09)                   |
|          |                          | 0.42 (0.10)          | 0.04 (0.10)                   |
| Hispanic | 0.19 (0.05)              | 0.17 (0.07)          | 0.23 (0.09)                   |
|          | 0.91                     | 0.17 (0.07)          | 0.08 (0.08)                   |
|          |                          | 0.17 (0.08)          | 0.78 (0.10)                   |
|          |                          | 0.16 (0.09)          | 0.17 (0.10)                   |
|          |                          | 0.15 (0.10)          | 0.99 (0.10)                   |
| Other    | 0.06 (0.03)              | 0.07 (0.05)          | 0.00 (0.05)                   |
|          | 0.88                     | 0.17 (0.05)          | 0.08 (0.05)                   |
|          |                          | 0.13 (0.05)          | 0.81 (0.05)                   |
|          |                          | 0.11 (0.04)          | 0.08 (0.03)                   |
|          |                          | 0.12 (0.03)          | 0.83 (0.06)                   |
| Income   | 51481.17 (5273.15)       | 46723.86 (6801.52)   | 54499.73 (8284.95)            |
|          | 0.92                     | 41145.59 (5318.39)   | 53333.10 (8047.47)            |
|          |                          | 41874.75 (6966.59)   | 0.66 (4792.71)                |
|          |                          | 37321.23 (8462.20)   | 40344.71 (7994.04)            |
|          |                          | 53461.23 (53461.23)  | 0.16 (53461.23)               |
| N        | 54                       | 29                   | 30                            |
|          | 48                       | 36                   | 24                            |
|          | 56                       | 29                   | 26                            |

Notes: Same variable description as Table 1. The hypotheses are tested using Kruskal-Wallis rank tests. Other race includes subjects identifying themselves as African American and ‘other’ race.

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