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An ecological momentary episodic future thinking intervention on mother's weekly food purchases

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Abstract

Background: Imagining one's own future (episodic future thinking, EFT) has helped mothers with overweight purchase healthier groceries during an online shopping task in the laboratory. The present study explored whether delivering an EFT intervention to participant's devices via an ecological momentary intervention (EMI) tool would help mother's purchase healthier food at brick-and-mortar stores.

Methods: Participants (N=43, mother's 31–52 years of age, BMI≥24.9 kg/m^2) were randomized to EFT or standardized episodic thinking (SET). EFT cues include a positive and vivid description of future events while SET cues focus on the recent experience of playing games in the laboratory. Cues were uploaded to participant profiles on an EMI site. Participants were trained on how to read and listen to cues as well as how to detail purchases. Participants received text reminders to listen to cues before shopping and returned with receipts the following day. Receipt data was analyzed to derive dependent variables, calories and nutrients purchased per person. Correlations were used to analyze associations between study variables of interest and ANOVAs were conducted to compare dietary variables by group.

Results: Participants in the EFT group purchased fewer calories than participants in the SET control group ($F(1,41)$=6.25,p=0.02;η_p^2 =.13) as well as fewer grams of fat ($F(1,41)$=10.03,p<0.01;η_p^2= .20), saturated fat ($F(1,41)$=6.15,p =0.02;η_p^2=.13), and sodium ($F(1,41)$=7.93, p<0.01;η_p^2 = .16).

Conclusion: Delivering EFT cues to participant devices may be a promising way to improve the calorie and nutrient content of food purchases. Future research should include a longer follow-up and analyze calorie changes over time.

MeSH Keywods:

Delay Discounting; Mobile Applications; Mothers; Overweight; Food

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The access and availability of obesogenic foods in the home is an important determinant in energy balance, and hence obesity. The increased availability of high-calorie foods in the home has been associated with the overconsumption of these foods (Campbell et al., 2007), inadequate fruit and vegetable intake (Rosenkranz & Dzewaltowski, 2008), and overweight and obesity (Birch & Ventura, 2009). The majority of calories consumed by a family come from foods purchased by parents, specifically mothers (Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). Although traditional gender roles are changing, the most recent research still shows that mothers are the primary household food shoppers (PLMA, 2013) and primary food preparers (Hannon, Bowen, Moinpour, & McLerran, 2003) for the majority of families. As a result, mothers have a significant effect on the eating behaviors and health outcomes of their children. Due to the overwhelming influence of mothers on family food consumption through food shopping and preparation, an intervention to help overweight and obese mothers purchase healthier food (e.g. fewer calories, better macronutrient profiles) may promote better dietary behaviors for the entire family and has the potential to reduce family overweight and obesity.

Episodic future thinking (EFT) is the ability to mentally project oneself into the future to pre-experience an event that could potentially occur (Atance & O'Neill, 2001; Schacter, Benoit, & Szpunar, 2017; Szpunar, 2010). The degree to which a person engages in EFT affects the way they make decisions in the present (Schacter, Benoit, & Szpunar, 2017), such that when people are cued to think about their personal future, they make more adaptive decisions in the moment. Other benefits of EFT include improvements in affect (e.g. reduced anxiety), prospective memory (e.g. remembering to complete a planned action), and spatial navigation (e.g. remembering the route to a goal) (Schacter, Benoit, & Szpunar, 2017). Prompting people to vividly imagine their future has been used as a behavioral intervention to improve self-regulation in some tempting situations (Daniel, Stanton, & Epstein, 2013b).

Discounting of the future (e.g. "delay discounting", DD), a preference for a smaller immediate reward (e.g. junk food consumption) over a larger distant reward (e.g. future health) (Rung & Madden, 2018), has been associated with numerous maladaptive behaviors and outcomes, including obesity (Epstein, Salvy, Carr, Dearing, & Bickel, 2010). Recent research has also shown that DD is related to participant's food purchasing, such that greater discounting of the future is significantly associated with purchasing higher calorie foods and lower healthy eating index scores (Appelhans, Tangney, French, Crane, & Wang, 2019).

EFT is an intervention that has successfully decreased discounting of the future and may help people to resist temptation (Daniel et al., 2013b). EFT has decreased consumption in hypothetical alcohol and cigarette (Snider, LaConte, & Bickel, 2016; Stein, Tegge, Turner, & Bickel, 2018) purchasing tasks, as well as a self-administered cigarette smoking task (Stein et al., 2016). The impacts of EFT on eating behaviors have also been studied, and EFT training has reduced energy intake in ad libitum eating tasks for adults in a laboratory setting (Daniel, Stanton, & Epstein, 2013a), adults in a cafeteria setting (O'Neill, Daniel, & Epstein, 2016), and children in a laboratory setting (Daniel, Said, Stanton, & Epstein, 2015).

The NIH Stages Model is a translational research framework that describes how basic science can be used to inform the design, refinement, and implementation of interventions to

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help improve clinical health outcomes (Onken, Carroll, et. al, 2015). The model establishes an iterative process that seeks to identify 1) the causes and mechanisms by which an intervention is working throughout the entire development of the intervention, 2) why, how, and for whom results may sometimes be sub-optimal, and 3) what adaptations can be made to bolster the effects and/or implement the intervention into new settings (Onken et. al, 2015). Using EFT as an intervention is predicated on basic science findings that explain the adaptive mechanisms and functions of EFT (Schacter, Benoit, & Szpunar, 2017), in particular EFT's potential to influence DD (Critchfield & Kollins, 2001) and subsequent health behaviors. The present study is part of a larger translational research program that seeks to examine and refine EFT interventions to change behavior and reduce chronic disease burden.

In the first applications of using EFT to modify mother's food shopping behaviors (NIH "Stage 1") we tested EFT in the laboratory and found that participants who use EFT before and during grocery shopping purchase fewer calories and healthier nutrient profiles than participants in control conditions in an online grocery store (Hollis-Hansen, Seidman, O'Donnell, & Epstein, 2019a). To systematically replicate those findings we set out to examine whether EFT could improve food purchasing behavior in the natural environment. As a secondary exploratory hypothesis, we sought to identify whether EFT could influence DD in an uncued context, as it is one of the hypothesized underlying mechanisms by which EFT is thought to improve health decision-making (e.g. in this case, grocery purchases). If people in an EFT group show increases on the DD task when not cued to think about their future during the task, it could be an indication that listening to the cues over a period of time may help EFT to become a "default" way of thinking that changes decision-making even when unprompted.

The present study utilizes an ecological momentary intervention (EMI) platform, an intervention delivered to participants in real time in their usual setting. EMIs implemented through mobile technology have been effective in several behavioral interventions, including smoking cessation, diabetes self-management, and weight loss (Heron & Smyth, 2010). The "Mobile Audio Manager and Response Tracker" (MAMRT) EMI tool used in the present study has been shown to be feasible for the delivery of EFT outside of the laboratory and has the potential to reduce parent weight and energy intake (Sze, Daniel, Kilanowski, Collins, & Epstein, 2015). In the present study, we used MAMRT to deliver an early-phase EFT intervention to mothers before they went grocery shopping or made food purchases for their household.

METHODS

The present study was a between subject's design with participants randomized to an episodic future thinking (EFT) group or a standardized episodic thinking (SET) control. Ethical standards were followed and the study was approved by the University at Buffalo Social and Behavioral Sciences Institutional Review Board on 9/17/2018 (Study ID: 00002757).

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Participants were recruited through e-mails from our Division of Behavioral Medicine participant database, fliers on open message boards throughout the Buffalo community, and targeted Facebook ads. Recruitment materials directed interested community members to an online eligibility screener where they answered demographic questions, a brief health history questionnaire, and one-item on recent participation in grocery or EFT studies. Individuals were excluded if: they did not have a child between the age of 2 and 15 in the household for whom they buy groceries; they self-reported untreated psychopathologies, as their illness may impair their ability to positively and vividly imagine their own personal future (Roepke & Seligman, 2016); if their calculated body mass index (BMI) was ≤ 24.9, which indicated they were normal weight; if they reported eating disorders, as the illness may influence the food one is buying; and lastly if they participated in an EFT study within the past six months, in order to eliminate the possibility of carryover effects. The one-item on previous participation asked “Have you recently participated in another research study involving grocery shopping or generating cues?”, with the “Yes” response requiring an answer to an open-field that said “If yes, please describe the study and when you participated”. To be eligible for the present study participants must have indicated “no” or that they participated ≥ 6-months prior to the present study.

Included participants (N = 43) were mother’s aged 31 – 52 years of age with a BMI ≥ 25.0 (Range to 60.9, Mean = 36.0 ± 7.4). Detailed participant and study characteristics can be found in Table 1. One participant randomized to the SET control group completed the baseline appointment and used the MAMRT application once, but failed to return with receipts after repeated attempts to reschedule and collect follow-up data. The participant’s data was not included in the analyses as we did not collect baseline receipt data from which to impute follow-up receipt data and researchers report it is unnecessary to impute data when there is <5% missing (Jakobsen, Gluud, Wettersley, Winkel, 2017).

The study was designed to take place over a three-day period. Participant baseline appointments were scheduled via phone or text message for the day before the participant planned to grocery shop. Participants were randomized to the EFT intervention group or the SET control group at the baseline appointment. The participant shopped on Day 2 and returned on Day 3 with receipts. There were two cases where participants had a family circumstance which led to rescheduling their follow-up appointments for 15 days and 22 days after baseline. In those instances, participants were instructed to wait to use their cues and collect receipts until the day before their new follow-up appointment date, so that the same number of days would be collected even though there was a difference in time between appointment.

At the beginning of the baseline session participants completed a paper demographic questionnaire (Gage-Bouchard & Devine, 2014) which included questions on their age, race/ethnicity, education, income, house size, perceived social status, and their use of government benefit programs.

After the demographic questionnaire participants completed a computer based adjusting amount delay discounting task. The adjusting amount task asks people if they would rather have X (smaller) amount of money now or Y (larger) amount of money at different time

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points in the future (Sze et al., 2015). The amount of money available in the present stays the same, while the amount of money in the future increases or decreases by 50% of the preceding value. For this study participants were asked how much of a commodity (e.g., money) they would prefer immediately over a larger reward after 5 time delays (1 day, 1 week, 1 month, 6 months, and 1 year) (Koffarnus & Bickel, 2014). These choices provide us with an indifference point for each time delay – the point when the decision-maker is indifferent to the delay or has equal preference for both choices (Odum, 2011). One's indifference points are used to plot a curve, and the area-under-the-curve (AUC) is used to quantify how much they discount the future, with a lower AUC indicating a greater tendency to discount the future (Odum, 2011).

After the DD task, participants completed an online survey, with the following measures included. We collected the shopping habits survey because people are known to shop in different locations at different frequencies (Minaker et al., 2016). This survey asks participants how frequently they buy or procure food from supermarkets, supercenters, food co-ops, convenience stores, specialty stores, farmers' markets, food banks, and home delivery. Response options range from "Never/rarely" (infrequent, "0") to "Once or more per week" (frequent, "5"). We measured food insecurity using the USDA Economic Research Service 6-item short form of the food security survey module (Blumberg, Bialostosky, Hamilton, & Briefel, 1999) as food insecurity may influence the quantity and quality of food purchased (Dachner, Ricciuto, Kirkpatrick, & Tarasuk, 2010). The CFC scale is a 12 item scale that measures whether people identify themselves as immediate or future focused in their day-to-day decision-making and actions (e.g. "I only act to satisfy immediate concerns, figuring the future will take care of itself.") (Strathman, Gleicher, Boninger, & Edwards, 1994). Respondents indicate whether an item is characteristic to them on a scale from 1 ("extremely uncharacteristic) to 5 ("extremely characteristic"). We included 5-items on fruit and vegetable (F&V) intake and 2-items on fast food and regular restaurant intake from the Behavioral Risk Factor Surveillance Survey (Moore et al., 2015). The F&V items were included to determine participant's baseline healthy food consumption. We included the fast food and restaurant items as a precaution and planned to control for them if we found group differences, as we anticipated that people who report eating outside of the home more frequently would be buying and eating fewer groceries.

After completing questionnaires, participants generated text cues on Qualtrics (a survey platform) with a research assistant following similar procedures as our previous studies (Hollis-Hansen, Seidman, et al., 2019a). Participants in all groups played five mobile application games (e.g. Flow Free, Trivia Crack, Bubble Witch, Geometry Dash, Solitaire) and rated each game on a scale from one to five where one was "do not like at all" and five was "like very much".

Participants then played their three top-rated mobile application games immediately before generating cues.

Participants in the EFT group are asked to vividly imagine and describe a positive future event or experience that could really happen or that they already have planned for 1-month, 6-months, and 1-year in the future. The cues include the event or experience, who is with

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them, where they are, what they are doing, and how they are feeling ("In about 1 month I am sitting at my kitchen table singing happy birthday to my daughter. She is blowing out the candles and we are clapping and laughing. We are talking about what she wished for and our dreams for the year ahead. We are feeling happy to spend this time together as a family."). The research assistant guides them through the process of writing the cue and transcribes their description into Qualtrics.

Participants in the SET control group generate cues similarly, but they are asked to vividly imagine the experience of playing the mobile application games during their laboratory appointment. SET participants provide a detailed description of their experience in a similar style as the EFT cue, including who, what, where, and how they are feeling ("About 10 minutes ago I was playing Geometry Dash on a tablet in a beige room at UB. In the game, I was a square, jumping over other geometrical obstacles, racing to the finish line. I was feeling happy as I cleared a difficult level.").

In both groups participants are asked how vividly they can imagine the place where they are, the time of the day, and what is going on around them when they picture their event or experience as well as how much they like the event or experience. Though it did not happen in the present study, participants who rate the event or experience below a "3" on a scale from 1 (not at all vivid/do not like at all) to 5 (very vivid/like very much) would have been asked to pick a different event or experience.

After creating cues, the research assistant directed the participant to read their cues out loud and recorded the cues using Audacity, a computer voice recording program. The text and audio cues were uploaded to our EMI platform, MAMRT, and attached to the participants personal MAMRT account. Participants were trained on how to use MAMRT and demonstrated an ability to independently access their account and practice their cues before leaving their baseline appointment. Participants were given a training guide on how and when to use MAMRT. Participants were asked to practice (e.g. read and listen to) their cues on the evening they created them and during the day before they went grocery shopping for a total of two cue recalls. Participants were sent a reminder to listen to their cues by a scheduled text or e-mail. After participants read and listened to their cues, they were presented with a series of manipulation check questions, such as how vivid their thoughts were about their cues (Likert scale, 1 [not at all vivid] – 5 [very vivid]), how much they were paying attention to their cues (Likert scale, 1 [not at all] – 5 [very much]), where they were completing their thought training (open-ended text entry), how they were feeling in the moment (open-ended text entry), and what decision(s) they were thinking about in the moment (open-ended text entry). The attention and vividness questions were used to confirm whether or not the cues were distinctly imagined, and if the participant was paying attention while completing their thought training (e.g. cue recalls). Additionally, MAMRT records each time the participant completes a cue recall, and we created the variable "number of cue recalls" to analyze whether there were group differences in how frequently participants accessed their cues.

In addition to the MAMRT training guide, participants received a thorough explanation of how to properly document their food purchases and were sent home with food receipt forms

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and a food receipt training guide adapted from the ShOPPER study (Appelhans et al., 2019; French, Tangney, Crane, Wang, & Appelhans, 2019). The food receipt forms ask participants to give a very detailed and thorough explanation of the food items they purchased (e.g. whole fat, low-fat, brand name), the size of the item, and the price. Participants were unrestricted as to where they could make food purchases. Though the main focus of the intervention was on changing grocery purchases, we also collected and analyzed receipts on all food purchases (e.g. fast food, restaurant, takeout, etc.) to provide a complete picture of calories purchased during the intervention period.

At the follow-up appointment participants returned with all of their food shopping receipt(s) and the completed food receipt forms. While research assistants reviewed the receipts in the control room, participants completed a follow-up DD task that was identical to the task at the baseline appointment. In most studies on DD, participant's EFT or control cues are presented while the participant is tasked with selecting their preferred amount of money (e.g. participants are shown their cue and instructed to read and think about their cue while making a choice about money now or later) (O'Donnell, Hollis-Hansen, & Epstein, 2019). We did not display the participant's cues during the follow-up DD task for this study as we wanted to explore whether EFT could improve DD in an uncued context (e.g. become a "default" way of thinking).

After participants completed the DD task and research assistants finished reviewing receipts, research assistants did a thorough receipt interview with the participant, matching each receipt item to the details on the food receipt form. Research assistants inquired about any additional information that would help to properly match the food item when inputting the item into NutrionistPro for nutrient analysis. For example, if the participant purchased yogurt and failed to specify what type of yogurt on the food receipt form, the participant was asked what type of yogurt (e.g. Greek, whole fat, low-fat, etc.) and if anything was added to the item that wasn't already indicated by the receipt or food receipt form (e.g. fruit, nuts, chocolate, etc.).

Participant grocery receipts were analyzed using NutritionistPro, following the same procedures as described in Hollis-Hansen et. al, 2019 to determine the dependent variables of calories and nutrients purchased per person in the household (Hollis-Hansen, Seidman, et al., 2019a). Receipts were input and reviewed by two separate research assistants, and then checked again by the first author.

Participants were paid $20.00 at the end of the first appointment, $25.00 at the end of their second appointment, and had a 1-in-10 chance to win a $100 gift card to a local grocery store. After every 10 participants, 10 ID numbers were input into a random number generator and the participant that was selected returned to the laboratory to pick up the gift card and sign a receipt. Those who did not win received an e-mail to inform them the drawing had taken place.

We previously conducted two studies to test whether EFT could improve online grocery shopping in the laboratory (Hollis-Hansen et al., 2019). Our first laboratory study used a semantic control group and our second laboratory study used the SET control group we

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planned to use for the present study. Therefore, to power the present study, we used the effect size from our second laboratory study (cohen's f = .51 or η_p^2 = 0.106), which to our knowledge provides the closest comparable estimate available. Using the second laboratory study's effect size, we determined that the present study would require a minimum of 34 subjects or 17 subjects per group at an alpha of .05 and power of .80 to detect a between-subjects effect on calories. To be more conservative, we wanted to have a minimum of 20 people per group and increased the sample size to 44 subjects, with the assumption that up to 4 people (10%) would dropout based on rates from a similar field experiment (O'Neil, et. al, 2016). We only had one person fail to return for their follow-up appointment which resulted in 43 subjects in the total sample.

Between-group analysis of variance (ANOVA) and chi-square tests were used to identify differences in participant characteristics or important study characteristics (e.g. demographics, number of times participants used MAMRT, attention to cues, how vividly one imagined their cues, amount spent on groceries, etc.) that may influence the dependent variable. Fisher's exact test was used for any categorical variable with less than 5 in a given cell (e.g. percent overweight).

There were a few variables we measured that we thought may influence the independent or dependent variable, such as: baseline delay discounting as it's related to the central theory guiding the present research; income, as the amount of money one has may dictate how much they buy and the quality of the food they buy; the frequency at which participants shop at the grocery store as with the short study timeline we were concerned we may not catch a representative snapshot of calories for those who shop more frequently; how often people listened to their cues, and how much they paid attention to their cues. Therefore, in addition to looking at between-group differences on these variables, we also looked at Pearson correlations between study variables of interest.

To address the primary research hypotheses, we used between-group analysis of variance (ANOVA) with randomized group assignment as the independent variable and calories and nutrients purchased as dependent variables in separate models. To address the secondary research hypothesis, we used a repeated-measures ANOVA with group as the independent variable and baseline and follow-up AUC as the dependent variables. As baseline DD (AUC) was correlated with calories purchased and is theoretically relevant to the dependent variable (Appelhans et al., 2019), we also included it as a covariate in a separate model (ANCOVA) to confirm whether it would alter findings.

RESULTS

Between-groups ANOVAs and chi-square tests resulted in no statistical differences between groups for demographic or control variables, except the percent of participant's who were overweight versus obese, as there was only one overweight subject in the control group (Table 1). Participant's baseline DD (e.g. AUC) was inversely correlated with calories ($r(43) = -.33$, $p < .05$), such that a higher baseline AUC was associated with fewer calories purchased and higher CFC scores ($r(43) = .32$, $p < .05$), consistent with our proposed theoretical framework. Participant's supermarket shopping frequency was also correlated

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with calories (r(43) = −.45, $p < .01$), such that people who shopped at supermarkets more frequently purchased fewer calories. We found that age was inversely associated with fast food (r(43) = −.31, $p < .05$) and home delivery purchases (r(43) = −.30, $p < .05$). Higher income was associated with more frequent supermarket shopping (r(43) = .39, $p < .05$) and less frequent use of food pantries (r(43) = −.39, $p < .01$). Receipt of government benefits (e.g. TANF, SNAP, WIC, etc.) was associated with less frequent supermarket shopping (r(43) = −.32, $p < .05$) , and more frequent supercenter (r(43) = .36, $p < .05$), corner store (r(43) = .31, $p < .05$), and pantry (r(43) = .35, $p < .05$) shopping. Food insecurity was associated with a lower baseline AUC (r(43) = −.38, $p < .05$) and more frequent supercenter (r(43) = .34, $p < .05$), corner store (r(43) = .33, $p < .05$), pantry (r(43) = .47, $p < .01$), and home delivery (r(43) = .56, $p < .01$) shopping. Higher education was associated with fewer corner store (r(43) = −.49, $p < .01$) and fast food (r(43) = −.31, $p < .05$) trips. All correlations are reported in an online-only supplement (Table 2).

Participants in the EFT group purchased significantly fewer calories (M = 7,650 ± SD = 5,095) than the SET control group (Mean = 12,470 ± SD = 7,471), ($F(1,41) = 6.25$, $p=0.02$; $\eta_p^2 = .13$) (See Figure 1A). Additionally, EFT participants purchased fewer grams of fat ($F(1,41) = 10.03$, $p<0.01$; $\eta_p^2 = .20$), saturated fat ($F(1,41) = 6.15$, $p = 0.02$; $\eta_p^2 = .13$), and fewer milligrams of sodium ($F(1,41) = 7.93$, $p<0.01$; $\eta_p^2 = .16$) than the SET control group (See Figure 1B, 1C, and 1D). No significant differences were found on grams of carbohydrates ($F(1,41) = 1.46$, $p = 0.23$; $\eta_p^2 = .03$) or sugar purchased ($F(1,41) = 0.59$, $p = 0.45$; $\eta_p^2 = .01$). After controlling for baseline AUC, effects remained significant for calories ($F(1,40) = 4.29$, $p=0.05$), grams of fat ($F(1,40) = 7.47$, $p<0.01$), grams of saturated fat ($F(1,40) = 4.04$, $p = 0.05$), and milligrams of sodium ($F(1,40) = 5.99$, $p = 0.02$) purchased.

There was no significant change in uncued DD from baseline to follow-up ($F(1,41) = 2.78$, $p=0.10$; $\eta_p^2 = .06$) though results were trending in the right direction.

Participants used and accessed their cues using any device that connected to the internet, and the majority of cue recalls (e.g. times listening to the cues) were conducted using the participant's smartphone (91.11%), followed by computers (7.78%), and tablets (1.11%). Most recalls were completed within the participant's home (60.22%) or in their car (33.33%), often in the grocery store parking lot. A few cue recalls were completed at the participant's work (5.38%) or at a relative's home (1.07%). The number of cue recalls across participants range from zero to eight, with an average of two recalls (Mean = 2.07 ± SD = 1.06). 70% of participants listened as instructed by the protocol (two times) and 12% listened more than two times. 16% listened one time and one participant did not use the application after their baseline appointment (2.3%).

DISCUSSION

Delivering an EFT intervention to the participants preferred device (e.g. smartphone, computer or tablet) via a mobile web application helped mothers make healthier food purchases during this pilot study. Previously we showed that EFT helped mothers with overweight and obesity to purchase healthier groceries in a hypothetical grocery shopping task in the laboratory. In this study, we systematically replicated and extended that finding as

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EFT helped mother's purchase fewer calories and healthier nutrient profiles while shopping at their preferred brick-and-mortar stores.

In the present study 82% of participants adhered to the research protocol by listening to their cues a minimum of two times, and 98% listened to their cues at least once before shopping. All but one participant completed the study and all of those who completed the follow-up appointment returned with their receipts and food receipt forms. Participants in the EFT group reported that thinking about future events was a positive experience for them, and thinking about those events seemed to help parents to improve their food purchasing choices given that their purchases were on average lower calorie, lower fat, and lower sodium than the control group.

The NIH Stages model proposes that when developing an intervention there should be multiple refinements while moving towards effectiveness ("Stage IV") and implementation and dissemination ("Stage V") trials (Onken, Carroll, et. al, 2015). Our findings from this Stage I/II study suggest, 1) that EFT may have helped people make more adaptive decisions when they were in a tempting situation or location, such as shopping at a store and 2) that using a mobile EMI application may have helped prompt people to think about their future when they were in a natural environment outside of a research laboratory, but there is still a great deal to explore.

One possible avenue for exploration is whether EFT interventions (e.g. generation and recall of EFT cues) can make future-orientation a "default" way of thinking in tempting situations, which is why we chose not to present the cues while the participant was completing the follow-up DD task in the present study. Withholding cues may have been one reason we did not see a statistically significant change in DD from baseline to follow-up, given that participants were prompted to think about their cues before they went shopping (where we found an effect), but not before they engaged in the DD task. Alternatively, these findings could also suggest that it may take longer than 48 hours and two cue recalls for EFT to become a "default" way of thinking in uncued contexts. It's possible that EFT interventions are less effective when participants are unprompted to think about their cues (Rung & Madden, 2019), but it is also possible that people need more frequent exposure to their cues and more opportunities to use their cues in tempting situations in order to change their default way of thinking and decision-making. Future research with longer follow-up should seek to establish whether it is possible to make EFT a "default" way of thinking when faced with temporal decisions as well as to identify the appropriate dose and duration of EFT interventions.

The present study has many strengths, including an experimental design, a validated control group (Hollis-Hansen, O'Donnell, Seidman, Brande, & Epstein, 2019b), and a sample powered to detect an effect on calories purchased. Additionally, the study is a systematic replication of two prior studies which resulted in the same findings on calories, fat, and saturated fat (Hollis-Hansen, Seidman, et al., 2019a). Further, in this study participants used the intervention and went shopping in their preferred environment (outside of the laboratory).

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There are limitations of the present study. First, this study only included mothers with overweight or obesity because of the academic and consumer literature that indicates mothers are the primary food shoppers and food preparers for the household. Therefore, our results do not tell us how well EFT works for normal weight women with children, adult men and women without children, or for fathers who are primary food shoppers for their households. It would be interesting to conduct a study with normal and overweight mothers and fathers to identify whether intervening on food purchases early can help to prevent weight gain for the entire family. Although prior research has shown that maternal weight gain has a stronger association with child's weight change than father's (Whitaker, Jarvis, Beeken, Boniface, & Wardle, 2010), there could be additive benefits from including fathers in future studies (Davison et al., 2019).

Second, people shop at different frequencies throughout the week, which has been associated with diet quality (Minaker et al., 2016). To account for that, we included the shopping habits survey and tested for group differences on all of the participants reported shopping habits, but future studies would benefit from a longer follow-up period to account for monthly shopping variations. Third, vitamins and minerals have not been consistently reported on food labels and are not consistently reported in nutrition databases, such as NutrionistPro. Therefore, we were unable to calculate information on health-promoting nutrients. Future studies could attempt to use other nutrition databases that provide these outcomes and calculate health-indices, such as the healthy eating index (HEI) (Krebs-Smith, et. al, 2018).

Lastly, although we used a validated control group (Hollis-Hansen et. al, 2019b), it may not adequately control for between group differences in emotional intensity and personal significance, given that celebrating a birthday may be more meaningful to participants than playing mobile application games. We have been unable to find any research that had participant's subjectively or objectively rate the emotional intensity or personal significance of EFT and control cues and therefore we are unsure whether these factors would influence DD or health behaviors. The main benefit of SET (the control used in this study) is that it standardizes the recent experience for all control participants thereby reducing the variability in the control group's recent cues (Hollis-Hansen et. al, 2019b).

It is difficult to resist the temptation to eat highly reinforcing fat, sugar and salt laden foods once they are in our immediate environment. In fact, we are biologically driven to want to eat those foods (Finlayson, 2017) and our larger social environments (e.g. media and advertisements, food stores) are designed to trigger that drive and wanting (Epstein, Leddy, Temple, & Faith, 2007). Research suggests that the food one buys is correlated with diet quality (Appelhans et al., 2012), as outside of hunger relief programs, virtually no food is consumed that was not at one point purchased. Making better food choices at the point of purchase may be both a temptation management strategy (e.g. keeping it out of the cart) and a temptation prevention strategy (e.g. keeping it out of the home) (Appelhans, French, et. al, 2017). EFT may help people resist the temptation to buy unhealthy foods because mentally simulating one's own future is associated with improvements in affect, decision-making, planning, and spatial navigation (e.g. developing a pathway to achieving a goal) (Schacter et. al, 2017). Specifically, EFT may help by 1) improving emotional regulation when someone

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is in a “hot state” after seeing a food cue in the store, 2) by making the future goal (e.g. better health or weight loss) seem more salient than the immediate gratification of buying a bag of chips, and 3) by encouraging one to think ahead about what food stores one may want to frequent or what foods one may want to buy or avoid. If we can use EFT to help parents to reduce the temptation to buy unhealthy foods and instead purchase healthier foods for their families, we may be able to improve the nutrient profiles of foods purchased, which in turn should help people change their home food environment and eating behaviors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

Appelhans BM, Tangney CC, French SA, Crane MM, & Wang YM. (2019). Delay Discounting and Household Food Purchasing Decisions: The SHoPPER Study. Health Psychology, 38(4), 334–342. doi:10.1037/hea0000727 [PubMed: 30896220]

Appelhans BM, Waring ME, Schneider KL, Pagoto SL, DeBiasse MA, Whited MC, & Lynch EB. (2012). Delay discounting and intake of ready-to-eat and away-from-home foods in overweight and obese women. Appetite, 59(2), 576–584. doi:10.1016/j.appet.2012.07.009 [PubMed: 22819735]

Appelhans BM, French SA, Pagoto SL, & Sherwood NE. (2016). Managing temptation in obesity treatment: A neurobehavioral model of intervention strategies. Appetite, 96, 268–279. doi:10.1016/j.appet.2015.09.035 [PubMed: 26431681]

Atance CM, & O’Neill DK. (2001). Episodic future thinking. Trends in Cognitive Sciences, 5(12), 533–539. [PubMed: 11728911]

Birch LL, & Ventura AK. (2009). Preventing childhood obesity: what works? International Journal of Obesity, 33, S74–S81 [PubMed: 19363514]

Blumberg SJ, Bialostosky K, Hamilton WL, & Briefel RR. (1999). The effectiveness of a short form of the household food security scale. American Journal of Public Health, 89(8), 1231–1234. doi:Doi 10.2105/Ajph.89.8.1231 [PubMed: 10432912]

Campbell KJ, Crawford DA, Salmon J, Carver A, Garnett SP, & Baur LA. (2007). Associations between the home food environment and obesity-promoting eating behaviors in adolescence. Obesity, 15(3), 719–730. doi:DOI 10.1038/oby.2007.553 [PubMed: 17372323]

Critchfield TS, & Kollins SH. (2001). Temporal discounting: basic research and the analysis of socially important behavior. Journal of applied behavior analysis, 34(1), 101–122. doi:10.1901/jaba.2001.34-101 [PubMed: 11317983]

Dachner N, Ricciuto L, Kirkpatrick SI, & Tarasuk V. (2010). Food purchasing and food insecurity among low-income families in Toronto. Canadian Journal of Dietetic Practice amd Research, 71(3), e50–56. doi:10.3148/71.3.2010.127

Daniel TO, Said M, Stanton CM, & Epstein LH. (2015). Episodic future thinking reduces delay discounting and energy intake in children. Eating Behaviors, 18, 20–24. doi:10.1016/j.eatbeh.2015.03.006 [PubMed: 25863227]

Daniel TO, Stanton CM, & Epstein LH. (2013a). The future is now: Comparing the effect of episodic future thinking on impulsivity in lean and obese individuals. Appetite, 71, 120–125. doi:10.1016/j.appet.2013.07.010 [PubMed: 23917063]

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Daniel TO, Stanton CM, & Epstein LH. (2013b). The Future Is Now: Reducing Impulsivity and Energy Intake Using Episodic Future Thinking. Psychological Science, 24(11), 2339–2342. doi:10.1177/0956797613488780 [PubMed: 24022653]

Davison KK, Gavarkovs A, McBride B, Kotelchuck M, Levy R, & Taveras EM. (2019). Engaging Fathers in Early Obesity Prevention During the First 1,000 Days: Policy, Systems, and Environmental Change Strategies. Obesity, 27(4), 525–533. doi:10.1002/oby.22395 [PubMed: 30900405]

Epstein LH, Leddy JJ, Temple JL, & Faith MS. (2007). Food reinforcement and eating: A multilevel analysis. Psychological Bulletin, 133(5), 884–906. doi:10.1037/0033-2909.133.5.884 [PubMed: 17723034]

Epstein LH, Paluch RA, Carr KA, Temple JL, Bickel WK, & MacKillop J. (2018). Reinforcing value and hypothetical behavioral economic demand for food and their relation to BMI. Eating Behaviors, 29, 120–127. doi:10.1016/j.eatbeh.2018.03.008 [PubMed: 29656049]

Epstein LH, Salvy SJ, Carr KA, Dearing KK, & Bickel WK. (2010). Food reinforcement, delay discounting and obesity. Physiology & Behavior, 100(5), 438–445. doi:10.1016/j.physbeh.2010.04.029 [PubMed: 20435052]

Feda DM, Roemmich JN, Roberts A, & Epstein LH. (2015). Food reinforcement and delay discounting in zBMI-discordant siblings. Appetite, 85, 185–189. doi:10.1016/j.appet.2014.11.023 [PubMed: 25464024]

Finlayson G. (2017). Food addiction and obesity: unnecessary medicalization of hedonic overeating. Nature Reviews Endocrinology, 13(8), 493–498. doi:10.1038/nrendo.2017.61

Gage-Bouchard EA, & Devine KA. (2014). Examining parents' assessments of objective and subjective social status in families of children with cancer. PLOS One, 9(3), e89842. doi:10.1371/journal.pone.0089842 [PubMed: 24599006]

Hannon PA, Bowen DJ, Moinpour CM, & McLerran DF. (2003). Correlations in perceived food use between the family food preparer and their spouses and children. Appetite, 40(1), 77–83. [PubMed: 12631508]

Heron KE, & Smyth JM. (2010). Ecological momentary interventions: Incorporating mobile technology into psychosocial and health behaviour treatments. British Journal of Health Psychology, 15, 1–39. doi:10.1348/135910709×466063 [PubMed: 19646331]

Hollis-Hansen K, Seidman J, O'Donnell S, & Epstein LH. (2019a). Episodic future thinking and grocery shopping online. Appetite, 133, 1–9. doi:10.1016/j.appet.2018.10.019 [PubMed: 30342066]

Hollis-Hansen K, O'Donnell SE, Seidman JS, Brande SJ, & Epstein LH. (2019b). Improvements in episodic future thinking methodology: Establishing a standardized episodic thinking control. PLOS One, 14(3). doi:ARTNe021439710.1371/journal.pone.0214397

Jakobsen JC, Gluud C, Wetterslev J, & Winkel P. (2017). When and how should multiple imputation be used for handling missing data in randomised clinical trials - a practical guide with flowcharts. BMC medical research methodology, 17(1), 162. doi:10.1186/s12874-017-0442-1 [PubMed: 29207961]

Koffarnus MN, & Bickel WK. (2014). A 5-Trial Adjusting Delay Discounting Task: Accurate Discount Rates in Less Than One Minute. Experimental and Clinical Psychopharmacology, 22(3), 222–228. doi:10.1037/a0035973 [PubMed: 24708144]

Krebs-Smith SM, Pannucci TE, Subar AF, Kirkpatrick SI, Lerman JL, Tooze JA, Wilson MM, Reddy J. (2018). Update of the Healthy Eating Index: HEI-2015. Journal of the Academy of Nutrition and Dietetics, 118(9), 1591–1602. doi: 10.1016/j.jand.2018.05.021 [PubMed: 30146071]

Minaker LM, Olstad DL, Thompson ME, Raine KD, Fisher P, & Frank LD. (2016). Associations between frequency of food shopping at different store types and diet and weight outcomes: findings from the NEWPATH study. Public Health Nutrition, 19(12), 2268–2277. doi:10.1017/S1368980016000355 [PubMed: 26956712]

Moore LV, Dodd KW, Thompson FE, Grimm KA, Kim SA, & Scanlon KS. (2015). Using Behavioral Risk Factor Surveillance System Data to Estimate the Percentage of the Population Meeting US Department of Agriculture Food Patterns Fruit and Vegetable Intake Recommendations. American Journal of Epidemiology, 181(12), 979–988. doi:10.1093/aje/kwu461 [PubMed: 25935424]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

O'Donnell S, Hollis-Hansen K, & Epstein LH. (2018). Mix and Match: An Investigation into Whether Episodic Future Thinking Cues Need to Match Discounting Delays in Order to Be Effective. Behavioral sciences (Basel, Switzerland), 9(1), 1. doi:10.3390/bs9010001

Onken LS, Carroll KM, Shoham V, Cuthbert BN, & Riddle M. (2014). Reenvisioning Clinical Science: Unifying the Discipline to Improve the Public Health. Clinical psychological science : a journal of the Association for Psychological Science, 2(1), 22–34. doi:10.1177/2167702613497932 [PubMed: 25821658]

O'Neill J, Daniel TO, & Epstein LH. (2016). Episodic future thinking reduces eating in a food court. Eating Behaviors, 20, 9–13. doi:10.1016/j.eatbeh.2015.10.002 [PubMed: 26562686]

Odum AL. (2011). Delay Discounting: I'm a K, You're a K. Journal of the Experimental Analysis of Behavior, 96(3), 427–439. doi:10.1901/jeab.2011.96-423 [PubMed: 22084499]

Peters J, & Buchel C. (2010). Episodic future thinking reduces reward delay discounting through an enhancement of prefrontal-mediotemporal interactions. Neuron, 66(1), 138–148. [PubMed: 20399735]

PLMA. (2013). Today's primary shopper. PLMA Consumer Research Study. Retrieved from https://plma.com/2013plma_gfk_study.pdf

Roepke AM, & Seligman MEP. (2016). Depression and prospection. British Journal of Clinical Psychology, 55(1), 23–48. doi:10.1111/bjc.12087 [PubMed: 26096347]

Rosenkranz RR, & Dzewaltowski DA. (2008). Model of the home food environment pertaining to childhood obesity. Nutrition Reviews, 66(3), 123–140. doi:10.1111/j.1753-4887.2008.00017.x [PubMed: 18289177]

Rung JM, & Madden GJ. (2018). Experimental Reductions of Delay Discounting and Impulsive Choice: A Systematic Review and Meta-Analysis. Journal of Experimental Psychology-General, 147(9), 1349–1381. doi:10.1037/xge0000462 [PubMed: 30148386]

Rung JM, & Madden GJ. (2019). Demand characteristics in episodic future thinking II: The role of cues and cue content in changing delay discounting. Experimental Clinical Psychopharmacology. doi: 10.1037/pha0000260 [Epub ahead of print]

Scaglioni S, Arrizza C, Vecchi F, & Tedeschi S. (2011). Determinants of children's eating behavior. American Journal of Clinical Nutrition, 94(6), 2006s–2011s. doi:10.3945/ajcn.110.001685. [PubMed: 22089441]

Schacter DL, Benoit RG, & Szpunar KK. (2017). Episodic future thinking: mechanisms and functions. Current Opinion in Behavioral Sciences, 17, 41–50. doi: 10.1016/j.cobeha.2017.06.002 [PubMed: 29130061]

Snider SE, LaConte SM, & Bickel WK. (2016). Episodic Future Thinking: Expansion of the Temporal Window in Individuals with Alcohol Dependence. Alcoholism-Clinical and Experimental Research, 40(7), 1558–1566. doi:10.1111/acer.13112

Stein JS, Sze YY, Athamneh L, Koffarnus MN, Epstein LH, & Bickel WK. (2017). Think fast: rapid assessment of the effects of episodic future thinking on delay discounting in overweight/obese participants. Journal of Behavioral Medicine. doi:10.1007/s10865-017-9857-8

Stein JS, Tegge AN, Turner JK, & Bickel WK. (2018). Episodic future thinking reduces delay discounting and cigarette demand: an investigation of the good-subject effect. Journal of Behavioral Medicine, 41(2), 269–276. doi:10.1007/s10865-017-9908-1 [PubMed: 29270887]

Stein JS, Wilson AG, Koffarnus MN, Daniel TO, Epstein LH, & Bickel WK. (2016). Unstuck in time: episodic future thinking reduces delay discounting and cigarette smoking. Psychopharmacology, 233(21–22), 3771–3778. doi:10.1007/s00213-016-4410-y [PubMed: 27553824]

Strathman A, Gleicher F, Boninger DS, & Edwards CS. (1994). The Consideration of Future Consequences - Weighing Immediate and Distant Outcomes of Behavior. Journal of Personality and Social Psychology, 66(4), 742–752. doi:Doi 10.1037//0022-3514.66.4.742

Sze YY, Daniel TO, Kilanowski CK, Collins RL, & Epstein LH. (2015). Web-Based and Mobile Delivery of an Episodic Future Thinking Intervention for Overweight and Obese Families: A Feasibility Study. JMIR Mhealth Uhealth, 3(4), e97. doi:10.2196/mhealth.4603 [PubMed: 26678959]

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Sze YY, Stein JS, Bickel WK, Paluch RA, & Epstein LH. (2017). Bleak Present, Bright Future: Online Episodic Future Thinking, Scarcity, Delay Discounting, and Food Demand. Clinical Psychological Science, 5(4), 683–697. doi:10.1177/2167702617696511 [PubMed: 28966885]

Szpunar KK. (2010). Episodic Future Thought: An Emerging Concept. Perspectives on Psychological Science, 5(2), 142–162. doi:10.1177/1745691610362350 [PubMed: 26162121]

Whitaker KL, Jarvis MJ, Beeken RJ, Boniface D, & Wardle J. (2010). Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. American Journal of Clinical Nutrition, 91(6), 1560–1567. doi:10.3945/ajcn.2009.28838 [PubMed: 20375189]

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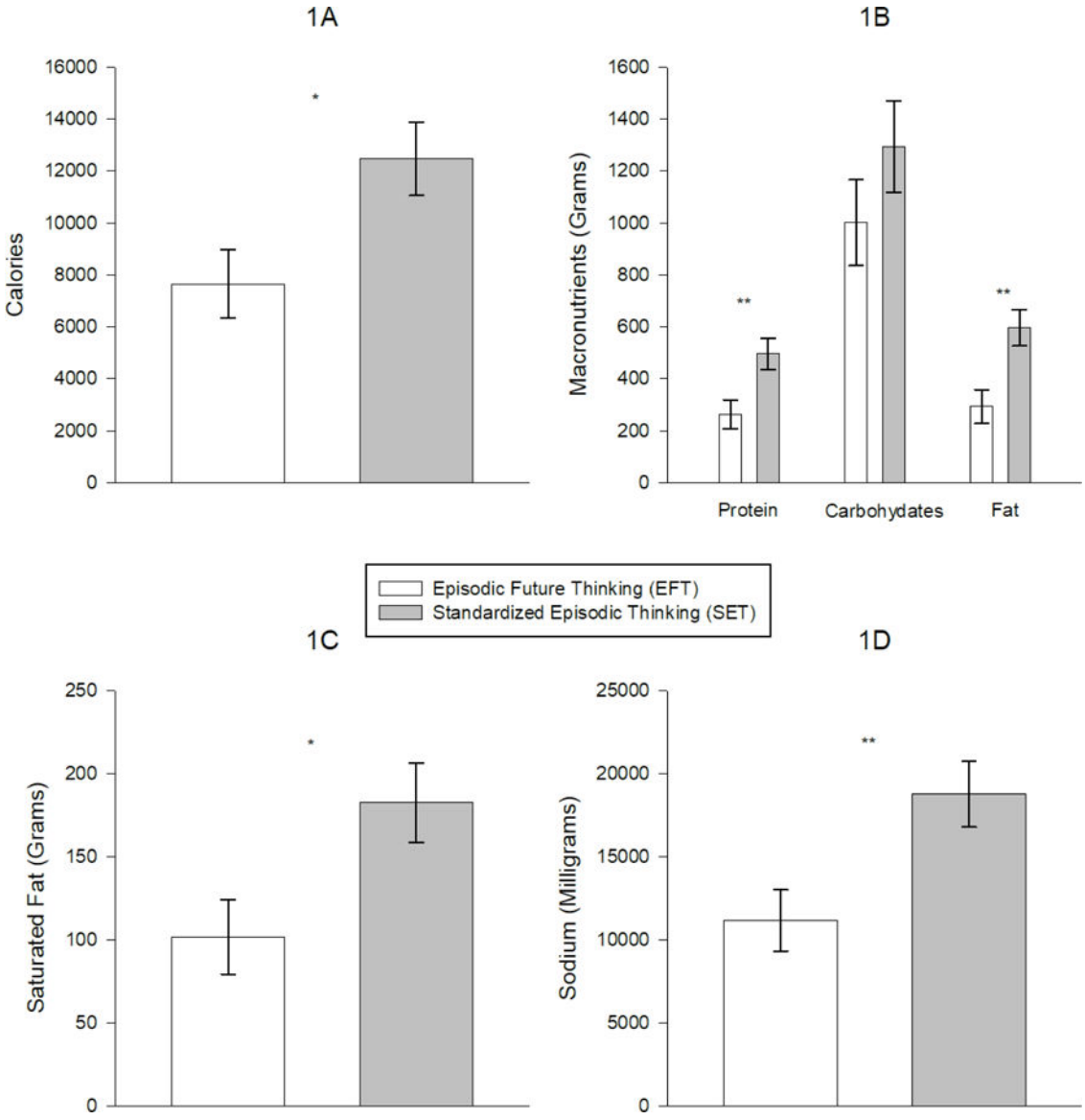

Figure 1.

Calories (mean ± SE) (**Figure 1A**), grams of macronutrients (mean ± SE) (**Figure 1B**), grams of saturated fat (mean ± SE) (**Figure 1C**) and milligrams of sodium (mean ± SE) (**Figure 1D**) purchased per person in the family. Participants randomized to the EFT group purchased fewer calories, grams of fat, grams of protein, grams of saturated fat, and milligrams of sodium than those who were randomized to the SET control group. *p ≤ .05 **p ≤ .01 ***p ≤ .001.

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Table 1.

Participant and Study Characteristics.

	EFT **n = 23**	**SET** **n = 20**	**p-value**
Baseline Characteristics			
Age (Mean ± SD, years)	38.83 ± 6.34	37.5 ± 4.09	.43
Income (Mean ± SD, $*)*	74195 ± 46028	70187 ± 39821	.76
Subjective Social Status (Mean ± SD)	5.28 ± 1.68	6.08 ± 1.52	.11
Government Benefits (n, %)			.89
Yes	11 (47.83%)	10 (50.00%)	
No	12 (52.17%)	10 (50.00%)	
Food Insecurity (Mean ± SD)	1.52 ± 2.23	1.25 ± 2.10	.69
Education (Mean ± SD, years)	16.74 ± 1.96	15.85 ± 2.23	.17
Body Mass Index (Mean ± SD)	34.42 ± 8.17	37.87 ± 5.96	.13
Overweight (n, %)	8	1	.02
Obese (n, %)	15	19	
Family Size (Mean ± SD, people)	4.44 ± 1.78	4.05 ± 1.0	.40
Race (n, %)			.64
White	17 (73.91%)	16 (80.00%)	
Non-white	6 (26.09%)	4 (20.00%)	
Prior Participation (n, %)[2]			.28
Yes	0 (0.00%)	1 (5.00%)	
No	23 (100.00%)	19 (95.00%)	
Baseline AUC (Mean ± SD)[3]	0.66 ± 0.27	0.54 ± 0.26	.13
CFC Score (Mean ± SD)	3.91 ± 0.61	3.61 ± 0.65	.13
Shopping Frequency (Mean ± SD)			
Supermarket	4.09 ± 0.73	4.15 ± 0.88	.80
Supercenter	1.96 ± 1.46	2.50 ± 1.57	.25
Cornerstore	1.61 ± 1.83	1.40 ± 1.86	.71
Specialty Store	0.83 ± 1.19	0.70 ± 1.08	.72
Farmer’s Market	0.78 ± 0.95	1.15 ± 1.18	.27
Pantry	0.09 ± 0.29	0.20 ± 0.52	.38
Home delivery	0.30 ± 0.93	0.10 ± 0.45	.37
Co-op	0.17 ± 0.65	0.35 ± 0.75	.41
Eating Habits (Mean ± SD, svgs/week)			
Fruit	4.22 ± 2.17	4.15 ± 2.32	.92
Green Vegetables	2.91 ± 1.35	2.55 ± 1.47	.40
Fried Potatoes	1.70 ± 1.87	1.80 ± 1.70	.85
Other Potatoes	1.26 ± 1.29	2.15 ± 1.60	**.05**
Other Vegetables	4.35 ± 2.04	4.95 ± 2.04	.34
Fast Food	3.30 ± 3.25	2.60 ± 2.46	.43

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	EFT **n = 23**	**SET** **n = 20**	**p-value**
Restaurant Food	1.00 ± 0.91	1.10 ± 1.07	.74
Study Characteristics			
Mobile Game Liking (Mean ± SD)	3.52 ± 0.62	3.38 ± .47	.41
Cue measures (Mean ± SD)			
Number of trainings	2.04 ± 0.83	2.10 ± 1.48	.88
Attention to cue	4.71 ± 0.53	4.53 ± 0.66	.33
Vividness	4.50 ± 1.09	4.40 ± 0.74	.73
Total spent (Mean ± SD, $*)*	122.88 ± 63.83	141.07 ± 73.59	.39
Follow-up AUC (Mean ± SD)	0.70 ± 0.28	0.53 ± 0.28	.10

[1]A BMI of 25.0 to < 30 is considered overweight, a BMI > 30 is considered obese

[2]Prior participation means that during the eligibility screener the participant indicated previous participation in a study "involving the creation of cues" in our laboratory or online ≥ 6-months prior to the present study,

[3]AUC stands for "area under the curve", which is used as a measure of delay discounting, a higher AUC (e.g. closer to 1) suggests less discounting of the future outcome while a lower AUC (e.g. closer to 0) suggests greater discounting of the future outcome