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Changing how I feel about the food: experimentally manipulated affective associations with fruits change fruit choice behaviors

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Abstract

Fewer than half of Americans meet current recommendations for fruit and vegetable intake. The behavioral affective associations model posits that feelings and emotions associated with a behavior are a proximal influence on decision making. Cross-sectional evidence supports the model and suggests that affective associations predict fruit and vegetable consumption. The purpose of this study was to test whether a causal relation exists between affective associations about fruits and future fruit consumption behavior, as measured by a snack selection task. Following a baseline assessment of cognitive and affective variables, participants' (N = 161) affective associations about fruits were experimentally manipulated with an implicit priming paradigm. Images of fruits were repeatedly paired with positive, negative, or neutral affective stimuli. The key outcome measure was a behavioral choice task in which participants chose between fruit and a granola bar. Participants in the positive prime condition were three times more likely than those in the negative condition to select a piece of fruit over the granola bar alternative in the snack selection task. They were also twice as likely as those in the neutral condition to select fruit. There were no changes in self-reported affective associations or cognitive beliefs. These findings provide further evidence of the implicit and direct influence of affective associations on behavior, suggesting the need to both incorporate the role of affect in health decision making models, as well as the potential utility of intervention strategies targeting affective associations with health-related behaviors.

Keywords

Health decision making; Affect/emotions; Evaluative conditioning; Fruit and vegetable consumption

Introduction

Feeding a child Brussels sprouts, spinach, or other vegetables can elicit reactions of disgust or even fear (Birch & Marlin, 1982; Rozin, 2006). On the other hand, many people can identify one or more "comfort foods", foods that they associate with warmth, happiness, and contentment (Wansink et al., 2003). The feelings we associate with particular food items can play a strong role in the choices we make—the child's experience of disgust is unlikely to

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result in eating the green leafy vegetable, whereas the comfort food is likely to be eaten precisely because it is associated with positive feelings.

Both of these examples describe *affective associations* with food items—a linking between one's mental representation of a behavior (intake of a particular food) and an affective state (contentment, disgust). Affective associations are related to behavior in a number of domains (Ajzen & Driver, 1991; Kiviniemi et al., 2007; Lawton et al., 2007, 2009), including dietary behavior (Keer et al., 2010; Kiviniemi & Duangdao, 2009). In this paper, we report a laboratory study examining the effect of experimentally manipulating affective associations with fruits on subsequent behavior. We begin by reviewing the evidence for relations between affective associations and behavior and discuss the importance of causal evidence for the nature of the relation.

Affective associations and behavior

The relation between affective associations and behavior has been demonstrated across several different health behaviors. Greater levels of behavioral engagement are related to more positive affective associations in domains including physical activity (Conner et al., 2011; Kiviniemi et al., 2007; Lawton et al., 2009; Rhodes & Conner, 2010), eating behaviors (Dean et al., 2008; Kiviniemi & Duangdao, 2009), risky sexual behavior (Ferrer et al., 2011), substance use (Elliott & Ainsworth, 2012; Simons et al., 2005) and organ donation (O'Carroll et al., 2011). Further, this relation between affective associations and behaviors holds across different populations and different specific measures of affective associations. For instance, in a meta-analysis that examined the relationship between affective judgments and physical activity, the affective components, such as exercise enjoyment, contributed considerably larger effect sizes than environmental, social, and other psychological factors (Rhodes et al., 2009).

Although the interrelation of affective associations and behavior is well established, the vast majority of the research evidence is observational and cross-sectional. Thus, an important question is whether the relation is causal. Despite limited evidence, theoretical formulations concerning affective associations and related affective constructs assume a causal role. For example, Damasio's (1994) somatic marker hypothesis and Slovic et al.'s (2007) affect heuristic assert that affective cues or evaluations serve as a signal to the appropriateness of a behavioral choice given the degree of risk involved. In other domains, theories of attitude that include an affective component, such as the tripartite model (Breckler, 1984) and Ajzen's extension of the theory of planned behavior to include affective attitudes (Ajzen & Driver, 1991, 1992), argue that the affect associated with an attitude object serves as a source of information that either directly informs judgment and subsequent behavior, or informs an overall, global evaluation which in turn informs judgment (Keer et al., 2010; Lawton et al., 2009).

Although the theoretical perspectives outlined above argue for a causal role of affective associations as an influence on behavior, and the empirical evidence reviewed above is consistent with a causal interpretation, there is remarkably little evidence in the literature to directly support the assertion of a causal relation between affective associations and behavior. Directly supportive evidence would be valuable for both theory refinement and intervention development. Given the increasing focus on affective processing in health decision making, understanding the causal relations advances our knowledge and development of theoretical models. From an intervention perspective, demonstrating that affective associations can be manipulated, and that such changes will influence subsequent behavior under laboratory conditions is an important precursor to the development of real-world interventions that try to address health behavior problems by changing affective associations.

Study overview

The central purpose of the current study was to examine how experimentally manipulated positive or negative affective associations with a health behavior influence subsequent behavioral practice. Examining the causal effect of affective associations on behavioral outcomes allows us to determine the nature and causal direction of the demonstrated relation between affective associations and behavior.

We manipulated affective associations with fruits (apples and bananas specifically) using an implicit priming paradigm, which is an evaluative conditioning procedure based on the premise that attitudes can develop and change via classical conditioning (Gibson, 2008; Olson & Fazio, 2002; Prestwich et al., 2011; Richetin et al., 2007). This paradigm involves repeatedly pairing stimuli evoking positive or negative affect, the unconditioned stimuli (US), with a neutrally valenced object, the conditioned stimulus (CS). Past research has experimentally measured and changed people's attitudes about foods by priming sensory experiences, such as odors (Hermans et al., 2005) and taste (Verhulst et al., 2006), as well as cognitively-based beliefs, such as the adverse health consequences of fatty foods (Hollands et al., 2011). For the current study, the CS were photographs of fruits (apples and bananas). US were words and images previously demonstrated to evoke positive, negative, or neutral (control condition) affect.

Data collection occurred at two time points. Participants completed a baseline survey over the telephone that assessed their pre-existing cognitive beliefs about and affective associations with fruits and vegetables, as well as their current fruit and vegetable consumption. In a second, laboratory session, participants completed the computer-based implicit priming task (the independent variable; intended to induce positive, negative, or neutral affective associations with fruits) followed by a series of outcome measures, including a snack selection task.

Based on the evidence reviewed above for cross-sectional relations between affective associations and behavioral patterns, we hypothesized that the manipulation of affective associations using the implicit priming paradigm would influence behavior, such that, relative to the neutral/control condition, those in the positive affective associations condition would be more likely to select a fruit in the snack selection task, whereas those in the negative affective associations condition would be less likely to select a fruit in the selection task.

Methods

Participants

Participants (n = 161) took part in the study in exchange for a cash payment. Participants were 59 % female, most (91 %) were university students and had a mean age of 23.6 years (SD = 7.2 years). Forty-five percent self-identified as white and 42 % were Asian/Pacific Islander. They were recruited by means of advertising flyers that were distributed throughout the campus community. All but four participants completed the second interview within 2 weeks of their baseline interview. The university's Institutional Review Board approved the data collection protocol prior to data collection.

Procedure

Baseline interview—Participants completed a baseline telephone survey in which they reported fruit and vegetable consumption over the past month, cognitive beliefs, and affective associations with fruits and vegetables (see "Measures").

Laboratory task—Random assignment using a random numbers table took place following completion of the phone interview and scheduling of the in person lab session. Participants were randomly assigned to one of three conditions (positively, negatively, or neutrally valenced priming task) using a blocked design, with separate random assignment for those high versus low in baseline affective associations with fruits and vegetables based on a median split. This ensured an equal distribution of participants with high and low affective associations across conditions.

The implicit priming paradigm consisted of a sequence of 190 words and images, which appeared for 1,000 ms individually in the center of a computer screen using the DirectRT computer software (Jarvis, 2006). An additional 40 blank screens were randomly scattered between images to reduce participants' awareness of sequential or systematic patterns (Olson & Fazio, 2001). The task consisted of three consecutive blockings, each with separate instructions that substantiated the cover story. The first and third block consisted of 76 images, while the middle block consisted of 38 images.

Interspersed within randomly ordered neutral filler items, 20 CS–US sequential pairs were intended to produce the priming effect. CS images were 10 different photographs of apples and bananas. The US were 10 positively, negatively, or neutrally valenced images (e.g.: positive: *chipmunk*; negative: *junk cars*; neutral: *basket*), and 10 valenced words (e.g.: positive: *terrific*; negative: *upsetting*; neutral: *impartial*). US images were selected from the International Affective Picture System, which is a standardized set of thousands of photographs varying in affective content (IAPS; Lang et al., 2005), and both words and images were pretested, used, and validated in similar evaluative conditioning studies (Jones et al., 2009; Olson & Fazio, 2001, 2002). Positively and negatively valenced images were intended to be mildly rather than strongly evocative based on prior evidence that mildly evocative stimuli are more effective primes (Jones et al., 2009). Images were also equivalently arousing and strongly valenced based on published norms (Ito et al., 1998; Lang et al., 2005). Neutral filler images were obtained from the IAPS database and a database of standard food images.

Since words and images were displayed long enough for conscious awareness and debate continues as to whether contingency awareness attenuates or amplifies the effects of implicit priming paradigms (Gawronski & Bodenhausen, 2006; Olson & Fazio, 2002; Pleyers et al., 2007), several efforts were made to ensure that participants were attentive, but did not consciously detect the CS–US pairings during the priming activity. Positively and negatively valenced US words and images were selected to be moderately, but not highly arousing and salient, and each US was non-repeating. A cover story was also used. Participants were told that they were completing a computer-based attention task, in which they were to pay close attention as images flashed on the computer screen, and to press the spacebar as quickly as possible each time they observed a word or image that matched a specified category. The categories changed with each of the three blocks of images and were: (1) *dessert foods*, (2) *pastas*, and (3) *photos of people*.

Following the priming task, participants completed a behavioral choice task, in which they selected either a granola bar or fruit (apple or banana) as a snack (see "Measures"). This served as the key outcome variable of interest. Participants also completed measures of cognitive beliefs about, and affective associations with fruits and vegetables (see "Measures").

Measures

Affective associations

Specific food affective associations: At baseline and post-priming manipulation, participants rated how much they enjoyed each of 15 food items. Responses were made on an 8-point scale ranging from “1 = not at all” to “8 = extremely.” Embedded within these food items were the three snack options: apples, bananas, and granola bars, in order to assess participants’ pre-existing affective associations with the snack options.

Global affective associations: Participants’ affective associations about fruits and vegetables were assessed with a 14-item scale modified from Crites et al.’s (1994) affective associations measure (Crites et al., 1994). Participants were given the prompt “When I think about eating fruits and vegetables, I feel ____” followed by 7 positive words (e.g. joy, calm, delighted; $\alpha = 0.88$) and 7 negative words (e.g. angry, sorrow, bored; $\alpha = 0.89$). Each item was rated on a 9-point scale from “0 = not at all” to “8 = extremely.” For the baseline interview, a 6-item subscale was used with 3 positive ($\alpha = 0.88$) and 3 negative words ($\alpha = 0.57$). Participants responded using a 5-point scale. Mean scores were calculated for participants’ positive and negative affective associations with fruits and vegetables at baseline and follow-up.

Cognitive beliefs: Participants’ perceived benefits and barriers to eating fruits and vegetables were assessed using a decisional balance scale (Ling & Horwath, 2001). This previously validated 22-item measure included 13 questions that assessed the benefits of eating more fruits and vegetables ($\alpha = 0.86$) and 9 items that assessed the barriers to eating more fruits and vegetables ($\alpha = 0.73$). Participants indicated the extent to which items were important in their decision whether or not to eat fruits and vegetables (e.g., “Preparing and cooking vegetables would be time consuming”) on a 5-point scale (1 = not very important; 5 = extremely important). For the baseline interview, a shortened 14-item version was administered (benefits: $\alpha = 0.75$; barriers: $\alpha = 0.72$; Ling & Horwath, 2001). Participants’ perceived benefits and barriers to eating fruits and vegetables were calculated based on their mean scores at baseline and follow-up.

Fruit and vegetable consumption behavior

30-day food recall: During the baseline interview, participants reported their consumption of 10 different categories of fruits and vegetables (e.g. lettuce salad, 100 % juice, fruits) using the National Cancer Institute’s (NCI) Quick Food Scan. For each food category, participants indicated the number of times they had eaten the food in the past month using 10 response categories that ranged from “never” to “5 or more times per day.” They also indicated the quantity or number of servings they consumed each time they ate the food item. Responses were used to calculate the number of servings of fruits and vegetables that each participant consumed per day based on an NCI algorithm (National Cancer Institute, 2007).

Snack selection: The snack selection task provided a measure of fruit consumption behavior. Participants selected from a box of apples, bananas, and a variety of granola bar flavors. These snack options were selected to be roughly calorically equivalent (approximately 100 kcal), to be easily transportable by the participant, and to reduce the chance that a strong distaste for one particular snack option would disproportionately guide participants’ snack choice. Using random assignment, half of participants selected their snack immediately following the priming activity, and half selected one after completing the other measures. Timing of the task did not influence results. In each case, the experimenter uncovered a previously hidden box of snacks and presented it to participants. There were four of each snack option in the box: granola bars, apples, and bananas. The experimenter offered each participant a snack from the box using the standardized prompt, "As a small token of appreciation for your effort and participation, we have some snacks here. Go ahead and pick one." After the participant selected the snack, the experimenter went to an adjoining room and immediately recorded the snack selection. Twenty-six (15 %) participants chose not to select a snack and were excluded from the snack selection analyses. Snack selection was dichotomized as a fruit or non-fruit selection, and served as the behavioral outcome variable.

Manipulation check

Awareness of co-occurrence: To assess participants' awareness of the CS–US pairings, they were asked to indicate whether 20 pairs of items had occurred sequentially during the priming activity. Eight out of the twenty pairs actually appeared together. For each pair, participants indicated on a scale from −2 (I am confident the images did not appear together) to 0 (unsure) to 2 (I am confident the images appeared together) their confidence that the two items appeared sequentially. Their responses were dichotomized (0 = did not appear together, 1 = appeared together), and the level of awareness of the pairings was calculated as the percentage of correct and incorrect responses.

Attention to priming task: Spacebar accuracy scores were defined as the percentage of correct spacebar responses to the embedded target images (pressing vs. not pressing the spacebar within 1,000 ms). Scores were standardized to mean = 0, SD = 1 in order to aid in interpretation. Participants with error rates exceeding two standard deviations from the mean were identified (n = 6). Subsequent analyses were run with and without these participants in order to assess whether they influenced results.

Data analysis strategy

All analyses were conducted in SPSS version 19. In preliminary analyses, we used χ^2 analysis and linear regression to examine baseline differences in demographics and predictor variables between the three conditions. We used linear and logistic regression to determine whether demographic variables influenced the three main outcomes of interest: snack selection, cognitive variables, and affective associations with fruits and vegetables. To test whether baseline characteristics moderated the effect of condition on any outcomes of interest, interaction terms were computed and included in the regression equations.

We used ANCOVA and logistic regression models to test for an intervention effect controlling for baseline scores. Models were run with and without participants who scored greater than two standard deviations from the mean on the spacebar accuracy task in order to determine whether the pattern of results differed for those with low task attention.

Results

Preliminary analyses

The baseline characteristics of participants are summarized in Tables 1 and 2. Across the three conditions, there were no significant differences in baseline cognitive variables and affective associations (*p*s > .05). The only demographic difference between conditions was race, with more Latin American participants in the positive condition compared to the other two conditions, $\chi^2 = 7.77$, $p = .021$. Also, Asian participants were slightly more likely than white participants to select a fruit over a granola bar in the snack selection task ($OR = 2.00$, 95 % CI [0.89, 4.53], $p = .095$).[1] Further, female participants had higher positive affective associations and reported more perceived benefits of eating fruits and vegetables at baseline compared to males, $Fs(1, 159) \geq 8.47$, $ps \leq .01$. Neither race nor gender moderated the effect of condition on any outcomes of interest, as indicated by nonsignificant interaction terms. However, they were included as covariates in hypothesis testing analyses in which they produced main effects.

Greater task attention, as measured by higher accuracy of spacebar responses, was associated with greater odds of selecting a fruit, $OR = 1.57$, 95 % CI [1.002, 2.45], $p < .05$. However, a condition by accuracy interaction term was not significantly associated with any outcomes of interest, suggesting that accuracy did not moderate the effect of condition on any outcome variables. Additionally, including accuracy as a covariate in subsequent analyses did not change the pattern of results.

Examining recognition of co-occurring images similarly revealed no concerns for interpreting effects of the manipulation. Across conditions, there were no significant differences in the likelihood of reporting that two images co-occurred between images that actually appeared together relative to those that did not, $t(160) = -1.72$, $p > .05$. Among images that appeared together, participants were more accurate in their estimates for the valenced pairs compared to the non-valenced pairs, $t(160) = -9.25$, $p < .001$. Neither co-occurrence awareness nor a condition by awareness interaction term predicted any outcomes of interest. Therefore, accuracy and awareness are not retained as covariates in subsequent analyses.

Fruit consumption behavior

The primary aim of the study was to determine whether manipulating affective associations with fruits led to differences in actual behavior. We estimated a series of logistic regressions in order to examine the influence of study condition on snack selection.[2] Because race significantly predicted snack selection, it was included as a covariate in the models.

Table 3 provides the percentage of participants in each condition who selected a fruit as their snack. As can be seen in the table, the adjusted likelihood of selecting a fruit differed by condition, with 78 % ($SD = 6.54$ %) of the positive condition selecting a fruit compared to 60 % ($SD = 9.35$ %) of the neutral and 55 % ($SD = 9.86$ %) of the negative condition. This difference by condition was statistically significant based on a test of the full model against a constant only model, $\chi^2(4) = 10.00$, $p = .040$. Study condition accounted for significantly more variance beyond the race covariate, $\chi^2(2) = 6.20$, $p = .045$. The odds of participants in the positive condition selecting a fruit was 3 times greater than the odds of participants in the negative condition selecting a fruit ($OR = 3.04$, 95 % CI [1.16, 7.97], $p < .05$), and 2.41 times greater than the odds of participants in the neutral condition selecting a fruit ($OR = 2.41$, 95 % CI [0.99, 5.87], $p < .05$). The odds of selecting a fruit over a granola bar did not differ between the negative and neutral groups ($p > .10$).[3]

Cognitive and affective constructs

The study also examined whether the implicit priming paradigm changed participants' affective associations and cognitive beliefs about fruits. Adjusted means for each outcome variable by condition are summarized in Table 3. Analysis of covariance (ANCOVA) models tested whether there were differences by condition in positive and negative affective

[1]Due to small cell sizes for African American, Latin American, and Native American participants, a 3-category race variable was computed and used for hypothesis testing. Categories were: Asian/Pacific Islander (n = 68), white (n = 67), and Other (n = 26).

[2]Results from multinomial logistic regression models that included participants who did not select a snack produced equivalent results, and there were no differences by condition in likelihood of refusing a snack.

[3]Because participants' accuracy of spacebar responses predicted snack selection, the model was also run with accuracy included as a covariate. A significant condition effect remained, with the positive condition having significantly greater odds of selecting a fruit than the negative condition ($OR = 2.70$, $p < 0.05$).

associations, perceived benefits, and perceived barriers. Controlling for baseline scores, conditions did not differ at follow-up in any cognitive or affective variables. Further, tests of simple and multiple mediation models suggest that the intervention's effect on snack selection was not mediated by these constructs (*p*s > .10; Preacher & Hayes, 2008).

Discussion

The experimental manipulation of affective associations with fruits significantly influenced participants' snack choices following the priming task. In particular, participants who were primed with positive affective associations with fruits were significantly more likely to select a fruit over a granola bar alternative compared to participants in either the neutral or the negative affective association conditions. Given that baseline cognitive beliefs about fruits and affective associations with fruits were equivalent across the three conditions, the behavioral outcome data provides convincing evidence for a causal relation between lab-created (or altered) affective associations and behavioral choice. Further, the priming paradigm manipulated affective associations with fruits, a food item for which most people have strong preexisting affective associations. Consistent with the distinction often made between the processes of attitude formation and attitude change, the current study changed preexisting attitudes, which lends support to the targeting of affective associations in health behavior interventions.

Implications

These findings have key implications for our understanding of how people regulate and make decisions about healthrelated behaviors. Most importantly, the finding that priming affective associations shifts actual choice behavior highlights the central role of affective associations as an influence on engagement in health-related behavior. Although the importance of considering affective influences on behavior has been highlighted by multiple commentators on health decision making (Johnson-Askew et al., 2009; Kiviniemi & Bevins, 2007; Manstead & Parker, 1995; Peters et al., 2006; van der Pligt et al., 1997) and there is observational empirical evidence in specific behavioral domains (the relation between exercise-related affect and longevity of exercise performance, e.g., Dunton & Vaughan, 2008; the degree of affective arousal with smoking and addiction, e.g., Payne et al., 2007), the central and causal role of affect is, we believe, underappreciated.

The behavioral affective associations model (Kiviniemi & Bevins, 2007, 2008; Kiviniemi & Duangdao, 2009; Kiviniemi et al., 2007) does incorporate affective associations with behavioral practices as an influence on decision making outcomes. As described in the introduction, the model posits that affective associations are a key proximal driver of behavioral outcomes. The experimental manipulation of affective associations and subsequent effects of that manipulation on behavioral outcomes reported here is strong evidence in support of the model (Shadish et al., 2002). In addition, the model posits that the influence of cognitively-based outcomes on decision making is indirect and mediated through affective associations. Although the mediational prediction is not directly supported in the study reported here, it is notable that the experimental manipulation did not alter expected utility beliefs about fruits, which argues against a hypothetically plausible alterative to the behavioral affective associations model in which cognitive beliefs mediate the relation of affective associations and behavior.

In addition to the behavioral affective associations model, the priming results presented here are consistent with models for the role of affect in decision making. Specifically, the somatic marker hypothesis posits that affect serves as a shorthand cue to the degree of risk (i.e., possible expected loss or possible expected reward) associated with a behavioral choice (Bechara et al., 1994, 1997; Damasio, 1994). Related work has shown that there are distinctive affective neurological signals associated with decisions that are characterized by reward versus punishment (Knutson et al., 2001; Paulus et al., 2003). The idea that positive affective associations increase and negative affective associations decrease the likelihood of making a particular behavioral choice is consistent with this affective signaling notion.

The second key implication of this work concerns the causal relation between affective associations and behavior. The behavioral affective associations model posits a direct, causal relation. Our previous empirical work on the model (Kiviniemi & Duangdao, 2009; Kiviniemi et al., 2007), as well as work by other lab groups (Lawton et al., 2007, 2009) is consistent with this prediction of the model but, being observational data, cannot directly demonstrate causality. Thus, the experimental evidence presented here extends and supports the existing body of empirical evidence in support of a direct, causal role for affective associations as an influence on health behaviors. Because this relation has been demonstrated in observational studies covering a range of health-related behaviors, the causal evidence has potentially wide ranging implications for our understanding of health decision making.

The third key implication concerns interventions to change health behaviors. Many current intervention strategies are based on changing cognitive constructs related to a health behavior (e.g., increasing self-efficacy, changing perceptions of benefits, reducing real or perceived barriers) and, indeed, many guides to developing interventions specifically recommend using one or more of the current, cognitively-based models as a guiding framework for intervention development (Glanz et al., 2008; National Cancer Institute, 2001). The findings reported here demonstrate that affective associations can be altered, at least in the short term. This finding is an important first step towards development of interventions targeting affective associations—knowing that a factor can be changed in the laboratory is a first step in the development chain for intervention approaches (Flay, 1986; Greenwald & Cullen, 1985).

Given the widespread interpretation of implicitly held attitudes as reflective of affectively-based or impulsive decision-making, as well as the tendency for implicit measures to be more highly correlated with affective than cognitive self-report measures (Friese et al., 2008), it may be particularly worthwhile to examine whether changes in implicitly held attitudes mediate the intervention's effects on behavior. Gawronski and Bodenhausen (2006) make similar distinctions in their associative-propositional model, in which they suggest two qualitatively different mental processes: associative processes that underlie implicit attitudes, and propositional processes that underlie explicit attitudes. They argue that associative processes can be influenced directly, thereby leading to changes in implicit attitudes independent of any change in explicit attitudes (Gawronski & Bodenhausen, 2006). However, we do not have a measure of implicit associations, thus leaving an exploration of the implicit-explicit distinction for affective associations for future work.

Limitations

There are, of course, limitations to the study which should be acknowledged and considered in interpretation of our results. First, the laboratory setting and the priming task are both very artificial situations compared to the real-world, complex, environments in which individuals make their day to day dietary decisions. The controlled, laboratory environment is a desirable feature form the viewpoint of internal validity and control of extraneous influences on behavior (Stone et al., 1994), and therefore has positive attributes given the purpose of the study. However, it does leave open the question of whether manipulation of affective associations would have the same effect in the more complex, real world environments in which dietary choices are made, where choices are likely impacted by a range of factors such as availability of foods when shopping, preferences of friends and family members, and relative costs of foods.

Second, a distinction from the real world is also present in the nature of the food choice task. The dependent measure created a highly constrained choice among a small range of snack options. In most dietary choice situations, individuals are likely faced with more than the simple fruit versus granola bar choice they had in the laboratory setting. Here too, the constrained choice has desirable features for precisely examining effects of the experimental manipulation on behavior (e.g., making the choices equivalent in terms of calories and transportability), but it does raise the important question of what magnitude of an effect the manipulation would have in richer dietary choice setting.

Third, it should be acknowledged that the behavioral measure is assessing food selection rather than food consumption. Although it seems reasonable to infer that participants selected a food with the intention of consuming it (especially given that a subset of participants elected not to select either food item), we did not directly assess food consumption. It is also important to acknowledge that the measure is of immediate (2–20 min, depending on the blocked timing of snack selection variable) effects of the manipulation. Questions concerning manipulation longevity are important, especially for considering the possibility of interventions targeting affect associations, but are not addressed by the study reported here.

We should also note that our post-manipulation measure of explicitly-held affective associations did not differ by condition, despite a change in behavior. This is consistent with results of prior evaluative conditioning studies, in which self-reported attitudes and beliefs about a range of target objects, from food items to racial minority groups, did not change following priming paradigms, but implicitly measured attitudes and beliefs, as well as actual behavior, did change (Conner et al., 2007; Friese et al., 2008; Hofmann et al., 2008; Hollands et al., 2011; Richetin et al., 2007; Verhulst et al., 2006). Finally, we should note that for logistical reasons, the experimenter was not blind to experimental condition, which may bias interpretation of the effect sizes reported here (Schulz et al., 1995). However, randomly assigning all participants to their condition *after* recruitment and the completion of the phone interview, as well as computerized administration of measures and the use of a standardized snack presentation script with every participant attenuated the impact of this limitation.

Conclusion

Given the increasing focus on affective processing in health decision making, the current study's findings substantiate previous cross-sectional support for the role of affective associations as a proximal influence on health behaviors. Such causal evidence is useful for both theory refinement and intervention development. By demonstrating that affective associations can be manipulated, and that such changes influence subsequent behavior, this study provides preliminary evidence for the development of realworld interventions that try to address health behavior problems by changing affective associations.

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Table 1

Baseline characteristics across conditions

Condition	% female	Age *M* (*SD*)	BMI *M* (*SD*)	Race/ethnicity (#)				
				Af. Amer.	Asian	White	Lat. Amer.	Other
Neutral (n = 58)	63.8	23.59 (7.72)	23.33 (3.34)	6	25	25	1	2
Negative (n = 44)	65.9	23.98 (9.20)	23.52 (3.32)	5	18	19	0	2
Positive (n = 59)	49.2	23.24 (4.74)	22.96 (3.63)	5	25	23	4	2
Overall (n = 161)	59.0	23.57 (7.23)	23.24 (3.43)	16	68	67	5	6

Table 2

Baseline affective associations and cognitive beliefs (5-pt scales)

Condition	Affective associations		Cognitive beliefs	
	Positive *M* (*SD*)	Negative *M* (*SD*)	Benefits *M* (*SD*)	Barriers *M* (*SD*)
Neutral	3.61 (0.94)	1.22 (0.39)	3.86 (0.74)	1.87 (0.66)
Negative	3.96 (0.85)	1.16 (0.36)	4.03 (0.62)	1.90 (0.61)
Positive	3.93 (0.87)	1.18 (0.30)	3.96 (0.64)	1.81 (0.59)
Overall	3.83 (0.90)	1.18 (0.35)	3.94 (0.67)	1.86 (0.62)

Table 3

Post-intervention snack choice, affective associations, and cognitive beliefs (adjusted for baseline scores and covariates)

Condition	Selected fruit % (*SD*)	Affective associations		Cognitive variables	
		Positive *M* (*SD*)	Negative *M* (*SD*)	Benefits *M* (*SD*)	Barriers *M* (*SD*)
Neutral	60.49 (0.094)	3.86 (0.64)	1.36 (0.56)	3.66 (0.51)	1.78 (0.40)
Negative	55.04 (0.099)	3.83 (0.64)	1.32 (0.55)	3.63 (0.51)	1.78 (0.40)
Positive	77.59 (0.065)	3.88 (0.64)	1.36 (0.55)	3.66 (0.51)	1.80 (0.40)