TITLE PAGE

Pairing images of unhealthy and healthy foods with images of negative and positive health consequences: impact on attitudes and food choice

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ABSTRACT

Objective: To examine the impact of presenting images of foods paired with images of positive and negative health consequences of their consumption, on food choice and attitudes.

Method: Participants (N=711) were randomly allocated in a 2 x 3 factorial design (food type x affective valence) to one of six conditioning procedures that paired images of either energy-dense snack foods or fruit, with (a) images of negative health outcomes, (b) images of positive health outcomes, or (c) a no image control. The primary outcome was food choice assessed post-intervention with a behavioral choice task. Secondary outcomes were implicit attitudes (assessed pre- and post-intervention) and explicit attitudes (assessed post-intervention).

Results: Presenting images of negative health outcomes led to more healthy food choices relative to control and positive image conditions, irrespective of whether they were paired with images of energy-dense snack foods or fruit. This relationship was partially mediated by changes in implicit and explicit attitudes. Images of positive health outcomes did not alter food choices.

Conclusions: This study replicates and extends previous research showing that presenting images of negative health consequences increases healthy food choices. Because effects were elicited by manipulating affective valence irrespective of paired food type, these results appear more consistent with an explanation based on priming than on evaluative conditioning.

Keywords: images; food; conditioning; priming; behavior

INTRODUCTION

Visual images of the potential adverse health consequences of behavior are widely used in

health communication to motivate behavior change, with the most prominent example being the widespread global implementation of graphic picture warnings on tobacco packaging. Such interventions could in theory be equally applied to change behaviors other than smoking that contribute to the premature mortality of populations. This potential is reflected in media and public health practitioner attention on the possibility of introducing graphic picture warnings for the packaging of alcohol and unhealthy food products (Parry, 2014). Such interventions can be contextualized within growing policy and research interest in the potential for environmental stimuli to cue behavior change at the population level (Marteau, Hollands, & Fletcher, 2012; Hollands et al., 2013).

The existing evidence base for the effects of aversive imagery on health behavior and underlying mechanisms is most plentiful in relation to graphic picture warnings and smoking. The current study replicates and extends one of the few experimental studies focused on food products (Hollands, Prestwich, & Marteau, 2011). This previous research showed that presenting associations of energy-dense snack foods with aversive images of potential negative health consequences led to healthier food choices, mediated by changes in implicit attitudes.

Implicit attitudes are postulated to reflect the affective valence attached to objects, such as food products, as a result of automatic associative networks in memory (Gawronski & Bodenhausen, 2006). Unlike explicit attitudes, traditionally assessed by self-report, implicit attitudes are assessed by indirect methods such as reaction-time based tasks. There is now substantial evidence that implicit attitudes predict health behavior including purchasing and consumption of food (Prestwich, Hurling, & Baker, 2011). To our knowledge, however, there remains little direct experimental evidence that eliciting affective associations can alter health-related behavior via changing implicit attitudes (Sheeran, Gollwitzer, & Bargh, 2013). For example, recent studies report effects on behavior but do not assess implicit attitudes (Walsh & Kiviniemi, 2014), or have failed to find effects on behavior (Lebens et al., 2011). This highlights a clear need to replicate the findings of the aforementioned study. Direct replication of research findings has

been strongly advocated by many commentators, reflecting multiple failures to replicate prominent findings across the behavioral and medical sciences (Cesario, 2014). By ensuring that the original experimental manipulation remains nested within the design, but also significantly extending its scope, the current study fulfils this requirement whilst testing additional hypotheses and addressing some key limitations.

First, the original experiment included two experimental groups only: energy-dense snack foods images paired with i) images of negative health consequences, and ii) a no image control. The current study includes six groups, adding a third group pairing snack food images with images of positive health consequences, plus a further three groups mirroring these manipulations but applied instead to a healthy category of food, namely fruit. This allows us to examine whether pairing positive images of good health and wellbeing is as potent as aversive images of ill-health, and also whether the intervention is similarly effective when applied to healthy food products (fruit) and unhealthy food products (energy-dense snacks). These questions have important implications for intervention development. For example, if we wish to reduce the intake of unhealthy foods, eliciting positive associations with healthy foods, via imagery of good health and wellbeing, potentially provides an alternative strategy to one of forming negative associations with unhealthy foods. We are aware of only one study in which the unique effects of positive and negative image pairings were disentangled, finding that pairing positive images with fruit increased its selection (Walsh & Kiviniemi, 2014). Consonant with this, we hypothesize that presenting associations of fruit with positive health-related images will increase subsequent choices of fruit. Second, the sample has been broadened demographically – the original experiment had used a university community sample - to enable examination of moderation of the intervention effect by key participant characteristics including socio-economic status.

In summary, the current study tests the hypothesis that pairing images of i) negative or ii) positive health consequences respectively reduces or increases behavioral preferences for that food with effects being mediated by changes in implicit attitudes.

METHOD

Sample. Participants were recruited by a national research agency, purposefully targeting a general population sample living in England to include a wide range of location, age, gender and social grades. A power calculation was conducted based on data from the original experiment (Hollands et al., 2011), estimating that at least 86 participants per study group were required.

Intervention. The intervention was delivered online using Inquisit. Participants viewed a slideshow that featured 100 trials (five food images each shown 20 times in a random order). Each trial lasted 2500ms in total and comprised presentation of a food image for 1000ms, followed by an affective health-related image for 1000ms - with the nature of these images depending on the group the participant was assigned to. Finally, a blank screen (the intertrial interval) was presented for 500ms. Participants were randomly allocated to one of six study groups in a 2 x 3 factorial design manipulating food type (snacks; fruit) and affective valence (negative; control; positive). The nature of the six groups was therefore as follows: Images of either i) energy-dense snack foods or ii) fruit, paired with either: (a) negative health-related images; (b) positive health-related images; or (c) blank screens (a no image control). The five snack images used were of chocolate, biscuits, cake, crisps, and a range of snacks and the five fruit images were of an apple, an orange, a banana, a bunch of grapes and a range of fruit. The five negative health-related images consisted of two images of obesity (in men and women), two images of arterial disease and one of heart surgery. The five positive health-related images portrayed individuals being physically active in various ways (e.g. jogging, cycling) whilst simultaneously showing positive facial expressions and/or body language (*see Supplementary Materials for further details of intervention development*).

Outcomes. All measures were administered online using Inquisit and Qualtrics survey software. The primary outcome was a behavioral choice task adapted from the original experiment, with participants asked to make two separate choices between fruit and snack products. The first

choice was made from an image of an array of fruits (apple, orange, banana, grapes) and snacks (cake bar, chocolate bar, crisps, biscuits), with participants asked to choose one item (or no item) that they most want to consume at present. The range of food items corresponded to those used in the conditioning procedure and in the measure of implicit attitudes. For the second choice, participants were offered a £4 voucher (approx. $6, €5) for either fruit or confectionery to spend at a UK food store. This was presented ostensibly as the compensation that they would receive for participating in the study. For each of the two choices, participants could respond by choosing a fruit (scored as +1), a snack (scored as -1), or neither, representing no preference (scored as 0). Combined responses were summed on a 5-point scale of preference for fruit or snacks, ranging from -2 (making two choices of snacks) to +2 (making two choices of fruit) (measure $\alpha = .62$).

Secondary outcomes were implicit and explicit attitudes towards fruit and snacks. Age, gender, ethnicity, educational attainment, height and weight (for BMI) were also measured. *See Supplementary Materials for further details of measures.*

Procedure. After providing informed consent, the procedure for participants was as follows: a) complete demographic measures plus baseline measure of implicit attitudes; (b) complete distraction word-search task using unrelated (animal name) words for 5 minutes; (c) complete intervention procedure as described above; (d) complete post-intervention measure of implicit attitudes; (e) complete explicit attitude measure; (f) behavioral choice task; (g) debriefing in which participants were asked what they thought the aim of the study was and if any of the tasks may have affected their responses or thoughts.

RESULTS

Participants ($N = 711$) had a mean age of 46.4 years (range of 18-80 years) and 50.5% were female. Mean BMI was 26.9, consistent with UK population estimates (Finucane et al, 2011). There were no significant differences in characteristics between experimental groups (all p-values >.05). *See Table 1 and Supplementary Materials for further participant information.*

Intervention effects on primary and secondary outcomes. A factorial ANOVA (food (snacks; fruit) x affective valence (negative; control; positive)), indicated a significant main effect of affective valence on the behavioral choice: $F(2,705)=10.20$, $p<.001$ (see Table 2). Post-hoc Bonferroni tests with 1000 bootstrap samples conducted in SPSS revealed that participants shown negative images chose fruit (as opposed to snacks) significantly more often than did those shown control images ($M_{diff}=.56$, $p=.001$, $d=0.37$) or positive images ($M_{diff}=.58$, $p=.001$, $d=0.39$), with no difference between the latter two groups ($M_{diff}=.02$, $p=.879$). There was no main effect of food type ($F(1,705)=.65$, $p=.419$), and there was no food x affective valence interaction effect ($F(2,705)=.16$, $p=.853$).

Regarding secondary outcomes, factorial ANCOVA and post-hoc Bonferroni tests revealed a marginally non-significant main effect of affective valence on post-intervention implicit attitudes controlling for baseline, $F(2,704)=2.90$, $p=.056$. Participants shown negative images and participants shown positive images both displayed a similarly increased implicit preference towards fruit relative to control participants (respectively, $M_{diff}=.09$, $p=.040$, $d=.20$; $M_{diff}=.09$, $p=.034$, $d=.19$). For explicit attitudes (ANOVA: $F(2,705)=9.13$, $p<.001$), participants shown negative images displayed an increased preference towards fruit relative to control ($M_{diff}=2.27$, $p=.001$, $d=.36$) or positive images ($M_{diff}=2.39$, $p=.001$, $d=.36$), with no difference between the latter two groups ($M_{diff}=-.13$, $p=.851$). For both secondary outcomes, there were no main effects of food type and no interaction effects (p-values>.258).

To examine whether changes in attitudes mediated the observed effects of negative images on the primary outcome, multiple mediation analysis was conducted using a bias-corrected bootstrap (10,000 samples) (INDIRECT; Preacher & Hayes, 2008). This showed that the effect of negative images versus control on behavioral choice was partially mediated by both post-intervention implicit attitudes: indirect effect *B* coefficient = .05, 95% CI = .01, .11, $p<.05$, and explicit attitudes: indirect effect *B* coefficient = .23, 95% CI = .12, .35, $p<.05$. The effect of negative versus positive images on behavioral choice was partially mediated by explicit attitudes:

indirect effect *B* coefficient = .12, 95% CI = .07, .18, $p < .05$, but not by implicit attitudes (*B*=.00, 95% CI = -.01, .02, $p > .05$).

Additional analysis. To assess potential moderation of intervention effects on food choice, socio-economic status (indexed by attaining a university degree or above) and BMI (BMI of 25 or above, indicating overweight) plus interactions with the intervention (negative versus control images) were entered into a general linear model. There was no evidence of moderation by socio-economic status, but there was a marginally non-significant interaction of the intervention with BMI, p=.057, suggesting that the intervention may be more effective in participants who were overweight or obese. When shown negative versus control images, overweight participants showed a greater increase in choices of fruit than did normal weight participants (respectively, M_{diff}=.86; M_{diff}=.27). *See Supplementary Materials for additional analyses*.

DISCUSSION

As with the original experiment (Hollands et al., 2011), pairing food images with aversive images of negative health consequences increased healthy choices and implicit attitudes. Crucially, however, and contrary to our hypothesis, this was a result of a main effect of affective valence and irrespective of whether negative images were paired with snacks or with fruit. The interactive effect of negative images that would have been consistent with our hypothesis – whereby pairing negative images with fruit would have *decreased* fruit selection - was not observed. This suggests that our interpretation of the findings of the original experiment as reflecting an evaluative conditioning process, in which pairing a target attitude object (e.g. foods) with stimuli possessing positive or negative affective valence (e.g. affective images) elicits like or dislike of that target object, is not corroborated. The results instead appear more consistent with a priming explanation, in which exposure to images of ill-health activates healthy eating goals or elicits existing positive representations of healthy products, and thus shapes food choice and attitudinal responses (Stroebe,

van Koningsbruggen, Papies, & Aarts, 2013). This was an unexpected finding and merits further investigation to understand more precisely how negative images may exert effects. For example, the current design does not allow investigation of whether negative images elicit responses entirely on their own, or whether the accompanying images of food provide a context that enables representations relating to healthy eating to be more readily elicited.

The failure of positive images to engender effects on the behavioral choice in the current study may be explained by their content being relatively deficient in unmeasured domains that may contribute to efficacy, such as image vividness. However, the positive images were rated in piloting as equivalently positive in affective valence as the negative images were negative, and were evidently not benign, as they were potent enough to change implicit attitudes. These results are consonant with a large and diverse body of research in psychology and public health showing that negatively valenced affective stimuli are more effective than positive stimuli for eliciting cognitive and behavioral responses (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Sims et al., in press).

Our findings re-iterate the importance of examining implicit cognitions for understanding the causal pathways underlying interventions to change behavior. Changes in implicit attitudes partially mediated behavioral choice responses to negative images, although it is notable that whilst positive images increased implicit attitudinal preference for fruit, food choices did not change. Unlike the original experiment, explicit attitudes also partially mediated effects on food choice. This may be a result of the online nature of the current experiment. As opposed to set appointment times in the original laboratory setting, in an online context participants were able to take as much time as they wished to reflect on, and respond to, the intervention.

Finally, given inequalities in health, it is important to guard against intervention generated inequalities (Lorenc, Petticrew, Welch, & Tugwell, 2013). Whilst we found no evidence of moderation of intervention effects by SES, we did not power the study to detect such effects, and the sample was relatively highly educated (with over 39% holding a university degree). Stronger

evidence requires studies powered to assess differential intervention effects in groups that vary in SES.

An important methodological strength of this study was that it used a large sample of the general population that included a wide range of socio-demographic characteristics. However, in order to collect data from such a sample, the study was conducted online, which imposes some limitations. Not only are choices made online less vivid, but the component of the primary outcome that involved selecting from an array of foods no longer involved selection of real foods. It was retained, however, due to our intention to closely replicate the original experiment, including its primary outcome. The voucher choice component did, however, remain a behavioral choice with real-world implications, as it was presented ostensibly as compensation for participation (with this deceit only revealed at the conclusion of participation). Analyzing this more stringent outcome separately did not alter the results. An important related limitation is that we have not, as yet, provided direct evidence that the intervention changes food selection or consumption behavior outside the immediate confines of an experimental setting. Tests using more robust behavioral outcomes are a priority for future work.

This research could be further enriched by giving additional attention to potential interactions with cognitive resources including executive function, given potential interactive effects of implicit preferences and executive function in explaining subsequent dietary behavior (Friese, Hofmann, & Wiers, 2011). Laboratory-based experimental methods are increasingly being used to understand the effects and underlying mechanisms of scalable public health interventions. Such approaches can potentially provide insights relevant to health communication interventions where aversive visual images are used to alter the consumption of products, including foods, that impact on human health.

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SUPPLEMENTARY MATERIALS

APPENDIX TO METHOD SECTION

Further details on intervention development

The five snack images were those that had previously been used in the original experiment (Hollands, Prestwich, & Marteau, 2011), as were the five negative health-related images. The piloting process for selecting the positive health-related images was as follows.

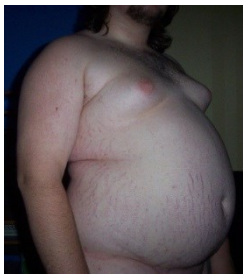
In a first stage, a broader set of potential images portraying positive health consequences - and as such conceptually equivalent to the images of negative health consequences – was rated by volunteers (N=14) on a scale of 1-10 for how positive they were and how well they communicated good health and wellbeing. Cumulative scores were collated, and the five images that were rated most positively were chosen for use in the experiment. In a second stage, because the negative images and positive images had been chosen in separate piloting processes and as a result of different rating scales, we conducted a further stage of piloting to ascertain whether the affective images selected for the experiment were equivalent in their degree of negative and positive affective valence when rated on the same scales. Volunteers (N=59; ages 16-72, mean age = 40.0, 58% female) rated each of the negative and positive images on three nine-point scales with values ranging from 1-9: i) bad health and illness-good health and wellbeing; ii) negative-positive; iii) unpleasant-pleasant. Negative images were rated as strongly negatively affective, with respective means (sd) on the three scales of 1.63 (0.70), 1.77 (0.81), and 1.88 (0.94). Positive images were rated as strongly positively affective, with respective means (sd) on the three scales of 8.49 (0.60), 8.48 (0.57), and 8.33 (0.74). The negative and positive ratings were distanced similarly from the scale midpoints (with negative images slightly less affective), suggesting that the affective images were highly equivalent in degree of valence. The five fruit images were chosen following piloting

as clear images of the various fruit from a wider selection of images. The content of the images used in the experiment is described in the main text. Examples of each type are shown in Figure 1 below.

Figure 1 – example conditioning procedure images: (a) snacks, (b) negative, (c) fruit, (d) positive

a)

b)



c)

d)

Further details on secondary outcomes and additional measures

Implicit attitudes. The IAT (Implicit Association Test: Greenwald, McGhee, & Schwartz, 1998) was used to assess implicit attitudes towards fruit and snacks. The IAT requires participants to sort words relating to one of four categories to one of two response keys. The four categories comprised two targets, namely fruits (exemplars: fruits, apple, banana, grapes, orange) and snacks (exemplars: chocolate, biscuits, cake, snacks, crisps), and two attributes, namely pleasant (exemplars: rainbow, happy, smile, joy, peace) and unpleasant (exemplars: pain, death, poison, agony, sickness). A positive score indicated a positive attitude towards fruit (and correspondingly a

negative attitude towards snacks), whilst a negative score indicated a negative attitude towards fruit (and correspondingly a positive attitude towards snacks).

Explicit attitudes. Explicit attitudes were assessed by participants rating fruit and energy-dense snacks on five 7-point semantic differential scales (*not at all healthy– healthy; bad–not at all bad; not at all enjoyable– enjoyable; not at all unpleasant– unpleasant; good–not at all good*). Composite scales were produced (α= .88 (fruit) and .73 (snacks), respectively), and scores for snacks were subtracted from those for fruits to give an overall explicit attitude score (Perugini, 2005). A positive score indicated a positive attitude towards fruit.

Educational attainment. Educational attainment was used as an index of socio-economic status and was assessed using a measure of highest level of educational qualification, with categorizations consistent with those of the 2011 United Kingdom census. As a categorical variable, responses were categorised into one of two groups: those with at least a university degree or equivalent professional qualification; and, those with a lower level of education (ranging from no qualifications to high school qualifications and equivalents).

Attention checks. Given concerns regarding the attention participants may pay in unsupervised settings, two attention checks were included:

i) Attention check 1: Two items were hidden in pre-randomization questionnaire items to check attention. Participants were asked if "You have been to every country in the world" and "You sleep for more than an hour per night". Those who answered the former affirmatively or the latter negatively were not assigned to an intervention and were instead automatically denied entry into the study.

ii) Attention check 2: For participants who did receive the intervention, we included a stimulus response attention check to ensure that participants were concentrated on the image slideshow that comprised the intervention. They were tasked with pressing a specified key in response to the brief random appearance of an unrelated stimulus (a white circle) at ten intertrial points. Those who did not press a key at any point during

the slideshow were deemed not to have attended to the intervention as they may have been absent from their computer. They were therefore excluded from the analysis. In the original 2011 experiment, the white circle appeared at only five intertrial points, but this was made more frequent here (ten intertrial points) as an attempt to keep participants engaged with the intervention, given they were completing it online in an unsupervised (as opposed to a laboratory) setting.

APPENDIX TO RESULTS SECTION

Further participant information

As stated in the main text, data from 711 participants were included in the analysis. 751 participants initially consented to participate and were randomized to receive the intervention, of whom 736 (98%) completed the study. Data from a further 25 participants were removed because they either attempted to enter the study more than once resulting in assignment to multiple groups and duplicate outcome data (15 participants), or failed the stimulus response attention check included in the intervention procedure because they did not produce any keyboard responses (10 participants).

Additional analysis

Sensitivity analysis. We conducted a series of sensitivity analyses relating to data treatment decisions where other decisions were possible. Further details are provided below, although in summary it was found that the results were unchanged when: i) only the voucher choice was used as the behavioral choice measure instead of the pre-specified composite primary outcome measure; ii) participants excluded due to lack of engagement with the intervention (as assessed by the stimulus

response task) were re-introduced to the analysis; and iii) participants who were aware of the aim or intended effects of the intervention were excluded.

i) *Use of only the voucher choice as the behavioral choice measure*. Unlike the image selection measure, this was a behavioral choice with real-world implications, as it was presented ostensibly as reward for participation in the experiment (with this deceit only revealed at the conclusion of participation). Analysing this outcome individually did not affect observed intervention effects on primary or secondary outcomes, or mediation effects.

ii) *Re-inclusion of participants who did not attend to the intervention*. Data from the 10 participants who provided no keyboard input during the stimulus response attention check task during the intervention procedure were re-introduced. The inclusion of these participants' data did not affect observed intervention effects on primary or secondary outcomes, or mediation effects.

iii) *Exclusion of participants aware of the aim or intended effects of the intervention.* Given responses in the funnel debriefing procedure, 51 participants (7%) were classed as being aware of the aim of the study, assessed as whether they explicitly recognized an attempt to change associations or behavior in the hypothesized direction or to educate them about food and health or behavior. A smaller group of 21 participants (3%) were classed as being aware of the intended effects of the conditioning intervention specifically. This was assessed in relation to whether participants explicitly recognized a potential link between exposure to visual images of food or health and effects on their or others' eating behavior, motivation or reflection on that behavior (either concerning the primary outcome in the study or behavior in general). Because excluding these participants did not affect intervention effects on the behavioral choice, demand effects resulting from awareness of the purpose of the intervention are not a plausible explanation for the results. However, such a global measure of subjective awareness may not have been

sufficiently sensitive to detect lower-level contingency awareness, which may be a key moderator necessary for evaluative conditioning effects to be elicited (Pleyers, Corneille, Luminet, & Yzerbyt, 2007; Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010).

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