Front-of-pack health imagery on both 'healthy' and 'unhealthy' foods leads people to misremember seeing health claims: Two memory experiments

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Front-of-pack health imagery can shape people's inferences about food products' health benefits, even leading people to falsely remember reading health claims they never saw. However, research has typically examined these effects in situations where participants have little contextual information to guide their inferences about a product. The present research aimed to replicate the finding that front-of-pack health imagery leads participants to falsely remember reading health claims. It also extends that finding, by exploring whether this effect is moderated by the presence of contextual information signaling the product's actual 'healthiness'. In two pre-registered experiments, participants saw images of fictitious food products accompanied by written nutrition claims. Some of the products contained a health-related image whereas others did not. The supposed 'healthiness' of each product was manipulated by altering the color of the products' multiple traffic light (MTL) label (Experiment 1), or with an explicit healthiness statement (Experiment 2). Participants then attempted to remember the written claims that had appeared on each product's packaging. Health-related images increased participants' tendency to falsely remember reading health claims. But this was true regardless of whether or not participants saw contextual cues about the products' healthiness, either indirectly (Experiment 1) or directly (Experiment 2). These findings suggest that the presence of health imagery on a food product's package can lead consumers to infer health benefits, even when other, more direct cues indicate that the product is unhealthy. This research informs debates on safeguarding consumers from potentially misleading health claims, through the regulation of imagery in food marketing.

Keywords: front-of-pack labeling; food; imagery; health claims; memory

1. Introduction

In a world where 39% of adults are overweight and a further 13% are obese (WHO, 2021), food manufacturers are increasingly eager to emphasize the health credentials of their products. Indeed, in the USA and around the world, roughly one in ten pre-packaged food and drink products feature health claims that suggest specific benefits of consuming the product (Colby et al., 2010; Hieke et al., 2016; Sobierajski et al., 2006). Whereas legal regulations governing the use of health claims on product packaging have existed for many years, it is notable that in many countries these regulatory frameworks apply not only to written claims, but also to images. For instance, the European Commission identify a claim as "any message or representation…including pictorial, graphic or symbolic representation… which states, suggests or implies that a food has particular characteristics" (European Commission, 2006, Article 2.2.1), whereas the US Food and Drug Administration also include the use of symbols in their definition of a health claim (Food and Drugs Administration, 2020). Regulators therefore assume that images appearing on product packages – much like written claims – can convey information about the supposed health properties of the product itself (Nathan et al., 2012).

This assumption is justified. Previous research studies have highlighted, for example, that adding a 'natural' or 'medical' image to a food product's package led participants to infer that the product was healthier (Saba et al., 2010), and that even ambiguous product images – such as a person running – can have health connotations (Carrillo et al., 2014). More recently, Delivett et al. (2020) reported that the addition of a health-related image on a dietary supplement's packaging increased the perceived benefits associated with consuming that product, and in some cases decreased the perceived risks. Similarly, front-of-pack images of foods in their raw, unprocessed form can enhance perceptions of healthiness and naturalness (Szocs & Lefebvre, 2016), particularly among health-conscious individuals

(Machiels & Karnal, 2016). Unlike written claims however, images can evoke a variety of different interpretations (Smith et al., 2015), and can suggest unintended meanings (Gil-Pérez et al., 2019).

In most studies of how imagery shapes people's health inferences, participants have been directly asked to report their beliefs and inferences. Two crucial limitations of this approach are that (1) people may be unaware of the inferences they have formed, and (2) people may only form those inferences because they have been directly asked. These limitations can be somewhat circumvented by using indirect measures of inferences, such as by examining what people *remember* after being exposed to a novel food product. The reasoning behind such an approach is that, according to the source monitoring framework, when people make inferences they tend to generate thoughts and mental imagery that are consistent with those inferences. These thoughts and images, in turn, are easy to misremember as having originated from direct experience—such as from having seen or having been told the inferred information—rather than having only thought about it (Johnson et al., 1993). In this way, if an image of a bone appeared on a food product, people might infer that the product helps build strong bones, and as a result might sometimes later misremember that the product's package actually featured a written health claim to that effect.

In short, what people (mis)remember can provide a valuable window to what they have inferred. Research using this indirect measurement approach confirms that health imagery can not only enhance the perceived general healthiness of a product, but can lead people to infer specific health benefits (Klepacz et al., 2016). In Klepacz et al.'s studies, participants saw fictional food products that either did or did not feature a health-related image on their packaging, such as a symbol of a heart, and they read additional information about those products. Participants subsequently completed a memory test for the information

given about each product. Notably, when a product's packaging had included a health-related image, participants were more likely to falsely remember having read specific health claims about the product. In fact, people made these types of memory errors even when they had been explicitly told to ignore these images. These findings suggest that when people see health-related imagery on a product's packaging, they tend to spontaneously infer that (and how) consuming this product will be beneficial to their health.

This is a timely concern, especially in light of evidence highlighting that when people perceive certain foods to be healthier, they tend to consume those foods in greater quantities. For instance, female undergraduates in one study consumed 35% more cookies if they were labelled as a "healthy snack", rather than as a "gourmet cookie" (Provencher et al., 2009). In other studies, restrained eaters consumed significantly more cookies when they were attributed to a healthful brand (Cavanagh & Forestell, 2013), and prospective dieters consumed significantly more candies when they were labelled as "fruit chews" (Irmak et al., 2011). With these kinds of findings in mind, it is clearly important to understand the inferences people make about products' healthiness and health benefits, and the role that health imagery can play in the formation of these inferences.

In most studies that explore how packaging imagery affects people's judgments of products, participants have studied fictional product packages that provide minimal contextual information about the product. In particular, participants typically receive no additional information that would provide a frame of reference when judging the plausibility of the product having health benefits. For example, the stimuli in Saba et al.'s (2010) research consisted of simplistic black and white line drawings of food products (e.g., bread), appearing either with or without a health-related image. Likewise, the fictional product packages used by Klepacz et al. (2016) featured details such as brand names, a colorful design, the product's weight, and sometimes a picture of the product itself, yet no explicit indicators of healthiness,

except when a health-related image was added. Such materials do not mirror the fact that in most Western countries, for example, regulations require nutritional information to be displayed on a food product's packaging (Food and Drug Administration, 2020; European Union, 2011). Whereas conventional numeric-based labelling systems – such as the Nutrition Facts table – are commonly cited as a source of confusion among consumers (Cowburn & Stockley, 2005), other labelling strategies attempt to accommodate the fact that people often make purchasing decisions under time constraints with depleted cognitive resources (Chalamon & Nabec, 2016). Indeed, several countries communicate information about healthiness using visual devices such as the Green Keyhole in Sweden (Swedish Food Agency, 2021), Multiple Traffic Light (MTL) labels in the UK (United Kingdom Department of Health, 2016), and the Nutri-Score in large parts of Europe (Colruyt Group, n.d.). The MTL label for instance, assigns each nutrient group (fat, saturated fat, sugar, salt) a color code based on whether that nutrient is present in high (red), medium (amber), or low (green) amounts. These labels utilise familiar heuristics, such as the colour green signifying 'health/go', and red signalling 'danger/stop' (Tham et al., 2020), to provide consumers with an easy-to-process snapshot of a product's nutritional quality. Even without close scrutiny, then, a predominantly green label therefore generally indicates a healthy food that is suitable for regular consumption, whereas a mainly red label represents a food that should be eaten only in moderation.

There is good reason to predict that these more objective indicators of a product's 'healthiness', such as an MTL, would affect people's likelihood of drawing inferences from front-of-pack health imagery. First, it has long been suggested that written claims on a product's packaging and the product's nutritional information have independent effects on people's beliefs (Ford et al., 1996). In one study for instance, participants rated both 'healthy' and 'less healthy' drinks as significantly healthier when their packages carried a disease

reduction claim than when they did not (Franco-Arellano et al., 2020a). However, for those participants who chose to also consult the products' Nutritional Facts table – and thus directly assess the products' nutritional information – no such effect of the disease reduction claim was found. Similarly, Franco-Arellano et al. (2020b) reported that the presence of a nutrition claim on a food's packaging led to higher ratings of perceived healthiness, and greater purchasing intentions, but only among those who did not consult the Nutritional Facts table.

Notably, we see comparable effects when participants are presented with an MTL label. For instance, using a best-worst scaling choice task, Maubach et al. (2014) showed that participants were more likely to select a product with a poor, or moderate, nutritional profile as the 'best' option available to them if that product's packaging contained a health claim. Yet health claims had no such effect on participants' best-worst selections when the products' packaging also featured an MTL label. These findings imply that whereas written claims – and by extension, health-related images – may shape people's beliefs about a product, people tend to principally rely on explicit contextual information whenever it is readily available. Given that self-reported nutrition label usage is high (Campos et al., 2011), it is important to determine whether additional contextual information about a product's healthiness might similarly affect consumers' likelihood of forming health-related inferences based on packaging imagery.

1.1. The present study

In this paper we firstly set out to replicate Klepacz et al.'s (2016) finding that health-related packaging imagery increases people's likelihood of falsely recalling having read health claims on product packages. Participants saw images of fictitious products whose packages featured written nutrition claims and we subsequently tested participants' memory for these claims. Based on Klepacz et al.'s findings, we predicted that when the packages

146 featured health-related imagery, participants would be more likely led to make health-related
147 inferences about the products' health functions, and as a consequence they would be led more
148 often to misremember these packages as having featured written health claims (e.g., "with
149 calcium for healthy bones"), rather than only nutrition claims (e.g., "source of calcium").

150 Secondly, we sought to extend Klepacz et al.'s finding by examining the extent to
151 which adding an explicit indicator of a product's healthiness would eliminate the predicted
152 effect of health imagery. In Experiment 1, we manipulated the supposed 'healthiness' of the
153 products by altering the color of their MTL labels. We did so because our participants would
154 be highly familiar with the MTL labelling system, and because MTLs offer a straightforward
155 and effective way of manipulating apparent healthiness through a mere change of color. In
156 Experiment 2, we instead presented explicit healthiness statements, identifying each product
157 as either a relatively 'healthy' or 'unhealthy' food choice. We therefore predicted that
158 whereas health-related images would lead participants to more often mistakenly remember
159 reading health claims about the products, this imagery effect would only occur when the
160 product was portrayed as being relatively healthy, not when it was unhealthy.

161 Of course, when someone makes an inference this does not guarantee by any means
162 that they will misremember what they saw. The absolute prevalence of memory errors,
163 therefore, does not tell us *how many* participants formed false inferences. But if
164 misremembering is statistically more common for certain products—such as those whose
165 packages feature health-related imagery—than for others, then we could conclude that
166 participants were more likely to make false inferences about those products. Here we used
167 separate recall and recognition tests, which give different but complementary insights into
168 participants' cognitive processes. Specifically, one strength of a recall test is that it tells us
169 whether participants misremember seeing health claims spontaneously, even without such
170 claims being suggested to them. One strength of a recognition test is that it tells us whether

participants will incorrectly choose a health claim from a list of possible options, even when that list also contains the correct, nutrition claim. In short, the different memory tests provide different strategies for participants to resist giving wrong answers.

2. Experiment 1

2.1. Method

Both of the studies reported in this paper received full approval from an institutional ethics committee. The procedure and analysis plan for Experiment 1 were pre-registered prior to data collection through AsPredicted.org, and can be found at https://aspredicted.org/blind.php?x=di9mn9.

2.1.1. Participants

To investigate a possible moderating effect of MTL color, we needed to ensure we could first obtain a robust main effect of health imagery on false recall/recognition that could plausibly be moderated. Given that Klepacz et al. had previously found a large, robust effect using a student sample, it seemed logical to begin looking for potential moderators within this demographic group. Per our pre-registered plan, we intended to recruit participants using conservative inclusion criteria, until a total of 60 had met these criteria. The planned sample size was based on Klepacz et al. (2016, Experiment 1), whose 36 participants provided high statistical power to detect medium-sized effects of imagery on participants' false recognition of health claims, using their within-subjects design. In the present research we also used a within-subjects design, and so our target sample of 60 was based on a decision to recruit approximately 50% more participants than Klepacz et al. (2016, Experiment 1).

In total this meant that 156 undergraduate students completed the study in late 2019, either in exchange for course credit or without compensation. A total of 96 participants were removed from the analysis based on our pre-registered inclusion criteria: specifically, 74 gave

invalid responses to more than 25% of trials during the recall task (see Sec 2.2.1 below); 4 reported that they, or someone in their immediate family, had been diagnosed as color blind; 3 said they were unfamiliar with traffic light labelling; and 15 failed our comprehension check described below. These removals left a final sample of 60 UK residents whose data were included in the pre-registered analysis (50 females, 9 males, and 1 other; mean age = 20.32, *SD* = 3.01, range = 18-34). We note that in hindsight our inclusion criteria seemed unduly conservative and led to a sizeable exclusion rate; however, we followed our pre-registered plans regardless. It is nevertheless helpful to mention that our conclusions described below were unchanged even when we ran exploratory analyses with the full sample of *N* = 156.

2.1.2. Materials

The Qualtrics Survey Platform was used to present the stimuli and record participant responses. We created a new set of critical stimuli adapted from the twelve fictional products used by Klepacz et al. (2016; Experiment 3). Each of Klepacz et al.'s stimuli depicted a fictional food product, featuring a brand name, a description of the contents (e.g., cereal bar), and some basic information about the product itself (e.g., the product's weight). Crucially, each product package also contained a short, written nutrition claim; referring to a specific nutrient that the product contained (e.g., "an important source of carbohydrates"; see Table S1 of the supplementary materials for a full list of the claims used). Each package image had a second identical variant, on which a simple health-related image was added to the packaging to represent a specific health function (e.g., an image of a person running, symbolizing enhanced muscular endurance; see Table S2 of the supplementary materials for a complete list of image descriptions and their implied health functions).

Next, we created a green MTL label (to convey mainly 'healthy' properties), a red MTL label (conveying mainly 'unhealthy' properties), as well as a "white", monochrome equivalent of an MTL label (conveying no discernible information about the products' health properties), which was designed to serve as a control condition. No textual nutritional information was visible on the MTL labels; the labels' color was therefore the only information they conveyed to inform judgments about the products' apparent 'healthiness'. These labels were then superimposed onto Klepacz et al.'s original food packages, creating three variants of each package and therefore 72 product stimuli in total [i.e., 12 (different products) x 2 (image: absent vs. present) x 3 (MTL label: green vs. red vs. white)]. These 72 images were blocked into six stimulus sets so that each participant saw one variant of each product (e.g. they only saw the 'peanuts' once, and this would be either with or without an accompanying health image, and with either the green, red, or white MTL; see Figure 1 for examples). We fully counterbalanced the assignment of products to the image and MTL label conditions, so that all participants saw two products, at random, in each of the six conditions. Together, these stimuli served as our critical materials, for which we were interested in participants' ability to remember the details.

We then designed twelve additional food products to use as filler (i.e., irrelevant) stimuli in the same manner as Klepacz et al.'s stimuli. Unlike the critical stimuli described above, each of these filler products featured a health claim chosen from the *EU Register of Nutrition and Health Claims Made on Foods* (European Commission, 2018), which referred to the health benefits of a particular nutrient (e.g., "Protein contributes to the maintenance of muscle mass"). We then added a health-related image to half of the filler packages that complemented the products' health claim (e.g., an image of a flexed arm). These twelve filler packages were not relevant to our analyses; rather, their inclusion served only to ensure that participants saw some health claims during the study, even though the critical products only

ever featured nutrition claims. Specifically, the filler stimuli were designed to enhance the likelihood that participants would think it plausible they could have read health claims on the critical products. No counterbalancing was used for the filler products.

2.1.3. Design and procedure

Participants completed the study individually within a laboratory. The study used a 2 (image: present vs. absent) x 3 (MTL label: green vs. red vs. white) within-subjects design. The dependent variables were the numbers of falsely recalled and falsely recognized health claims.

Encoding phase. To begin, participants were told:

> "In a moment you will be shown 24 pictures of fictional food products. These images will appear onscreen one after another for a set period of time. The pictures will automatically appear and disappear. During this time, please try to remember as much information about the pictures as possible. You will be asked about this information later."

Next, participants saw a random exemplar of a fictitious food package for 10 sec. After 10 sec had elapsed, a new random exemplar appeared onscreen for the same duration. This process then repeated until participants had seen one variant of all 24 products (i.e., they saw 12 *critical* foods, featuring nutrition claims, and 12 fillers, featuring health claims). Of the 12 critical food packages, each participant saw six image-present products and six image-absent products, and within each of the two image conditions, they saw two products with a green MTL label, two with a red MTL label, and two with a white MTL label. Once participants had seen all 24 products, they completed a short, 3-minute filler task: a series of logic puzzles that involved selecting the missing shape that best completed a 2x2 grid of three interrelated images. After 3 minutes had elapsed, the memory phase began.

Memory phase. The memory phase involved both a recall task and a recognition task. For the recall task, participants were again shown the same 12 critical product packages they had seen previously in a new random sequential order, only this time the written nutrition claim on each product was obscured by a black panel. For each product, participants were asked to recall what had originally been written in the obscured part of the package, and to type their response into a text box. In the event that participants were unable to remember the claim, they were instructed to type "Don't know".

Once participants had submitted their recall responses for all 12 critical packages, the recognition task began. Participants once again saw the same 12 critical products sequentially with the corresponding claim obscured, but this time each product was accompanied by a list of six statements, and participants were asked to select which had originally appeared on the package. The six statements were presented in a random order for each package; one was always the correct nutrition claim that actually appeared during the encoding phase (e.g., "Source of zinc"), one was our lure, namely a health claim associated with the image that had appeared in image-present conditions (e.g., "Zinc contributes to normal cognitive function"), and four were general claims (e.g., "Free from bones"). We also added one further element to our data collection that was not pre-registered. That is, after making each recognition response, participants were asked to qualify their decision by selecting either; [1] "I *remember* seeing it on the packaging", [2] "I *know* I saw it on the packaging, although I don't explicitly remember it", or [3] "It was just a *guess*".

Once participants had responded to all 12 critical products, they provided demographic information. To ensure that we only included data from participants who could correctly interpret the meaning of an MTL label, participants were then shown an example of an actual MTL label – complete with legible nutritional information – alongside a list of six statements (e.g., "This product is LOW in fat"). Participants were asked to correctly choose

292 which three of these statements accurately interpreted the information on the label. Finally,
293 participants were fully debriefed and thanked for their time.

294 **2.2. Results**

295 **2.2.1. Coding of recall data**

296 As per Klepacz et al. (2016), we coded each free recall response as either [1] a *health*
297 *claim*, whereby the participant referred to a health function of the product (e.g. "helps build
298 strong bones"), [2] a *non-health claim*, whereby the participant referred either to a specific
299 nutrient without mentioning its health properties, or referred to another characteristic of the
300 product (e.g. "easy to cook"), or [3] an *omission*, whereby the participant either gave no
301 meaningful response, said "Don't know", or referred to another detail that remained visible
302 on the packaging during the memory phase (e.g. the product's weight). Responses were
303 coded as valid if they fell into the first of these two categories, and thus, to meet the pre-
304 registered inclusion criteria, participants were expected to provide no more than three
305 omissions. The large proportion of excluded data was therefore primarily a consequence of
306 our unrealistic expectation about how much participants would recall. In our final dataset
307 after exclusions, 71.5% of all responses were coded as non-health claims, and 12.9% were
308 coded as health claims. Omissions accounted for 15.6% of responses. To be clear, whereas
309 we used this coding scheme for categorizing participants' responses, the participants
310 themselves were not expected to appreciate the conceptual distinctions between health claims
311 and non-health claims (or health vs nutrition claims).

312 **2.2.2. False recall**

313 We were interested in whether the addition of a health-related image to a product's
314 packaging would lead people to falsely recall nutrition claims as health claims. A 2 (image:
315 absent vs. present) x 3 (MTL label: green vs. red vs. white) repeated-measures ANOVA

revealed a significant effect of image, $F(1, 58) = 13.75$, $p < .001$, $\eta^2_p = .19$, with participants falsely claiming to have seen almost twice as many health claims about products whose packaging featured a health image ($M = 1.03$, $SD = 0.92$), than for comparable image-absent products ($M = 0.52$, $SD = 0.98$). Contrary to our hypothesis though, an MTL label depicting the general 'healthiness' of a product had no meaningful effect on the number of falsely recalled health claims, $F(2, 116) = 0.21$, $p = .81$, $\eta^2_p < .01$, and there was no significant image x MTL label interaction $F(2, 116) = 1.14$, $p = .34$, $\eta^2_p = .02$.

2.2.3. False recognition

In total, participants recognized the correct nutrition claim for 65.3% of products on average, but incorrectly chose the health claim for 28.8% of products. We conducted a 2 (image: absent vs. present) x 3 (MTL label: green vs. red vs. white) repeated-measures ANOVA of the number of instances in which participants incorrectly chose the health claim from the six options. These data once again revealed a significant main effect of image, $F(1, 59) = 31.28$, $p < .001$, $\eta^2_p = .35$, with participants more likely to falsely select the health claim when a health-related image was present on the packaging ($M = 2.23$, $SD = 1.39$), than when it was absent ($M = 1.22$, $SD = 1.12$). There was no significant effect of MTL label on the number of falsely recognized health claims, $F(2, 118) = 0.56$, $p = .57$, $\eta^2_p = .01$, nor a significant image x label interaction, $F(2, 118) = 0.15$, $p = .86$, $\eta^2_p < .01$.

Exploratory analysis of subjective recognition judgements. At face value it is perhaps unsurprising that health images increased the false recognition of health claims: even if participants recalled nothing about each product, then it would make sense to choose the recognition option most related to a visible cue on the product's packaging. If this educated guessing were the sole explanation of our findings, then we would expect the effect to disappear after we exclude those recognition responses that participants described as

'guesses'. To address this matter, we conducted further analyses extra to those we pre-registered (see Table 1). We found that of the falsely recognized health claims; 39.1% of responses were reportedly 'remembered', 41.5% were 'known', and 19.3% were 'guesses'. The presence of a health-related image did significantly increase the number of guess responses, $F(1, 59) = 15.56$, $p < .001$, $\eta^2_p = .21$. However, the main effect of image remained significant even after excluding these guess responses (i.e., leaving only 'remember' and 'know' responses), $F(1, 59) = 9.47$, $p < .01$, $\eta^2_p = .13$.

3. Experiment 2

The findings from Experiment 1 replicate Klepacz et al.'s (2016) finding that the inclusion of a health-related image on a product's packaging can lead people to falsely recall and recognize having seen health claims on the product's packaging. The occurrence of these false recollections tells us that as a result of seeing the health imagery, participants have inferred specific health benefits of consuming the product. Contrary to our hypothesis though, these false memories were just as common when the MTL label indicated an unhealthy product, as when the label indicated a healthy product (or when it conveyed no discernible health information). Therefore, people seemingly formed these inferences without considering the global healthiness of the product on which the image appeared.

Nevertheless, people's inferences are shaped by both the *relevance* and the *saliency* of the information they receive (Nisbett & Ross, 1980). One possible explanation of Experiment 1's findings is that the MTL labels were not sufficiently salient to over-ride the influence of the health imagery. Indeed, participants may not have always noticed these labels. A recent review of the nutritional labelling literature recommended making nutritional labels more salient as a means to help consumers make healthier food choices (Graham et al., 2012), whereas in contrast, we know that prominent imagery is an effective method of capturing

consumer interest (Varela et al., 2014). For instance, in one eye-tracking study people spent significantly longer looking at a photograph on a product's packaging than they spent looking at some textual information (Piqueras-Fiszman et al., 2013). The possibility that participants in Experiment 1 paid little attention to the MTL labels is therefore not necessarily a limitation of the materials we used; rather, it may accurately reflect reality. Nevertheless, it is important to rule out the possibility that MTL labels failed to moderate the effect of health imagery solely due to a lack of attention. We reasoned that if this were the case, then a more salient indicator of a product's healthiness (i.e., an explicit healthiness statement) would moderate this effect.

The aims of Experiment 2 were therefore twofold. The first aim was to replicate the effect of health imagery on false memories, as demonstrated in Experiment 1. The second aim was to determine the extent to which a salient and explicit statement – which overtly describes the product as either healthy or unhealthy – would moderate the occurrence of these memory errors. We again predicted that the effect of image would only occur for supposedly healthy foods, not for unhealthy foods.

3.1. Method

The procedure and analysis plan for this study were pre-registered prior to data collection through AsPredicted.org, and can be found at https://aspredicted.org/blind.php?x=yz3cy3.

3.1.1. Participants

Per our pre-registered plan, we intended to recruit participants using less conservative inclusion criteria than in Experiment 1, until a total of 64 had met these criteria. A total of 41 undergraduate students and members of university staff completed the study in exchange for course credit or a cash voucher, and an additional 58 participants who identified as 'students',

aged 18 and over, were recruited via Prolific in exchange for a small monetary credit. Face-to-face testing began in early 2020, however, data collection was subsequently moved online as a consequence of the Coronavirus (COVID-19) pandemic[1]. Per our pre-registered plan, participants were excluded from the analysis if they gave valid responses on 50% or fewer of trials during the recall task (n = 35); this left a final sample of 64 UK residents (50 females, 14 males; mean age = 21.98, SD = 5.59, range = 18-50) who were included in analyses. Note that the data exclusion rate was still relatively high even despite the amended inclusion criteria. Nevertheless, just as in Experiment 1, our conclusions described below were unchanged even when we ran exploratory analyses with the full sample of N = 99.

3.1.2. Materials

The materials were identical to those used in Experiment 1, with two main exceptions. Firstly, participants only saw eight filler packages rather than 12. Secondly, we removed the MTL labels from each product package. Instead of the MTL labels, participants saw a prominent message underneath each product that labelled the food as being either 'healthy' or 'unhealthy', meaning that participants now saw three products in each of the four conditions. Specifically, participants saw: "This product is recognized as very [healthy/unhealthy] in comparison to other brands" (see Figure 2 for an example). A small pilot study confirmed that these healthiness messages were salient. A total of 40 participants encoded a single product package in the same manner as in Experiment 1, with one of the two healthiness messages presented at random underneath the image, before completing the filler task and memory tests from Experiment 1, and finally being asked to report whether they had been told the product was healthy or unhealthy. In this pilot study, 95% of respondents selected the

[1] The pattern of results described here held in both the lab and online samples. When administration mode was included in our analyses as a between-subjects variable, none of the main effects or interactions involving administration mode were significant (all $p > .13$), and all effect sizes were small ($\eta^2_p < .04$) across all analyses.

410 correct answer, suggesting that the message had been sufficiently salient for them to encode
411 well. As in Experiment 1, the assignment of products to conditions was counterbalanced
412 across participants.

413 **3.1.3. Design and procedure**

414 Participants either completed the study on individual computers within a laboratory,
415 or online. The study used a 2 (image: present vs. absent) x 2 (healthiness: healthy vs.
416 unhealthy) within-subjects design. The dependent variables were the numbers of falsely
417 recalled and recognized health claims. Participants followed the same procedure as in
418 Experiment 1, viewing 20 images of food product packages accompanied by a statement of
419 the products' 'healthiness' [12 critical products, with 3 in each cell of the 2 (image: absent vs.
420 present) x 2 (healthiness: healthy vs. unhealthy) design, plus 8 filler products]. The MTL
421 label comprehension check from Experiment 1 was removed; instead, participants completed
422 an attention check at the end of the experiment, in which they were presented with one of the
423 filler products they had seen, plus three entirely new products. To pass the check, participants
424 were required to correctly select the product they had seen previously.

425 **3.2. Results**

426 **3.2.1. False recall**

427 Recall responses were coded in the same manner as Experiment 1. In our final dataset,
428 64.1% of responses were coded as non-health claims, and 7.4% as health claims. Omissions
429 accounted for 28.5% of responses. A 2 (image: present vs. absent) x 2 (healthiness: healthy
430 vs. unhealthy) repeated-measures ANOVA revealed that the presence of a health-related
431 image significantly increased the frequency of falsely recalled health claims, $F(1, 63) = 7.20$,
432 $p < .01$, $\eta^2_p = .10$ (see the top row of Table 2). Conversely, the messages about the products'
433 relative 'healthiness' had no meaningful effect on the number of falsely recalled health

claims, $F(1, 63) = 0.64$, $p = .43$, $\eta^2_p = .01$, and there was no significant image x healthiness interaction, $F(1, 63) = 0.80$, $p = .37$, $\eta^2_p = .01$.

3.2.2. False recognition

Overall, participants chose the correct nutrition claim for 63.4% of products, but incorrectly recognized the health claim for 24.5% of products. A 2 (image: absent vs. present) x 2 (healthiness: healthy vs. unhealthy) repeated-measures ANOVA once again revealed a significant effect of image, $F(1, 63) = 14.18$, $p < .001$, $\eta^2_p = .18$ (see the second row of Table 2). As in Experiment 1, participants were more likely to choose the health claim when a package featured a health-related image. The main effect of healthiness was not significant though, $F(1, 63) = 0.03$, $p = .86$, $\eta^2_p < .01$, and nor was the image x healthiness interaction, $F(1, 63) = 0.04$, $p = .85$, $\eta^2_p < .01$.

Subjective judgements for critical claims. Of the falsely recognized health claims; 32.4% of responses were 'remembered', 42.0% were 'known', and 25.5% were 'guessed' (see Table 2). The presence of a health-related image did not significantly increase the number of guess responses, $F(1, 63) = 3.10$, $p = .08$, $\eta^2_p = .05$, and the main effect of image remained significant after removing guesses as per our pre-registered plan for this experiment, $F(1, 63) = 9.00$, $p < .01$, $\eta^2_p = .13$.

4. Discussion

Taken together, the results of these studies demonstrate that decorative images on food packages can lead people to infer additional health properties about those products. That is to say, in both experiments, participants falsely remembered health claims that they had not actually seen, and these false memories were most common when a product's packaging had featured health-related imagery. Of particular importance, the data show that this effect of imagery occurred even when a product had been identified—indirectly, or directly—as an

458 unhealthy choice. Or in other words, health imagery on products' packaging increased the
459 likelihood of false memories irrespective of contextual cues to the products' supposed
460 healthiness.

461 These findings contribute to a growing body of empirical research, which illustrates
462 that health-related front-of-pack imagery can inflate the perceived healthiness of a product
463 (Saba et al., 2010; Delivett et al., 2020; Carrillo et al., 2014). However, contrary to previous
464 research that suggests additional contextual information could protect consumers from
465 potentially misleading health claims (Franco-Arellano, 2020a, b), we find here that a
466 product's reported healthiness did little to deter people from drawing health inferences on the
467 basis of health-related packaging imagery. Specifically, in Experiment 1 we found that the
468 color of a product's MTL label had no effect on the number of falsely remembered health
469 claims. In Experiment 2, an explicit and salient statement of a product's relative healthiness
470 once again had no effect on the number of falsely remembered health claims. We can
471 therefore conclude that the observed effect of health imagery on people's inferences occurs
472 even when more purposeful health information is available.

473 These findings provide important evidence to inform debates about how the use of
474 imagery is regulated in the marketing of food and health products. Whereas existing
475 regulations in some countries already focus on protecting consumers from misleading
476 pictorial claims, it is difficult to objectively measure what 'claim' any particular image is
477 making. This is a particularly pertinent concern given that images can evoke a variety of
478 different interpretations (Smith et al., 2015), and even ambiguous images can have health-
479 related connotations (Carrillo et al., 2014) that may lead consumers to make inferences about
480 a product's healthiness. Although previous research has advocated making nutritional labels
481 more salient on product packages to help consumers make healthier food choices (Graham et
482 al., 2012), our findings suggest that the effects of imagery on people's inferences could over-

ride those of more direct and even salient cues to product healthiness. Indeed, the data suggest that if featured on the packaging of an unhealthy product, a health-related image might be no less influential than when featured on the packaging of a healthy product. One possible recommendation then, is that regulators should pay particular attention to the overall nutritional profile of products featuring these kinds of pictorial claims. Whereas existing EU legislation advocates that regulated health claims should only appear on pre-packages foods provided they meet a specified nutrient profile, the proposed guidelines have not yet been formally agreed by the European Commission (2020). Though it would be unreasonable to suggest that unhealthy products should only use plain label packaging – particularly in light of findings that suggest such packages can increase candy consumption, at least amongst males (Werle et al., 2016) – regulators should nonetheless consider restricting the use of pictorial claims on such products.

A strength of the present research is that by using a memory-based task we were able to assess people's tendency to form these health-related inferences, without relying on direct questioning. Previous research has shown that product imagery can affect people's inferences about health when directly questioned. However, the act of asking a person to reflect upon their beliefs about a product might be what actually prompts them to make inferences. Importantly, we replicate Klepacz et al.'s (2016) findings that suggest these inferences often occur outside of conscious awareness and without effortful processing. In both experiments we demonstrate that these memory errors were not the product of educated guesswork, but rather that participants reportedly 'remembered' or 'knew' that they saw the claim previously. A logical next step would be to investigate whether the addition of a health-related image to a product's packaging would influence measures of consumer behavior. Previous research has demonstrated, for example, that packages containing a written claim can increase consumers' purchasing intent (Franco-Arellano, 2020b; Roe et al., 1999), and

that products perceived to be 'healthier' are typically consumed in greater quantities (Cavanagh & Forestell, 2013; Irmak et al., 2011; Provencher et al., 2009). We speculate that health-related imagery on product packages may similarly affect people's purchasing intentions and subsequent consumption. Future research is necessary to test this prediction.

In addition, research is needed to better understand how people's habitual eating behaviors affect the extent to which they are influenced by product imagery. Restrained eaters for instance have greater attentional bias towards food-related cues (Polivy & Herman, 2017), and appear to be more able to accurately judge the healthiness of foods, in spite of textual information designed to present stereotypically unhealthy foods as low-fat (Lwin et al., 2014). Further research is needed to explore whether restrained eaters are also less resistant to the effects of misleading health-related images on food packaging. Relatedly, one limitation of the present research is that our sample comprised mostly young, female undergraduate students who are perhaps less preoccupied than the general population with healthful eating and thus less attentive to on-pack nutritional information. Indeed, Chalamon and Nabec (2016) found that younger consumers typically employed heuristics that favored cheaper, convenience foods over more health-orientated search strategies. The authors reasoned that such individuals have yet to experience specific health problems associated with less healthful consumption, which may underlie a less effortful processing style. Future research should therefore consider that consumers who are more acutely aware of the disease-diet relationship may be more inclined to scrutinize on-pack nutrition information, and less susceptible to forming inferences on the basis of packaging imagery alone (Drichoutis et al., 2006).

As a final consideration, future research should consider the possible mechanism underpinning the observed effects of imagery. It has been suggested that package imagery might afford consumers a quick and easy sense of understanding that leads them to engage in

less effortful reasoning, but that this outcome may depend on whether other features of the product packaging undermine this sense of understanding (Delivett et al., 2020). If a similar theoretical mechanism were responsible for the effects shown here, then we might predict that people would make fewer health-related inferences—and therefore fewer false recollections—when packages also feature unfamiliar or technical information. For example, an image of a bone may invite inferences about bone health when featured alongside the claim "source of calcium," but may have little effect when shown with the claim "source of beta-glucans". Testing these kinds of predictions would support the development of richer theoretical accounts of how the effects of health imagery interact with the contexts in which they appear.

4.1 Conclusions

Images on food packages can capture consumer interest (Varela et al., 2014), and create sensory expectations about the products' contents (Gil-Pérez et al., 2019). Consequently, the way in which people (mis)remember product information can provide important information about their expectancies of those products. In this way the findings from Experiments 1 and 2 suggest that health-related images can lead people to attribute additional health properties to a product. That is to say, our participants misremembered written information about those products based on what they inferred from the package image. People's propensity to make these kinds of inferences, even when the product is explicitly recognized as an unhealthy food choice, suggests that this is not simply due to a lack of understanding. In light of research suggesting that 'healthier' foods are often consumed in greater quantities (Provencher et al., 2009; Cavanagh & Forestell, 2013; Irmak et al., 2011), regulators need to pay particular attention to the interplay between written and pictorial claims on product packages.

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Tables

Table 1. *Mean number of recognition errors made by participants in Experiment 1 for R/K/G responses (standard deviation in parentheses). The maximum possible frequency in each cell is 6.*

Response	Image-absent	Image-present
Remember	0.57 (0.81)	0.78 (0.88)
Know	0.52 (0.77)	0.92 (1.11)
Guess	0.13 (0.34)	0.53 (0.68)

Table 2. *Mean number of recall and recognition errors made by participants in Experiment 2 (standard deviation in parentheses). The maximum possible frequency in each cell is six.*

Response	**Image-absent**	**Image-present**
Recall	0.30 (0.66)	0.59 (1.15)
Recognition	1.09 (1.33)	1.84 (1.67)
Remember	0.34 (0.57)	0.61 (0.81)
Know	0.47 (0.87)	0.77 (1.05)
Guess	0.28 (0.52)	0.47 (0.78)

Figures

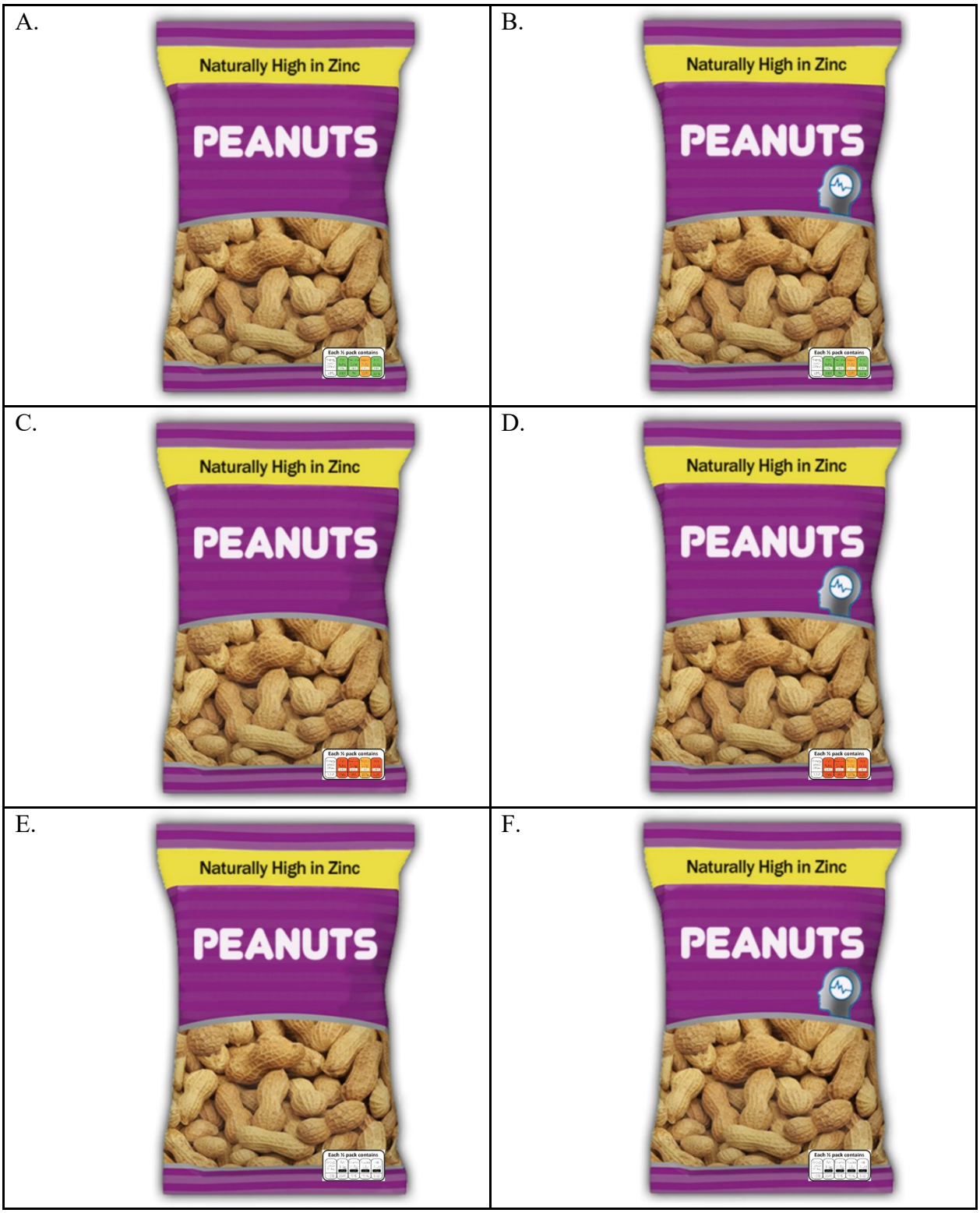

Figure 1. *Examples of fictional product packages used in Experiment 1, with green MTL labels (Panels A and B), red MTL labels (Panels C and D), and white MTL labels (Panels E and F). Exemplars in the left-hand column represent the image-absent condition; those in the right-hand column represent the image-present condition.*

Figure 2. An *example of a fictional product package used in Experiment 2, accompanied by a statement of the products' relative 'healthiness'.*