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Protocol for a Randomized Trial Assessing Consumer Evaluations of Pre-Packaged Foods that Systematically Vary by Nutrition Information and Product Attributes

Zenobia Talati[1*], Simone Pettigrew[1], Helen Dixon[2], Bruce Neal[3], Clare Hughes[4], Trevor Shilton[5] and Caroline Miller[6,7]

Abstract

Background: Nutrition information is increasingly provided on pre-packaged foods as a public health measure to help consumers make healthier food choices. Many studies have looked at the independent effects of three main sources of nutrition information: the Nutrition Information Panel (NIP), front-of-pack labels and health claims. However, few studies have considered their interactive effects. A better understanding of how these different sources of nutrition information interact with each other is important given they frequently appear together on food packs. There are also policy implications since many countries specifically mandate the provision of an NIP whenever a health claim is made.

Methods: This paper outlines a protocol for an experimental study assessing how nutrition information (FoPLs, health claims and NIP), in combination with food type, price and product healthiness interact to affect consumers' product evaluations. Consumers' global impressions, perceptions of healthiness, purchase intentions and assumptions relating to the amount of the product that is appropriate/desirable to consume will be assessed. The nutrition information presented will include NIPs, front-of-pack labels (Daily Intake Guide, Multiple Traffic Light system, Health Star Rating system) and health claims (nutrient content, general level, higher level). A diverse sample of approximately 2000 Australians will be recruited to complete an online survey that will require them to evaluate a range of hypothetical products with varying nutrition and price attributes. All attribute levels will be fully crossed with each other, resulting in a full factorial design. This design has not been used in past studies and offers a higher level of control than achieved previously due to the ability to explore interactions between all attribute levels.

Discussion: Study results will indicate (1) the independent and combined effects of each attribute on consumer evaluations, (2) which front-of-pack labels are more effective at helping consumers distinguish between healthier and less healthy foods and (3) how health claims affect perceptions of healthiness. The study will also provide crucial information on the effectiveness of the new Health Star Rating system, for which quantitative research is currently lacking.

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Keywords: Daily Intake Guide, Traffic light, Health Star, Health claim, Nutrition information, Front-of-pack labels

* Correspondence: zenobia.talati@curtin.edu.au
[1]School of Psychology and Speech Pathology, Curtin University, Perth, Western Australia, Australia
Full list of author information is available at the end of the article

Background

An unhealthy diet can lead to high blood pressure, high blood cholesterol, obesity and metabolic outcomes, which in turn are associated with a range of chronic illnesses such as coronary heart disease, hypertension, type 2 diabetes and some forms of cancer [1]. According to the most recent Global Burden of Disease assessment, poor diet is a leading risk factor in preventable morbidity [2]. One public health intervention aimed at promoting the consumption of a balanced diet that has been widely adopted across the world is the provision of nutrition information on packaged foods [3–5].

Nutrition information on food packs

Nutrition information can be presented on food packs in a variety of formats, such as a nutrition information panel (NIP; similar to the Nutritional Facts Label), a health claim and/or a front-of-pack label (FoPL). The NIP typically appears on the back or side of food packs and details the levels of key nutrients contained within a product. The main aim of the NIP is to provide comprehensive information on the nutrients within a food, with a second aim being to encourage healthier diets [6]. Worldwide, the NIP is the most mandated source of nutrition information to appear on pre-packaged foods [4]. Additional information on the contribution of each nutrient to an average adult's daily intake is sometimes required, depending on national regulations.

Health claims are any form of text that appears on packs promoting the health value of the food based on the level of a particular nutrient or nutrients. They typically appear prominently on the front of food packs and are often employed as a marketing tool [7]. Health claims can generally be classified into one of three categories: nutrient content claims (which describe the level of a nutrient within the food), general level health claims (which relate nutrients within the food to a health function) and higher level health claims (which relate a nutrient to a specific disease)[8]. Regulations around the use of health claims vary from country to country. For example, in the USA, Australia, New Zealand, and the European Union, products must meet or exceed a minimum nutrient level to make a nutrient content claim [9–11]. Many countries also now require the NIP to be provided whenever a general or higher level health claim is made on a product [4]. Studies conducted across numerous countries (e.g., the USA, the UK, Australia, Germany and the Netherlands) have found no difference [12–14] or only marginal differences [15, 16] in the overall healthiness of foods featuring a health claim compared to similar foods that do not feature a health claim.

FoPLs provide a summary of key information presented on the NIP and some additional content (e.g., percentages, colors, symbols) to help consumers make sense of this information. The use of FoPLs is voluntary in most countries. Many different FoPL formats exist in the global marketplace and within countries [5], which can undermine consumers' understanding and use of FoPLs. They can generally be categorized on a spectrum from reductive to evaluative [17]. Reductive FoPLs provide synthesized information with minimal interpretation, typically by specifying how the levels of nutrients within a food contribute to an 'average' adult's recommended daily intake. This presentation format appears in the Daily Intake Guide (DIG) used in Australia, the Guideline Daily Amounts used in the UK and the % Daily Value used in the US. Evaluative FoPLs provide additional information through an assessment of the overall health value of the food. For example, in addition to stating the grams (or milligrams) of certain nutrients, the Multiple Traffic Lights (MTL) FoPL also assigns a red, amber or green light based on whether the nutrient level is deemed high, medium or low respectively. In this way, the MTL is a *nutrient specific* evaluative FoPL. The MTL is currently being used in the UK and being considered for implementation elsewhere [18]. The Health Star Rating (HSR) is a newer voluntary labelling system that is currently being used in the Australian marketplace. While the HSR contains nutrient level information, it also provides a global evaluation of the product through a *summary indicator* that assigns the product a rating of half a star to five stars.

Although the aim of nutrition information on food packs is to help consumers accurately judge the health value of a food product, this does not always occur. The NIP can be confusing [19], especially for those with low literacy and numeracy skills [20], and is used infrequently [21–23]. Health claims are often regarded as a marketing tool [24, 25] and consequently can be viewed with skepticism [26, 27]. Reviews of the cognitive and affective effects of health claims conclude that they often induce a positivity bias. This occurs when the mere presence of a health claim leads people to think more favorably about a product (even if it is unhealthy) compared to when there is no health claim [28–31]. Conversely, numerous reviews have concluded that evaluative FoPLs can be effective at helping consumers distinguish between healthier and less healthy foods [32–35].

Independent effects of nutrition information

NIPs, FoPLs and health claims often appear in combination on products. However, most studies in this area have focused on the isolated effects of individual forms of nutrition information and either do not include or do not measure the impact of more than one source of nutrition information. As a consequence, it is unclear how the combination of such information could influence consumers' product-related assessments and decisions.

Existing research on how FoPLs and health claims perform in isolation does not provide insight into how consumers reconcile contradictory nutrition information conveyed on food products. Take the example of an unhealthy product that features both a health claim and an evaluative FoPL. The health claims literature would predict that the product would be evaluated favorably due to the positivity bias created by health claims [28–31], while the FoPL literature would predict that the food would be evaluated negatively because consumers would be able to accurately interpret the unhealthy profile conveyed in the FoPL [32, 33].

Research is therefore needed to identify the trade-offs involved when inconsistent nutrition information is featured on food products. In one of the few studies conducted in this area, researchers presented participants with mock food packs, some of which had been manipulated to depict conflicting health claims and FoPLs [36]. Participants reported that they would be less likely to use health claims in their decision-making if evaluative FoPLs were present on food packs. This finding has implications for policy makers because if certain FoPLs can prevent consumers being misled about the healthiness of foods with a health claim, the mandated use of these FoPLs whenever a health claims is made may have widespread beneficial effects. The next section reviews the limited research on how consumers respond to the presence of multiple sources of nutrition information on food products.

Combined effects of multiple sources of nutrition information

Some laboratory studies have used a randomized controlled design to observe how different nutrition information affects participants' reactions to products that vary in healthiness. In one study [37], participants were presented with high- and low-sodium products bearing an NIP and different combinations of front-of-pack nutrition information (i.e., FoPLs (DIG or MTL) and/or health claims). The results showed that of all the combinations of nutrition information, the combination of MTL and a 'reduced salt' claim led to the healthiest food choices. In another study [21], participants were presented with foods featuring combinations of FoPLs (DIG or MTL) and health claims and an NIP showing an unhealthy, moderate or healthy nutritional profile. A positivity bias (in the form of more positive evaluations) was observed when health claims appeared on unhealthy products. However, this effect was cancelled out when MTL (but not DIG) were present. Furthermore, participants provided the most accurate evaluations of healthy and unhealthy products when MTLs were present, regardless of whether a health claim was present. These studies suggest that health claims on unhealthy products have a weaker effect when a FoPL is shown alongside them. Since only two studies have examined this phenomenon, further research is needed.

Critique of previous methodologies

The two experimental studies described above are some of the most rigorously designed studies in the literature. The main outcome variable in these studies was choice behavior, measured through participant selection of the most and/or least preferred product. While choice is often used as an outcome variable because it reflects the behavior that public health professionals wish to change, it can be equally important to understand the process by which consumers arrive at a particular choice. This is an important outcome variable to measure separately since perceptions of healthiness do not necessarily determine choice.

In the present study, participants will evaluate each individual mock product on a number of dimensions including perceived healthiness, taste and quality. They will also rate their willingness to buy an amount of the product considered desirable/appropriate to eat. This methodology complements the discrete choice method by providing insight into how different on-pack elements affect purchase and consumption intentions. Furthermore a full factorial design (in which all levels of all attributes are fully crossed) will be used which will allow for the testing of all interactions [38, 39]. While the study design will not permit observation of between-product assessments as can be achieved with discrete choice approaches, the single-product observations across an extensive range of variables will provide novel insights into consumers' product evaluations.

In addition to taking into account a wider range of outcome variables, this study will consider other important but often neglected predictor variables to increase its ecological validity and its contribution to the literature. One such variable is price, which is generally understood to be the strongest predictor of pre-packaged food purchases [40–42]. The supermarket and laboratory studies discussed above did not incorporate price into their design, although the supermarket studies excluded foods that were on sale. If price were to be included in these studies, along with nutrition information, it would increase realism and explicate the trade-offs consumers make between price and healthiness.

Differences in responses to on-pack nutrition information between adults and children have received very little attention to date [43]. Given high rates of child obesity and the increasing role children play in choosing the foods they consume and their considerable buying power [44, 45], it is also important to understand how children utilize information on food packs when making decisions. A recent report by the World Health Organization on child obesity recommended that FoPLs that can be easily understood by both children and adults be more widely applied to foods [46].

Because of children's more immature cognitive skills and lack of acquired health/nutrition knowledge relative to adults, it cannot be assumed that they will respond in the same manner to nutrition information. Research suggests that children (even those as young as 6 years of age) are capable of using nutrient information to inform their judgements of whether a food is healthy or unhealthy (e.g., fat and sugar are perceived as unhealthy) [47]. They do, however, experience difficulty integrating the various components of nutrition information on food packs [48], particularly when it is expressed through daily intake percentages [49]. Rather, they tend to be more interested in the colors and text that appear on the front of packs [50]. Evaluative FoPLs (which often incorporate colors and symbols to reduce cognitive load) and health claims [51] appear to be easier for children to interpret [43]. Inclusion of child participants in the proposed study allows assessment of whether certain labelling schemes either facilitate or hinder accurate product evaluations by children. Most of the nutrition information research to date involving children has been in the form of focus groups [43, 47, 48, 50] or choice tasks [52]. This study will extend the limited literature by quantifying the extent to which children's evaluations of food are affected by on-pack nutrition information and providing insights into the manner in which labelling and product attributes influence children [52].

Aims and hypotheses

The study described in this paper will attempt to overcome some of the design issues of previous studies (noted above) that limit the generalizability of the results to the 'real world' marketplace. First, unlike the majority of studies in the literature, all three sources of nutrition information (NIPs, FoPLs and health claims) will be manipulated. Second, price will be included as an attribute, but price differences between products will be kept within a small range to prevent price from having a disproportionately strong influence on outcomes. Third, all attributes will have at least three levels to increase realism and provide a more sophisticated understanding of the trade-offs consumers make when multiple attributes are present. Fourth, each attribute of interest will be precisely manipulated and crossed with every level of all other attributes, resulting in a full factorial design that allows interaction effects to be tested. Finally, children will be included in the sample to provide insight into any differences that may exist between how adult and child consumers process multiple sources of nutrition information that are presented simultaneously on food products. The large number of variables being manipulated and measured along with the diverse sample included in this study relative to previous research will result in a large volume of relevant data which will shed light on many aspects influencing FoPL effectiveness.

The primary aim of this study is to investigate how nutrition information format, healthiness and price interact to affect overall perception of the product (e.g., perceived healthiness, tastiness, quality) purchase intentions and the amount of the product considered desirable/appropriate to eat. A secondary aim is to assess the effectiveness of the new HSR and its impact on consumer choice. The recent adoption of this FoPL in Australia means there is little evidence of its effectiveness and how it performs relative to other FoPLs [43].

The hypotheses for this study are as follows:

H1a: NIP views will be low across all products
H1b: NIP views will be a weak predictor of overall product perceptions (particularly perceived healthiness) and purchase intentions.
H2: Price will be the strongest predictor of purchase intentions.
H3: Across all conditions, participants will be more accurate in their perceptions of healthiness when evaluative FoPLs (MTL or HSR) are present on packs compared to when a reductive FoPL or no FoPL is present.
H4: Participants will have lower intentions to purchase less healthy products when evaluative FoPLs are present on packs compared to when a reductive FoPL (DIG) or no FoPL is present.
H5a: A positivity bias will be observed such that participants will report more favorable product perceptions, show greater purchase intentions and select larger portions for consumption for products featuring a health claim compared to products without a health claim.
H5b: The positivity bias induced by health claims will be reduced when an evaluative FoPL is present on the pack compared to when a reductive FoPL or no FoPL is present.

Method

Design

As shown in Table 1, the nutrition information elements manipulated in this study will be FoPLs (none, DIG, MTL, HSR) and health claims (none, nutrient content, general level, higher level). The food attributes manipulated will be food type (cookies, corn flakes, pizza, yoghurt), price (cheap, moderate, expensive) and healthiness (less healthy, moderate, healthier). All products will feature an NIP (which is a mandatory feature of product labelling in most jurisdictions), to enable assessment of whether consumers who choose to refer to the NIP when evaluating foods respond differently to the experimental manipulations compared to those who do not refer to the NIP. The NIP will vary according to product type and healthiness (e.g., a different NIP will be shown on the healthy cookies than the

Table 1 Attributes and levels of attributes manipulated in the mock packs

Attribute	Levels
Front-of-pack label	• None • Daily Intake Guide • Multiple Traffic Light • Health Star Rating
Health Claim	• None • Nutrient content claim • General level claim • Higher level claim
Price	• Cheap • Moderate price • Expensive
Healthiness	• Unhealthy • Moderately healthy • Healthy
Food type	• Cookies • Corn flakes • Pizza • Yoghurt

Table 2 Target number of respondents by gender, age and SES

Males				Females			
	SES				SES		
Age (years)	Low	High	Subtotal	Age (years)	Low	High	Subtotal
10–12	41	41	82	10–12	41	41	82
13–15	41	41	82	13–15	41	41	82
16–17	41	41	82	16–17	41	41	82
18–25	63	63	126	18–25	63	63	126
26–35	63	63	126	26–35	63	63	126
36–45	63	63	126	36–45	63	63	126
46–55	63	63	126	46–55	63	63	126
56–65	63	63	126	56–65	63	63	126
65+	63	63	126	65+	63	63	126
Subtotal			1002	Subtotal			1002
Total							2004

unhealthy cookies). The design will be full factorial so that each level of each attribute is crossed with all other attribute levels.

Participants

This study is funded by the Australian Research Council, the South Australian Health and Medical Research Institute, the National Heart Foundation, Cancer Council New South Wales, and Cancer Council Victoria. Ethics approval has been received from Curtin University Human Research Ethics Committee (approval reference: RDHS-11-15). A total of 2004 adult ($n = 1512$) and child ($n = 492$) participants will be recruited through a large web panel provider. With each participant viewing 8 mock packs each, this will result in at least 25 views for each of the 576 unique mock pack images. This is in line with the sample size recommendations for discrete choice tasks [53]. Previous studies have reported small to medium effect sizes for the FoPL x healthiness interaction on perceived healthiness ($\eta_p^2 = 0.008$ [54], 0.01 [55]; $d = 0.5$ [56]). Thus, a large sample will be employed to ensure that even small effects are detected.

Children will need to be at least 10 years of age to participate so they are sufficiently literate to complete the online survey and are likely to make some of their food selection decisions and have some influence on household food purchases [52, 57]. Furthermore, this is thought to be the age around which children develop an understanding of abstract concepts [58]. Quotas will be set based on gender, age and socioeconomic status (SES) (see Table 2). SES will be determined based on postcode and the Australian Bureau of Statistics' Socio-Economic Indexes for Areas [59]. Participants under 18 will be intentionally over-represented through smaller age ranges (i.e., a range of 2 years compared to a range of 10 years) because of the rapid and substantial cognitive development occurring at this life stage [60]. The smaller age ranges will provide insight into how product evaluations and understanding change from the pre-operational, concrete operational and formal operational stages [58]. Once a quota has been filled (e.g., 41 males aged 10–12 years from low SES suburbs have been recruited), further participants with that demographic profile will not be able to complete the survey.

Stimuli

The mock packs have been created by a graphic designer to look similar to existing foods in the market place. An example pack is shown in Fig. 1. The mock packs will vary on two three-level attributes and three four-level attributes, resulting in a total of 576 unique images. Participants will be given the option to view the NIP for each package by clicking a link that will make the NIP appear in conjunction with the front-of-pack product image and the rating scales, allowing participants to provide their rating while viewing the product and the NIP. This will replicate the in-store experience where shoppers have access at the point of sale to both the front-of-pack information and the NIP that is typically located on the back of the pack, with the latter requiring proactive interrogation. The duration of time the NIP is open on the screen will be recorded. Previous experimental studies with adults and children have successfully used this approach [52, 61].

Food type

The foods to be used in this study include those that both adults and children are likely to eat and/or buy. Given findings from previous research showing that people feel less positive towards FoPLs on discretionary foods as opposed to meals [43], one of the four foods was a discretionary

Fig. 1 Example mock pack

food (cookies) and one was a meal (pizza) to permit comparisons. Along with corn flakes and yoghurt, these four food types were chosen because they are commonly purchased products [62], vary widely in healthiness [46], often contain health claims [63] and consumers often make use of the nutrition information contained on the packs of these products [64]. These foods have also been studied frequently in the past, allowing the findings of this study to be compared with those of previous studies [55, 65–75].

Healthiness

The three healthiness profiles (less healthy, moderate, healthier) for each food were created based on existing products in the marketplace and previous research showing that a HSR rating of less than two stars is generally perceived as unhealthy and a star rating greater than three is generally perceived as healthy [43] (possible range of half a star to five stars). An equal distance of one and a half stars between the less healthy, moderate and healthier versions was applied to facilitate subsequent data analysis. Although the healthier versions of the pizzas and cookies in this study would not generally be considered 'healthy', important insights will be gained from comparing consumer judgements of these products with their less healthy counterparts. This reflects the real world where consumers wishing to buy an unhealthy product often still have the choice between a relatively healthier (i.e., 3 stars) or unhealthier (i.e., 1 star) version of the same product. A search was conducted to find existing cookies, corn flakes, pizza and yoghurt products in the Australian marketplace that fit these requirements. There were only a few instances where it was necessary to slightly change a nutrient value so the overall product profile conformed to the requirements outlined above. The resulting less healthy, moderate and healthier profiles are shown in Fig. 2.

Price

Price was set based on the price of the existing products carried by the two main supermarket chains in Australia. The price of the 'cheap' mock product was set at the level of the cheapest product available in that food category in the marketplace (e.g., the cheapest 1 kg vanilla yoghurt tub). Price increased in equal increments (e.g., $1) from cheap to moderate and from moderate to expensive, to enable assessment of participants' willingness to pay for increases in healthiness. The 'expensive' price did not necessarily reflect the cost of the most expensive product in the marketplace. Rather, prices were intentionally kept within a relatively small range so that the price attribute does not dominate choices. The prices for each food are shown in Table 3.

Health claims

One aim of this study is to examine the interaction between health claims and FoPLs. This can be revealed through participant evaluation of nutrition information that is seemingly (but not obviously) contradictory [76]. Table 4 lists the health claims applied to the food products that will be included in the study. Since health claims will appear on less healthy foods, the way these health claims are worded is important. For example, the word "reduced" is used rather than "low" because consumers are likely to be skeptical of a product claiming "low salt" while also showing a red light for salt. In countries with health claim regulations in place, the requirement for making a "low" claim is stricter and more transparent than for making a "reduced" claim and would likely prevent a low salt food achieving a red light for salt. In Australia, foods displaying "reduced" claims must contain 25% less of the specified nutrient than would be found in the same quantity of a reference food [11]. Loose guidelines exist on what can be considered a reference food, allowing manufacturers to compare their product to other foods in the same food category that are high in that nutrient. Thus the using the wording "reduced" is more consistent with the real world setting in which products making "low" claims would likely need to meet specific nutrition content requirements. Information on reactions to contradictory health claims and FoPLs will have implications for the many countries that do not have health claims regulations in place [4].

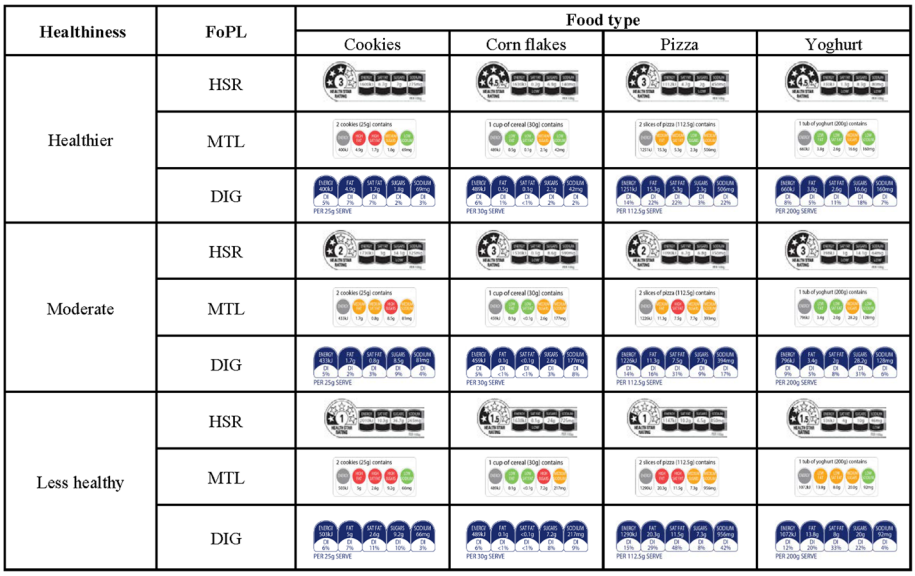

Fig. 2 FoPL stimuli by food type and food healthiness

FoPLs

The FoPLs to be used in this study (DIG, MTL and HSR) are shown in Fig. 2. All four FoPL levels (none, DIG, MTL and HSR) will be represented equally across the mock packs. The DIG and HSR images were created in accordance with guidelines and templates [77, 78]. In the MTL, nutrient information can be expressed per 100 g, per weighted serve (e.g., 160 g) or per meaningful serve (e.g., two slices of pizza). The unit of meaningful serve is recommended by the UK Food Standards Agency [18], and as such was selected for application in this study. In order to maintain the ecological validity of the study, the colors used in the traffic lights were allocated according to the nutrient levels of the mock pack stimuli (see the description provided in the Healthiness subsection above).

Procedure

Participants will be blind to the purpose of the survey and will complete the survey online via a (desktop or laptop) computer in a location of their choice. The survey will begin with demographic questions to assess participants' eligibility to take part in the survey based on the quotas. Participants will also be screened for the frequency with which they buy and consume the foods shown in the survey. Participants who indicate that they "never" purchase or consume more than two of the four foods used in the survey will not be eligible to participate.

Table 3 Price levels by food type

Price	Food type			
	Cookies	Corn flakes	Pizza	Yoghurt
Cheap	$2.65	$1.44	$3.00	$3.99
Moderate	$3.65	$2.94	$4.00	$5.49
Expensive	$4.65	$4.44	$5.00	$6.99

Those who pass the screening process will go on to answer questions on their diet, nutrition knowledge, food purchasing behaviors and attention to and preference for nutrition information on food packs. They will then be shown eight mock food pack images, one at a time, and asked to rate the food product on various outcomes. The rating task will be limited to eight packs to avoid respondent fatigue. This is especially important since each image will need to be rated on several dimensions. The first two packs presented will be 'no FoPL' packs to obtain a baseline measure of participants' perceptions of the products before they are exposed to FoPLs. For those mock products containing no FoPL and no health claim, participants will not have access to any front-of-pack nutrition information, allowing these mock packs to serve as the control condition. Participants will, however, have access to the NIP should they choose to click to view this. Throughout the survey, each participant will be exposed to two instances of each of the four FoPL conditions and two instances of each of the four food types. The occurrence of each level of health claim, price and healthiness will be randomized using the least fill procedure. The same food type will never be shown twice in a row to prevent participants assuming they are being shown the exact same food packet twice and hence failing to properly view the second image.

Participants will rate each food on various adjective rating scales with polar attributes on each end (e.g., unhealthy – healthy, low quality – high quality, boring – interesting). Purchase intentions will be measured using the item "Assuming you were interested in purchasing this

Table 4 Health claim levels by food type

Health claim	Food type			
	Cookies	Corn flakes	Pizza	Yoghurt
No claim	-	-	-	-
Nutrient content claim	Reduced saturated fat	High in fiber	Reduced salt	High in calcium
General level health claim	Reduced saturated fat to help reduce total blood cholesterol	High in fiber to help improve digestive function	Reduced salt to help maintain healthy blood pressure	High in calcium for strong bones
Higher level health claim	Reduced saturated fat. A diet low in saturated fat helps reduce the risk of coronary heart disease.	High in fiber. A diet high in fiber helps reduce the risk of bowel cancer.	Reduced salt. A diet low in salt helps reduce the risk of hypertension.	High in calcium. A diet high in calcium helps reduce the risk of osteoporosis.

type of food, how likely would you be to buy this specific item?". All items will be rated on a 5-point Likert scale.

Participants will then be shown an array of pictures of the food product, served out in different portion sizes with text below each picture describing the portion size (see Fig. 3). Participants will be asked "How much of this product would you like to eat at one time?" followed by "How much of this product should you eat at one time?". The portion size images have been selected from a comprehensive food image database [79]. A "None" option will also be provided for participants who feel they would not and/or should not consume any amount of that product. Fewer options will be provided for the yoghurt and corn flakes portions because these products are typically served in a bowl or tub and it is therefore more difficult to depict discrete serving sizes for these products compared to products such as pizza and cookies that can be broken down to a single unit. Across all the food products, regardless of the number of portion sizes shown, the second image will represent the recommended serving size as reported in the MTL, DIG and/or NIP applied to the mock pack. Given that people often exceed serving size suggestions (particularly for snack foods) [80, 81], this will allow for a range of responses above the recommended serving size.

After all eight mock packs have been rated, participants will be asked if they have used any of the FoPLs from the survey in the past (and, if so, how helpful they had found the labels for previous food purchases) and how useful they were in the survey. Optional demographic items will be posed relating to income and education, the language spoken at home, their height and weight (to permit body mass index (BMI) calculation). Participants will also be asked if they are color blind to enable individuals with this condition to be considered separately in analyses relating to the MTL FoPL. A separate child version of the survey will be created that is identical to the adult survey except that some questions (i.e., food purchasing behavior, household income and education level) will be omitted. Missing data will be

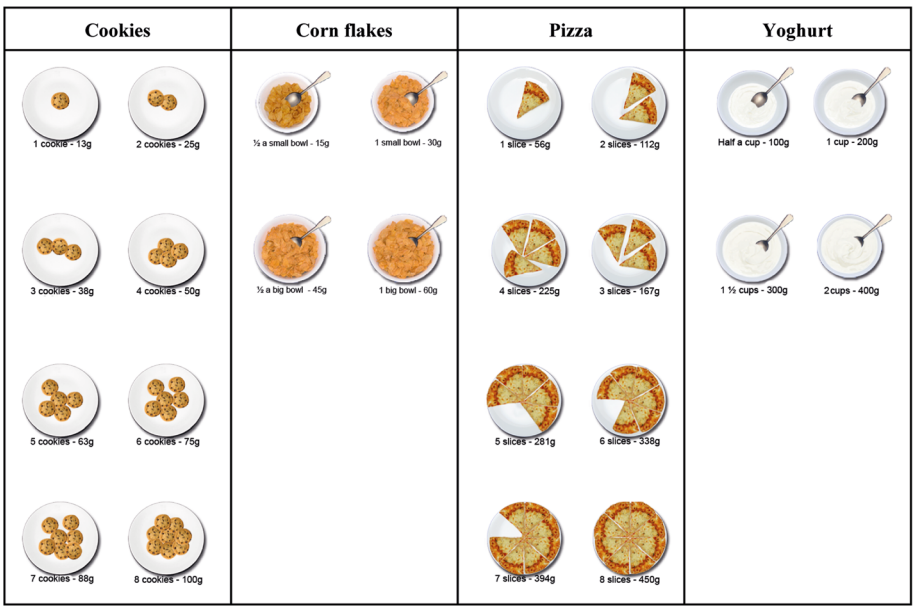

Fig. 3 Portion size options by food type

avoided through the use of forced response questions. For those items that are not forced response and contain missing data, pairwise deletion will be used for analyses concerning these variables. Data storage will be managed as per the Curtin University Ethics Committee requirements. Electronic data will be stored on secure, password protected servers. All Principal Investigators will be given access to the cleaned data sets.

Analysis

Descriptive statistics for participant characteristics, self-reported use of nutrition information, and FoPL preference will be summarized. NIP views will be calculated to test H1a. A factor analysis will be conducted on all adjective rating items to determine whether an overall product perception variable can be extracted. A perceived healthiness variable will be created using the 'unhealthy-healthy' and 'nutritious-non-nutritious' items. Analyses involving this variable will be prioritized over other outcome variables. Manipulation checks will be conducted to ensure that the levels of price and healthiness used in this study were perceived as intended. For the price manipulation check, a linear mixed model will be run with price as the independent variable, participant identifier number as the random factor and aggregated ratings on the 'expensive-cheap' and 'good value for money-poor value for money' items as the dependent variable. For the healthiness manipulation check, a linear mixed model will be run with healthiness of the mock food as the independent variable, participant identifier number as the random factor and perceived healthiness as the dependent variable.

H1a will be tested by measuring the frequency with which the NIP was viewed across all mock pack ratings. Linear mixed models will be used to test H1b and H2. The fixed effects will be participant characteristics (gender, age, SES, education, nutrition knowledge, diet, income and BMI) and mock pack attributes (FoPL type health claim type, NIP views, price, food type and healthiness). The random effect will be participant identifier number. The dependent variables will be overall product perceptions, perceived healthiness, purchase intentions and amount of the product considered appropriate/desirable to consume. The model will test for all main effects and select 2- and 3-way interactions of interest (i.e., FoPL x healthiness, FoPL x health claim, healthiness x NIP views, price x healthiness, health claim x healthiness, FoPL x healthiness x health claim, healthiness x health claim x NIP views). Post hoc comparisons will be conducted to explore the nature of any significant interactions.

Planned comparisons will be run to test specific hypotheses. H3 will be assessed by testing the effect of FoPL x healthiness on perceptions of healthiness. H4 will be assessed by testing for an effect of FoPL x healthiness on purchase intentions. H5a will be assessed by testing for an effect of health claim type on overall product perceptions, purchase intentions and amount of the product considered appropriate/desirable to consume. H5b will be assessed by testing for an effect of health claim x FoPL on overall product perceptions, purchase intentions and food portion sizes selected. A graph showing the predicted outcome for H6b is shown in Fig. 4. A Sidak correction will be applied to any unplanned comparisons.

Discussion

The aim of this study is to better understand how different front- and back-of-pack elements (i.e., NIPs, FoPLs and health claims) in combination with healthiness and price impact on consumers' evaluations of food products. The results will indicate whether particular FoPLs lead to more accurate perceptions of healthiness and, if so, whether they can prevent health claims from inducing a positivity

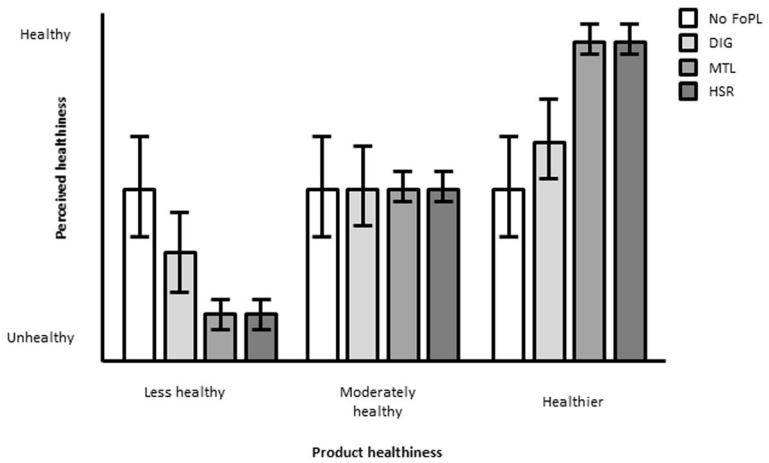

Fig. 4 Expected perceived healthiness ratings by FoPL type and product healthiness

bias in less healthy foods. This study is likely to be one of the first large-scale quantitative studies to include children and to examine the effectiveness of the new HSR front-of-pack labelling system. Recruiting a large, diverse sample of participants will permit identification of which results are generalizable to the population as a whole and which apply to certain demographic groups. A strength of the study will be the full factorial design that provides the ability to systematically vary and fully cross all levels of product attributes. This will minimize the influence of confounding effects (e.g., healthier foods being more expensive) and external variables (e.g., brand loyalty) and allow for a more comprehensive understanding of the influence of each attribute in the context of the other attributes. The results, which will be disseminated through publication in academic journals, are likely to be of substantial interest to public health policy makers and practitioners around the world.

Abbreviations
BMI: Body mass index; DIG: Daily intake guide; FoPL: Front of pack label; HSR: Health star rating; MTL: Multiple traffic lights; NIP: Nutrition information panel; SES: Socio economic status

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Availability of data and materials
Not applicable.

Authors' contribution
SP, HD, BN, CH, TS and CM conceptualized the study. ZT and SP designed the study protocol and prepared the manuscript with input from the other authors. All authors contributed to editing the manuscript. All authors read and approved the final manuscript.

Competing interests
HD, CH, TS and CM are employed by organizations that have contributed funding to this research.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Ethics approval was obtained from the Curtin University Ethics Committee (RDHS-11-15). Consent will be obtained from participants (and also from parents in the case of children) prior to them commencing the study.

Author details
[1]School of Psychology and Speech Pathology, Curtin University, Perth, Western Australia, Australia. [2]Center for Behavioural Research in Cancer, Cancer Council Victoria, Melbourne, Victoria, Australia. [3]The George Institute for Global Health, Sydney, New South Wales, Australia. [4]Cancer Council New South Wales, Sydney, New South Wales, Australia. [5]National Heart Foundation, Perth, Western Australia, Australia. [6]South Australian Health and Medical Research Institute, Adelaide, South Australia, Australia. [7]School of Public Health, University of Adelaide, Adelaide, South Australia, Australia.

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References
1. Nishida C, Uauy R, Kumanyika S, Shetty P. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: Process, product and policy implications. Public Health Nutr. 2004;7:245–50.
2. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2013;380:2224–60.
3. European Food Information Council. Global Update on Nutrition Labelling [Internet]. Brussels: 2015. Available from: http://www.eufic.org/upl/1/default/doc/GlobalUpdateExecSumJan2015.pdf. Cited 19 Nov 2015.
4. Hawkes C. Government and voluntary policies on nutrition labelling: A global overview. In: Albert J, editor. Innovations in food Labelling. Cambridge: Woodhead Publishing Ltd; 2010. p. 37–58.
5. Van Der Bend D, Van Dieren J, Marques MDV, Wezenbeek NL, Kostareli N, Rodrigues PG, et al. A Simple Visual Model to Compare Existing Front-of-pack Nutrient Profiling Schemes. Eur J Food Res Rev. 2014;4:429–534.
6. Balasubramanian SK, Cole C. Consumers' Search and Use of Nutrition Information: The Challenge and Promise of the Nutrition Labeling and Education Act. J Mark. 2002;66:112–27.
7. Ippolito PM, Mathios AD. Health Claims in Food Marketing: Evidence on Knowledge and Behavior in the Cereal Market. J Public Policy Mark. 1991;10:15–32.
8. Tapsell LC. Evidence for Health Claims: A Perspective from the Australia–New Zealand Region. J Nutr. 2008;138:1206S–9S.
9. Regulation (EC) No 1924/2006 of European Parliament and of the Council 20 December 2006 on nutrition and health claims made on foods. [Internet]. 2006. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1924&from=en.
10. Food and Drug Administration. Guidance for Industry: A Food Labeling Guide [Internet]. 2014 [cited 2016 Feb 3]. Available from: http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm2006828.htm#ftn1.
11. Food Standards Australia New Zealand. Standard 1.2.7: Nutrition, Health and Related Claims [Internet]. 2016. Available from: https://www.legislation.gov.au/Details/F2016C00082.
12. Schaefer D, Hooker NH, Stanton JL. Are Front of Pack Claims Indicators of Nutrition Quality? Evidence from 2 Product Categories. J. Food Sci. [Internet]. 2015 [cited 2016 Apr 14]; Available from: http://onlinelibrary.wiley.com/doi/10.1111/1750-3841.13150/pdf.
13. Debeljak K, Pravst I, Kosmelj K, Kac M. "Healthier" and "Less Healthy" Classifications According to Three Nutrient Profiling Systems Relative to Nutrition and Health Claims on Food Labels. Acta Aliment. 2015;44:561–9.
14. Hughes C, Wellard L, Lin J, Suen KL, Chapman K. Regulating health claims on food labels using nutrient profiling: what will the proposed standard mean in the Australian supermarket? Public Health Nutr. 2013;16:2154–61.
15. Kaur A, Scarborough P, Hieke S, Kusar A, Pravst I, Raats MM, et al. The nutritional quality of foods carrying health-related claims in Germany, the Netherlands, Spain, Slovenia, and the United Kingdom. Eur. J Clin Nutr. [Internet]. 2016 [cited 2016 Oct 10]; Available from: http://epubs.surrey.ac.uk/810903/.
16. Kaur A, Scarborough P, Matthews A, Payne S, Mizdrak A, Rayner M. How many foods in the UK carry health and nutrition claims, and are they healthier than those that do not? Public Health Nutr. 2016;19:988–97.
17. Hodgkins C, Barnett J, Wasowicz-Kirylo G, Stysko-Kunkowska M, Gulcan Y, Kustepeli Y, et al. Understanding how consumers categorise nutritional labels: A consumer derived typology for front-of-pack nutrition labelling. Appetite. 2012;59:806–17.
18. Food Standards Agency. Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets [Internet]. Unighted Kindom; 2013. Available from: https://www.gov.uk/government/publications/front-of-pack-nutrition-labelling-guidance.
19. Borra S. Consumer perspectives on food labels. Am J Clin Nutr. 2006;83:1235S.
20. Rothman RL, Housam R, Weiss H, Davis D, Gregory R, Gebretsadik T, et al. Patient Understanding of Food Labels: The Role of Literacy and Numeracy. Am J Prev Med. 2006;31:391–8.
21. Maubach N, Hoek J, Mather D. Interpretive front-of-pack nutrition labels. Comparing competing recommendations. Appetite. 2014;82:67–77.

22. Grunert KG, Wills JM, Fernández-Celemín L. Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. Appetite. 2010;55:177–89.
23. Signal L, Lanumata T, Robinson J-A, Tavila A, Wilton J, Ni Mhurchu C. Perceptions of New Zealand nutrition labels by Māori, Pacific and low-income shoppers. Public Health Nutr. 2008;11:706–13.
24. Calfee JE, Pappalardo JK. Public Policy Issues in Health Claims for Foods. J Public Policy Mark. 1991;10:33–53.
25. Nestle M, Ludwig DS. Front-of-package food labels: Public health or propaganda? J Am Med Assoc. 2010;303:771–2.
26. Chan C, Patch C, Williams P. Australian consumers are sceptical about but influenced by claims about fat on food labels. Eur J Clin Nutr. 2004;59:148–51.
27. Szykman LR, Bloom PN, Levy AS. A Proposed Model of the Use of Package Claims and Nutrition Labels. J Public Policy Mark. 1997;16:228–41.
28. Dean M, Lähteenmäki L, Shepherd R. Nutrition communication: consumer perceptions and predicting intentions. Proc Nutr Soc. 2011;70:19–25.
29. Leathwood PD, Richardson DP, Sträter P, Todd PM, van Trijp HCM. Consumer understanding of nutrition and health claims: sources of evidence. Br J Nutr. 2007;98:474–84.
30. Williams P. Consumer Understanding and Use of Health Claims for Foods. Nutr Rev. 2005;63:256–64.
31. Wills JM, Bonsmann SS, Kolka M, Grunert KG. European consumers and health claims: attitudes, understanding and purchasing behaviour. Proc Nutr Soc. 2012;71:229–36.
32. Hawley KL, Roberto CA, Bragg MA, Liu PJ, Schwartz MB, Brownell KD. The science on front-of-package food labels. Public Health Nutr. 2013;16:430–9.
33. Hersey JC, Wohlgenant KC, Arsenault JE, Kosa KM, Muth MK. Effects of front-of-package and shelf nutrition labeling systems on consumers. Nutr Rev. 2013;71:1–14.
34. Grunert KG, Wills JM. A review of European research on consumer response to nutrition information on food labels. J Public Health. 2007;15:385–99.
35. Cowburn G, Stockley L. Consumer understanding and use of nutrition labelling: a systematic review. Public Health Nutr. 2005;8:21–8.
36. Talati Z, Pettigrew S, Hughes C, Dixon H, Kelly B, Ball K, et al. The combined effect of front-of-pack nutrition labels and health claims on consumers' evaluation of food products. Food Qual Prefer. 2016;57–65.
37. McLean R, Hoek J, Hedderley D. Effects of alternative label formats on choice of high- and low-sodium products in a New Zealand population sample. Public Health Nutr. 2012;15:783–91.
38. Louviere JJ, Lancsar E. Choice experiments in health: the good, the bad, the ugly and toward a brighter future. Health Econ Policy Law. 2009;4:527–46.
39. Johnson FR, Lancsar E, Marshall D, Kilambi V, Mühlbacher A, Regier DA, et al. Constructing experimental designs for discrete-choice experiments: report of the ISPOR conjoint analysis experimental design good research practices task force. Value Health. 2013;16:3–13.
40. Sanlier N, Karakus SS. Evaluation of food purchasing behaviour of consumers from supermarkets. Br Food J. 2010;112:140–50.
41. French SA. Pricing Effects on Food Choices. J. Nutr. 2003;133:841S–3S.
42. Steenhuis IH, Waterlander WE, de Mul A. Consumer food choices: The role of price and pricing strategies. Public Health Nutr. 2011;14:2220–6.
43. Talati Z, Pettigrew S, Kelly B, Ball K, Dixon H, Shilton T. Consumers' responses to front-of-pack labels that vary by interpretive content. Appetite. 2016;101:205–13.
44. Marshall D. Understanding Children as Consumers. London: SAGE; 2010.
45. Calvert SL. Children as Consumers: Advertising and Marketing. Future Child. 2008;18:205–34.
46. World Health Organisation. Report of the commission on ending child obesity [Internet]. Geneva; 2016. Available from: http://www.who.int/end-childhood-obesity/en/.
47. Brierley M, Elliott C. Nutritional components and children's interpretations of packaged food. Int J Health Promot Educ. 2015;0:1–14.
48. Lytle LA, Eldridge Al, Kotz K, Piper J, Williams S, Kalina B. Children's Interpretation of Nutrition Messages. J Nutr Educ. 1997;29:128–36.
49. Neeley SM, Petricone B. Children's (Mis)understanding of Nutritional Information on Product Packages: Seeking Ways to Help Kids Make Healthier Food Choices. Adv Consum Res. 2006;33:556–7.
50. Elliott C, Brierley M. Healthy Choice?: Exploring How Children Evaluate the Healthfulness of Packaged Foods. Can J Public Health. 2012;103:e453-8.
51. Soldavini J, Crawford P, Ritchie LD. Nutrition Claims Influence Health Perceptions and Taste Preferences in Fourth- and Fifth-Grade Children. J Nutr Educ Behav. 2012;44:624–7.
52. Dixon H, Scully M, Niven P, Kelly B, Chapman K, Donovan R, et al. Effects of nutrient content claims, sports celebrity endorsements and premium offers on pre-adolescent children's food preferences: experimental research. Pediatr Obes. 2014;9:e47–57.
53. Wong SF, Norman R, Dunning TL, Ashley DM, Lorgelly PK. A protocol for a discrete choice experiment: understanding preferences of patients with cancer towards their cancer care across metropolitan and rural regions in Australia. BMJ Open. 2014;4:e006661.
54. Raats MM, Hieke S, Jola C, Hodgkins C, Kennedy J, Wills J. Reference amounts utilised in front of package nutrition labelling; impact on product healthfulness evaluations. Eur J Clin Nutr. [Internet]. 2014 [cited 2015 Jan 9]; Available from: http://www.nature.com/ejcn/journal/vaop/ncurrent/full/ejcn2014190a.html.
55. Hodgkins CE, Raats MM, Fife-Schaw C, Peacock M, Gröppel-Klein A, Koenigstorfer J, et al. Guiding healthier food choice: systematic comparison of four front-of-pack labelling systems and their effect on judgements of product healthiness. Br J Nutr. 2015;113:1652–63.
56. Roberto CA, Bragg MA, Seamans MJ, Mechulan RL, Novak N, Brownell KD. Evaluation of Consumer Understanding of Different Front-of-Package Nutrition Labels, 2010–2011. Prev Chronic Dis. [Internet]. 2012 [cited 2015 Sep 15];9. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3475525/.
57. Dixon H, Scully M, Kelly B, Chapman K, Wakefield M. Can counter-advertising reduce pre-adolescent children's susceptibility to front-of-package promotions on unhealthy foods?: Experimental research. Soc Sci Med. 2014;116:211–9.
58. John DR. Consumer Socialization of Children: A Retrospective Look At Twenty-Five Years of Research. J Consum Res. 1999;26:183–213.
59. Australian Bureau of Statistics. Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia [Internet]. 2011. Available from: http://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa2011?opendocument&navpos=260.
60. Huitt W, Hummel J. Piaget's theory of cognitive development. Educ Psychol Interact. 2003;3:1–5.
61. Dixon H, Scully M, Wakefield M, Kelly B, Chapman K, Donovan R. Parent's responses to nutrient claims and sports celebrity endorsements on energy-dense and nutrient-poor foods: an experimental study. Public Health Nutr. 2011;14:1071–9.
62. Penton Media, Inc. Data Table: Supermarket Categories by Dollar, Unit Sales. Supermark. News [Internet]. 2015 [cited 2016 Mar 15]; Available from: http://supermarketnews.com/[primary-term]/data-table-supermarket-categories-dollar-unit-sales.
63. The George Institute. FoodSwitch [Internet]. 2016 [cited 2016 Mar 15]. Available from: http://www.foodswitch.com.au/.
64. Williams P, Yeatman H, Ridges L, Houston A, Rafferty J, Roesler A, et al. Nutrition function, health and related claims on packaged Australian food products-prevalence and compliance with regulations. Asia Pac J Clin Nutr. 2006;15:10–20.
65. Bialkova S, Grunert KG, van Trijp H. Standing out in the crowd: The effect of information clutter on consumer attention for front-of-pack nutrition labels. Food Policy. 2013;41:65–74.
66. Dean M, Lampila P, Shepherd R, Arvola A, Saba A, Vassallo M, et al. Perceived relevance and foods with health-related claims. Food Qual Prefer. 2012;24:129–35.
67. Draper AK, Adamson AJ, Clegg S, Malam S, Rigg M, Duncan S. Front-of-pack nutrition labelling: are multiple formats a problem for consumers? Eur J Public Health. 2013;23:517–21.
68. Drescher LS, Roosen J, Marette S. The effects of traffic light labels and involvement on consumer choices for food and financial products. Int J Consum Stud. 2014;38:217–27.
69. Emrich TE, Qi Y, Mendoza JE, Lou W, Cohen JE, L'Abbé MR. Consumer perceptions of the Nutrition Facts table and front-of-pack nutrition rating systems. Appl Physiol Nutr Metab. 2013;39:417–24.
70. Helfer P, Shultz TR. The effects of nutrition labeling on consumer food choice: a psychological experiment and computational model. Ann N Y Acad Sci. 2014;1331:174–85.
71. van Herpen E, Seiss E, van Trijp HCM. The role of familiarity in front-of-pack label evaluation and use: A comparison between the United Kingdom and The Netherlands. Food Qual Prefer. 2012;26:22–34.
72. van Herpen E, van Trijp HCM. Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints. Appetite. 2011;57:148–60.

73. Vidal L, Antúnez L, Sapolinski A, Giménez A, Maiche A, Ares G. Can Eye-Tracking Techniques Overcome a Limitation of Conjoint Analysis? Case Study on Healthfulness Perception of Yogurt Labels. J Sens Stud. 2013;28:370–80.
74. Wasowicz-Kirylo G, Stysko-Kunkowska M. Attributes of Nutritional Information Labelling that Determine Attractiveness of Labels and Correctness of Inferences Made About Food Healthfulness. Procedia - Soc Behav Sci. 2011;30:722–8.
75. Watson WL, Kelly B, Hector D, Hughes C, King L, Crawford J, et al. Can front-of-pack labelling schemes guide healthier food choices? Australian shoppers' responses to seven labelling formats. Appetite. 2014;72:90–7.
76. Talati Z, Pettigrew S, Neal B, Dixon H, Hughes C, Kelly B, et al. A systematic review of consumers' responses to health claims in the context of other on-pack nutrition information. In press.
77. Commonwealth of Australia. Health Star Rating calculator and artwork [Internet]. 2014. Available from: http://healthstarrating.gov.au/internet/healthstarrating/publishing.nsf/Content/calculator.
78. Australian Food and Grocery Council. Code of practice for food labelling and promotion [Internet]. 2011. Available from: http://plesk.s78744.gridserver.com/doc-library/category/5-public-tools-and-guides.html?download=405%3Acode-of-practice-for-food-labelling-and-promotion-jan11.
79. Blechert J, Meule A, Busch NA, Ohla K. Food-pics: an image database for experimental research on eating and appetite. Eat Behav. 2014;5:617.
80. Antonuk B, Block LG. The Effect of Single Serving Versus Entire Package Nutritional Information on Consumption Norms and Actual Consumption of a Snack Food. J Nutr Educ Behav. 2006;38:365–70.
81 Wansink B. Environmental Factors That Increase the Food Intake and Consumption Volume of Unknowing Consumers. Annu Rev Nutr. 2004;24:455–79.