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Food-variety-focused labelling does not increase ideal portion size, expected fullness or snack intake.

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Abstract

As greater food variety has been shown to increase intake and is associated with a higher BMI, interventions that modify the effects of food variety have implications for combatting obesity. Previous research has shown that labelling a food with ‘high variety’ flavour-specific labels can reduce an individual’s satiation whilst eating. We were interested in whether the effects of ‘variety labelling’ would also be observed on portion size selection and *ad libitum* food intake. Therefore, two studies were conducted to explore the effects of labelling foods with different levels of variety on ideal portion size, ratings of expected fullness, and actual intake. In Study 1 (N = 294), participants viewed images of a range of foods that were presented with either high variety labels (descriptions of within-food components), low variety labels (general names of food items), or no label in an online survey. They selected their ideal portion size and rated their expected fullness for each food. In Study 2 (N = 99), they also consumed one of these foods *ad libitum* in the laboratory. It was hypothesised that foods presented with high variety labels would have an increased ideal portion size, reduced expected fullness, and increased intake compared to foods presented with low variety labels or no label. Our findings failed to support these predictions, and we found no evidence of an effect of variety labelling on ideal portion size, expected fullness or food intake. These findings highlight the importance of considering the ecological validity of consumer research studies.

Key words: food variety; food labelling; portion size; expected fullness; food intake

Abstract word count: 249

Global trends show that approximately 2 of every 3 adults are overweight or obese (World Health Organisation, 2017), and this has been associated with increased risk of conditions that reduce life expectancy such as type 2 diabetes, cardiovascular diseases, and cancer (Guh et al., 2009; Wang, McPherson, Marsh, Gortmaker, & Brown, 2011). Obesity is a multifactorial disease (Foresight, 2007). Though food variety across the diet is essential to maintaining dietary quality (Raynor & Vadiveloo, 2018), it is also a factor that is known to be related to obesity, influencing overconsumption, body fatness, and weight gain (McCrory, Burke, & Roberts, 2012; McCrory et al., 1999).

'Food variety' can be present at different levels of the eating environment. Food variety is often used to refer to when foods belonging to different food groups are consumed as part of a varied diet. However, in the extant literature, variety typically refers to when foods that differ in their sensory components are consumed across the courses of a meal. Specifically, these sensory components can refer to a food's flavour, colour and/or texture (for a comprehensive review, see Raynor & Vadiveloo, 2018). For instance, in a seminal study, Rolls, Rowe et al. (1981) demonstrated that presenting different foods across a succession of courses increased participant intake compared to sequentially presenting servings of the same food. Since then, this 'variety effect' has also been shown to occur when presenting different foods as part of a single course (Wijnhoven, van der Meij, & Visser, 2015). It has also been suggested that it may occur when single products consist of different sensory components (Raynor & Vadiveloo, 2018; Weijzen, Zandstra, Alfieri, & de Graaf, 2008).

The tasting of other foods with different sensory characteristics (i.e. variety) disrupts the process of 'sensory specific satiety' that is believed to be underpinned by habituation (Higgs, Williamson, Rotshtein, & Humphreys, 2008; Wilkinson & Brunstrom, 2016). Greater variety delays the decline in pleasantness that is experienced for a food being eaten relative to uneaten foods (Rolls, Rolls et al., 1981), and encourages the consumption of other available foods that have different sensory properties (Brondel et al., 2009; Hetherington, Foster, Newman, Anderson, & Norton, 2006).

Interventions for food variety typically adopt a direct dietary-focused approach to the management of food intake, recommending that individuals restrict their consumption of low-nutrient, high-energy-dense foods (defined as foods that provide few nutrients relative to their energy density). In the context of developing long-term specialised interventions for obesity, limiting the availability of low nutrient, high energy-dense foods to two choices whilst controlling daily calorie and fat intake has been found to successfully reduce energy consumption at 6 months (Raynor, Steeves, Hecht, Fava, & Wing, 2012). Restricting variety of low nutrient, high energy-dense foods, in addition to encouraging the repetition of meals on a weekly basis, has also been found to improve weight loss for both adults and children as part of a family-based treatment programme (Epstein, Kilanowski, Paluch, Raynor, & Daniel, 2015). In a short-term experimental setting, providing a choice of different fruits and vegetables at a meal has been found to increase intake compared to presenting multiple servings of the same fruit or vegetable, suggesting that variety can encourage the consumption of healthy foods in a single eating session (Meengs, Roe, & Rolls, 2012; Raynor & Osterholt, 2012).

Recently, it has been reported that meal planning is an important influence on intake (Brunstrom, 2014). Specifically, studies have shown that meals tend to be eaten in their entirety and are often pre-planned (Fay et al., 2011; Robinson, te Raa, & Hardman, 2015). In turn, this tendency to plate clear has been associated with a higher body weight (Robinson, Aveyard, & Jebb, 2015). In the context of meal planning, ‘expected satiation’ has been identified as a mechanism that influences ideal portion size selection; foods that are expected to be less filling are selected in larger portions (Brunstrom, 2011; Brunstrom & Rogers, 2009;

Wilkinson et al., 2012).

Moreover, Wilkinson et al. (2013) demonstrated that individuals can anticipate the variety effect when planning meals. They found that participants select larger portions of a food and rate a food as more pleasant if it is entirely different from their previous course rather than sensorially similar or the same. Considering this cognitive element to the appreciation of variety, one possibility is that labelling (which is also evaluated prior to or alongside consumption) may be used to influence the perception of variety.

Labelling strategies that influence the sensory evaluation and consumption of foods typically focus on the effects of presenting nutritional and health information to consumers (for a review, see Brown, Rollo, de Vlieger, Collins, & Bucher, 2018, and Piqueras-Fiszman & Spence, 2015). For example, labelling a food with a description that emphasises the benefits of its nutritional content for physical fitness (as opposed to mental fitness in a neutral condition) increased participants' selected serving size and intake in one study (Koenigstorfer, Groeppel-Klein, Kettenbaum, & Klicker, 2013). Labelling a food to emphasise healthy features (rather than taste and quantity-focused features) has also been shown to reduce self-reported satiety ratings after eating (Vadiveloo, Morwitz, & Chandon, 2013). Similarly, ingredient-focussed names have been found to influence the sensory perception of foods; participants reported a more 'chocolatey' taste when chocolates were labelled 'dark' rather than 'milk' (Shankar, Levitan, Prescott, & Spence, 2009).

One highly novel study has explored the possibility of manipulating the *perception* of food variety using labelling (an indirect manipulation of the variety effect). Redden (2008) asked participants to consume fruit flavoured jellybeans from a plastic tube. Each consecutive jellybean was presented with a food label on a computer screen, and participants viewed either flavour-specific labels (e.g. 'Cherry', 'Orange'), or a single general label that minimised within-food differences (i.e. 'Jellybean'). While eating the jellybeans, participants were asked to rate how much they were enjoying the food, and their desire to eat more of the food. Redden found that participants presented with flavour specific labels enjoyed eating the food more and had a greater desire to continue eating compared to participants presented with a general label. This indicates that flavour-specific labels have the potential to significantly reduce satiation and increase pleasantness of a food. However, we note that this study has poor ecological validity. For example, despite individuals tending to ordinarily select and consume foods in their entirety in the real world, the amount of food that participants consumed in Redden's study was controlled and participants were prevented from viewing the whole assortment of jellybeans at once.

Therefore, the aim of this study was to investigate the effect of presenting participants with foods labelled to reflect the variety in that food (or not) on portion size selection and expected satiation. In Study 1, we explored this idea in an online study using a modified version of a food photography method developed by Brunstrom and Rogers (2009), and asked participants to select their ideal portion size and rate the expected fullness (visual analogue scale; VAS) of a range of foods. The between-subjects factor was label type; images of foods were displayed to participants with either no label (study control), low variety labels (general names of food items), or high variety labels (descriptions of food components). It was hypothesised that a high variety label would increase ideal portion size and reduce expected fullness compared to a low variety label or no label. The within-subjects factor was food type; participants viewed and rated images of four different foods (breakfast food, main meal, sweet snack, savoury snack). It was hypothesised that there would be no interaction between labelling condition and food type, as it was expected that labelling effects would be consistent across foods.

In a second study, we extended Study 1 by testing effects of our labelling manipulation on actual intake in the laboratory. Participants selected their ideal portion size and rated their expected fullness for five different foods (breakfast food, main meal, sweet snack, savoury snack, dessert). They also consumed a savoury snack *ad libitum*. It was hypothesised that a high variety label would increase intake of a snack (in kcal), in addition to increasing ideal portion size and reducing expected fullness ratings for foods, compared to presenting foods with low variety labels or no label. Like Study 1, we also predicted that labelling effects would be consistent across foods.

2. Study 1

2.1. Method

2.1.1. Participants

The sample consisted of 294 participants (222 females; mean age 24.8 years, SD = 9.1). The mean self-reported BMI was 23.8 kg/m^2 (SD = 6.5). Required sample size was determined using g*power (N = 277), and data collection was stopped when 326 responses had been recorded to account for unusable data (e.g. where participants did not complete questions relevant to the study hypotheses and where the same participants provided more than one response). Participants were recruited online via Swansea University's participant subject pool, social media and survey sharing platforms (e.g. 'Survey Circle'). Participants were excluded if they were currently on a diet, had an existing/history of eating disorders, were vegetarian/vegan or had food allergies. Participants were informed that the aim of the study was to investigate an individual's reasons for choosing their 'perfect portion size of a particular food' and were compensated for their time with course credit and/or entry into a prize draw to win one of two £25 vouchers. The study was approved by the Department of Psychology's Research Ethics Committee.

2.1.2. Foods

Four test foods were presented to participants in Study 1 (see Table 1 for macronutrient information and labels in each condition). All foods were selected on the basis that; they each belonged to a different food category (i.e., breakfast food, lunch food, sweet snack, and savoury snack), they contained multiple food components that could be emphasised (or not) on a product label, and they would be recognisable to participants. For this reason, foods were sourced from popular supermarkets in the UK (Sainsbury's Supermarkets Ltd., London and Tesco plc., London). All foods were photographed against a white background from a top-down view using a high-resolution digital camera and tripod with lateral arm. The chicken chow mein (lunch food), chocolate (sweet snack), and crisps (savoury snack) were photographed on a white dinner plate (204-mm diameter, 36-mm depth). The granola (breakfast food) was photographed in a shallow white bowl (204-mm diameter, 36-mm depth). A series of 50 photographs were produced for each food to display a range of portion sizes to participants that incrementally differed by ≈20 kcal, increasing from a 20kcal portion to a 1000kcal portion. Lighting and positioning across images within a series were kept as consistent as possible. Photographs were edited using Microsoft Photos for Windows 10 and PhotoScape V3.7 (see Figure 1).

Table 1

Test foods used for photographs in studies 1 and 2, with accompanying 'variety' labels and macronutrient information for each food. Full product names are provided for each food.

	Low variety label	High variety label	Kcal/ 100 g	Fat/ 100 g	Sugars/ 100 g	Salt/ 100 g
Granola *Tesco Superberry Granola*	Granola	Oat clusters with pumpkin seeds, blackcurrants, blueberries and cranberries	433.5	13.3	20.5	0.03
Revels *Revels, by Mars Inc.*	Revels	Orange, raisin, coffee and toffee centre	483	21.0	63.3	0.29

		chocolates				
Strudel[1, 2] *2 Woodland Fruit Strudels by Sainsbury's*	Woodland fruit strudel	Apple, raspberry, blackberry and blueberry strudel	268	12.7	7.0	0.3
[3]Chicken chow mein *Chicken Chow Mein by Sainsbury's*	Chicken chow mein	Chicken noodles with beansprouts, cabbage, red peppers, carrots and onion.	96	2.5	2.4	0.55
Crisps *Salt & Black Pepper Combo Mix by Sainsbury's*	Seasoned crisps ('Salt and pepper snack mix' in Study 2)	Potato crisps with a sea salt, black pepper, onion and garlic seasoning ('Salt and pepper potato wheels, sticks, curls and ridged crisps' in Study 2).	476	21	1.6	1.8

[1]A puff pastry dessert with a mixed fruit filling.
[2]This food was presented to participants in Study 2 only.
[3]This food was low energy density (<2.5kcal/g), as defined by Albar, Alwan, Evans, and Cade (2014).

Fig. 1. ***Photographs of chicken chow mein (main meal).*** A 20kcal portion with no label, a 500kcal portion with a low variety label, and a 1000kcal portion with a high variety label are displayed from left to right, respectively.

2.1.3. Measures

2.1.3.1. Ideal portion size

To measure ideal portion size, we modified the approach by Brunstrom and Rogers (2009) for use in an online setting using the survey software 'Qualtrics' (Qualtrics, Provo, UT; https://www.qualtrics.com). Rather than presenting single images to participants consecutively, image size was reduced and all photographs of a given food were displayed on screen in order of portion size from smallest to largest as part of a Likert scale. Participants were instructed to move vertically through the images using the scroll bar in Qualtrics and select the option that best represented their "ideal portion size for that particular food". Each image was assigned a randomly-generated 3-digit code which was recorded by Qualtrics. This was used by the researcher to identify the corresponding serial number of the chosen image and in turn the calorie content of the selected portion in Excel.

2.1.3.2. Rating scales

To measure expected fullness, participants were asked 'How full would you expect to feel after eating the portion of food displayed above?' and provided ratings using Qualtrics on 100mm VAS anchored 'Not at all' to the left and 'Extremely' to the right.

Using the same format, liking was assessed by asking participants 'How much do you like this food?' (Strongly dislike–Strongly like), food wanting by asking participants 'How strong is your desire to eat this food right now?' (Very weak–Very strong), food familiarity by asking participants 'How often do you consume this food?' (Never–On a daily basis), baseline hunger by asking participants 'How hungry do you feel right now?' (Not at all–

Extremely) and baseline fullness by asking participants ‘How full do you feel right now?’ (Not at all–Extremely).

All ratings were provided in response to image 25 (the middle image of the range) for each food set.

2.1.3.3. Questionnaires

The three-factor eating questionnaire-R18 (TFEQ-R18; Karlsson, Persson, Sjöström, & Sullivan, 2000) was used to measure and control for potential differences in dietary restraint (“I deliberately take small helpings as a means of controlling my weight”), uncontrolled eating (“Sometimes when I start eating, I just can't seem to stop”), and emotional eating (“When I feel anxious, I find myself eating”) across conditions. Responses were provided on a 4-point Likert scale (this generally being; definitely true/mostly true/mostly false/definitely false), with higher scores on each respective sub-scale indicating a stronger tendency toward dietary restraint, uncontrolled eating and emotional eating. Internal consistency for the questionnaire is supported, with Cronbach Alpha values of 0.76-0.77, 0.83, and 0.85 for the dietary restraint, uncontrolled eating, and emotional eating subscales respectively (as reported by Karlsson et al., 2000).

At the end of the study, participants were asked two questions to check for demand awareness. First, participants were asked “What do you think the aim of the study was?”, and answers were provided in an open-text field. Second, participants were asked “Which condition do you think you were in?” and were provided with multiple choice options that revealed the study conditions (no label on food/low variety label on food/high variety label on food/don’t know).

2.1.4. Procedure

All participants were asked to abstain from eating for approximately 2 hours before completing the survey on Qualtrics. Participants were presented with an online information sheet detailing ethical concerns and the survey content. They completed an online consent form and read general task instructions. Participants provided information about their age and gender, the current time and the time they last ate to calculate time lapsed since eating (in hours). Participants rated their current hunger and fullness. Participants were randomised into a condition using the Qualtrics randomisation feature so that all images would have either a high variety label, low variety label, or no label. They were then presented with the first series of food images and after selecting their ideal portion size, they provided ratings of expected fullness, food familiarity, food liking, and food wanting for the given food. This was repeated for foods 2-4. Participants then completed the TFEQ, before self-reporting their height and weight measurements. Participants awareness of the study aims was checked before an online debrief form was presented. The survey was completed in approximately 30 minutes.

2.1.5. Data analysis

A series of one-way ANOVAs were used to ensure that randomisation of participants to labelling conditions was successful and that there were no significant differences between groups for baseline hunger, baseline fullness, age, BMI, restraint, uncontrolled eating, and emotional eating. Chi-square was used to check for differences in the allocation of participants to conditions by gender. A bivariate correlation matrix was used to identify potential covariates to be included in models; direct relationships between sample characteristics and dependent variables were assessed and if significant these characteristics were included (see supplementary materials). Two 3 x 5 mixed MANCOVAs were used to assess for differences in ideal portion size (controlling for significant effects of gender, uncontrolled eating and food wanting) and expected fullness (controlling for significant effects of gender, restraint and food liking) respectively. As necessary, Bonferroni pairwise comparisons were used to explore significant main effects and/or interactions. Supplementary analyses showed that results were consistent when participants who were unfamiliar with the test foods (Familiarity VAS = 0) were removed from analyses (see Supplementary Table 3). These analyses were conducted in IBM SPSS v22.

To clarify whether the data provided adequate evidence to support the alternative/null hypotheses, two Bayesian MANCOVAs were used to further investigate parameters of effects on ideal portion size and expected fullness. Bayesian analyses were conducted using the open source programme JASP (https://jasp-stats.org). The default JASP multivariate Cauchy prior scales were used in all Bayesian model comparisons (r scale fixed effects = 0.5, r scale covariates = 0.354), and covariates were added to the null model as nuisance variables. For ideal portion size, Bayesian main effect and interaction models were adjusted for significant effects of gender, uncontrolled eating, and food wanting. For expected fullness, Bayesian main effect and interaction models were adjusted for significant effects of age, gender, baseline fullness, food liking, and restraint. To isolate interaction effects, models with the interaction + main effect terms were divided by the main effect model. This was calculated for all interaction models following guidelines by Mathôt (2017) for two factors using BF_{10} values.

The full dataset has been made available on the Open Science Framework (https://osf.io/vut6k/).

2.2. Results

2.2.1. Participant characteristics

There were no significant differences in age, BMI, baseline hunger, baseline fullness, time lapsed since eating, cognitive restraint, uncontrolled eating, or emotional eating between groups (see Table 2). There was a marginal difference in the allocation of males and females to label conditions; there were 15 males in the no label condition, 21 males in the low variety label condition, and 29 males in the high variety label condition (χ^2 (2, N = 287) = 5.62, p = .06). All participants were unaware of the study aims – no participant referred to food variety or labelling effects when asked at the end of the study. When the labelling conditions were revealed to participants, 29.3% of participants correctly guessed their allocation to the no label condition, 41% to the high variety label condition, and 56.8% to the low variety label condition. For mean food liking, food wanting, and food familiarity across groups, see Supplementary Figures 1-3.

Table 2

Establishing that sample characteristics were matched across high variety label (HL), low variety label (LL), and no label (NL) groups in Study 1. Mean (M) and standard error (SE) values are displayed.

	Condition						Degrees of freedom	F-value	P-value
	NL (N = 99)		LL (N = 95)		HL (N = 100)				
	M	SE	M	SE	M	SE			
Age (years)	24.6	.99	25.0	.89	25.0	.89	2, 287	.05	.96
BMI (kg/m^2)	23.1	.72	21.1	.80	23.1	.99	2, 290	1.73	.18
Baseline hunger (mm)	36.3	2.66	42.1	3.30	39.6	3.03	2, 291	.93	.40
Baseline fullness (mm)	47.3	2.62	41.3	2.85	43.2	2.83	2, 291	1.24	.29

Time lapsed since eating (hours)	4.3	.47	4.3	.48	3.6	.37	2, 291	.90	.41
Restraint	13.3	.34	13.7	.38	13.3	.41	2, 287	.31	.74
Uncontrolled eating	22.3	.54	22.3	.53	22.8	.51	2, 287	.31	.74
Emotional eating	7.7	.26	7.3	.29	7.7	.27	2, 287	.71	.49

2.2.2. The effect of variety labelling on ideal portion size

There was no significant between-subjects effect of variety labelling condition on ideal portion size ($F(2, 269) = .04$, $p = .96$, $\eta_p^2 = .000$). As Mauchly's test of sphericity was significant ($p < .001$), the Greenhouse-Geisser correction was applied to within-subjects effects. There was no significant interaction between food category and variety labelling condition ($F(4.86, 653.02) = .26$, $p = .93$, $\eta_p^2 = .002$). See Fig. 2.

Bayesian comparisons revealed that the data infers 'very strong' evidence in favour of the null hypothesis that variety labelling does not influence ideal portion size (BF_{10} 0.02, Error = 1.427%). The data also infers 'decisive' evidence in favour of the alternative hypothesis that food category and labelling condition do not interact to affect ideal portion size (BF_{10} 0.001, Error = 1.746%).

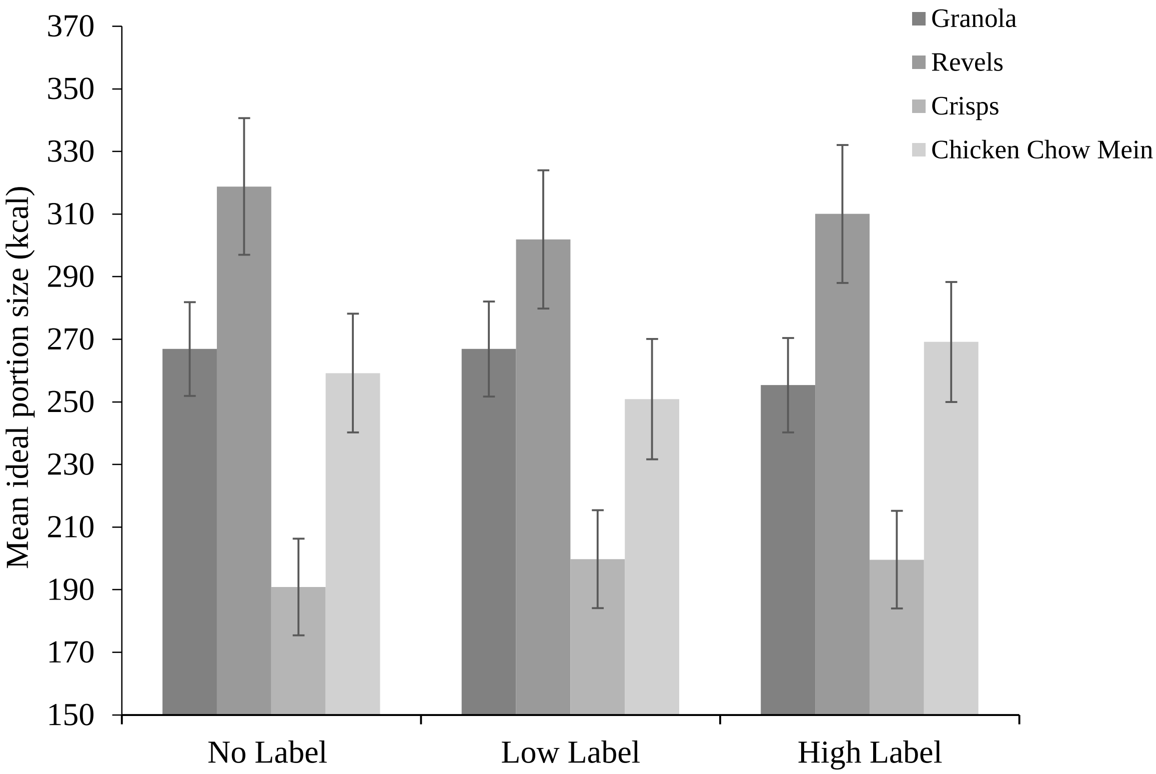

Fig. 2. *Mean ideal portion size* across variety labelling conditions for each food in Study 1. Error bars indicate standard error.

2.2.3. The effect of variety labelling on expected fullness

There was no significant between-subjects effect of variety labelling condition on expected fullness ($F(2, 273) = .77$, $p = .47$, $\eta_p^2 = .006$). As Mauchly's test of sphericity was significant ($p < .001$), the Greenhouse-Geisser correction was applied to within-subjects effects. There was no significant interaction between food category and variety labelling condition ($F(5.48, 748.42) = .1.07$, $p = .38$, $\eta_p^2 = .008$). See Fig. 3.

Bayesian comparisons revealed that the data infers 'strong' evidence in favour of the null hypothesis that variety labelling does not influence expected fullness (BF_{10} 0.034, Error = 0.984%). The data also infers 'decisive' evidence in favour of the alternative hypothesis that food category and labelling condition do not interact to affect ideal portion size (BF_{10} 0.006, Error = 0.47%).

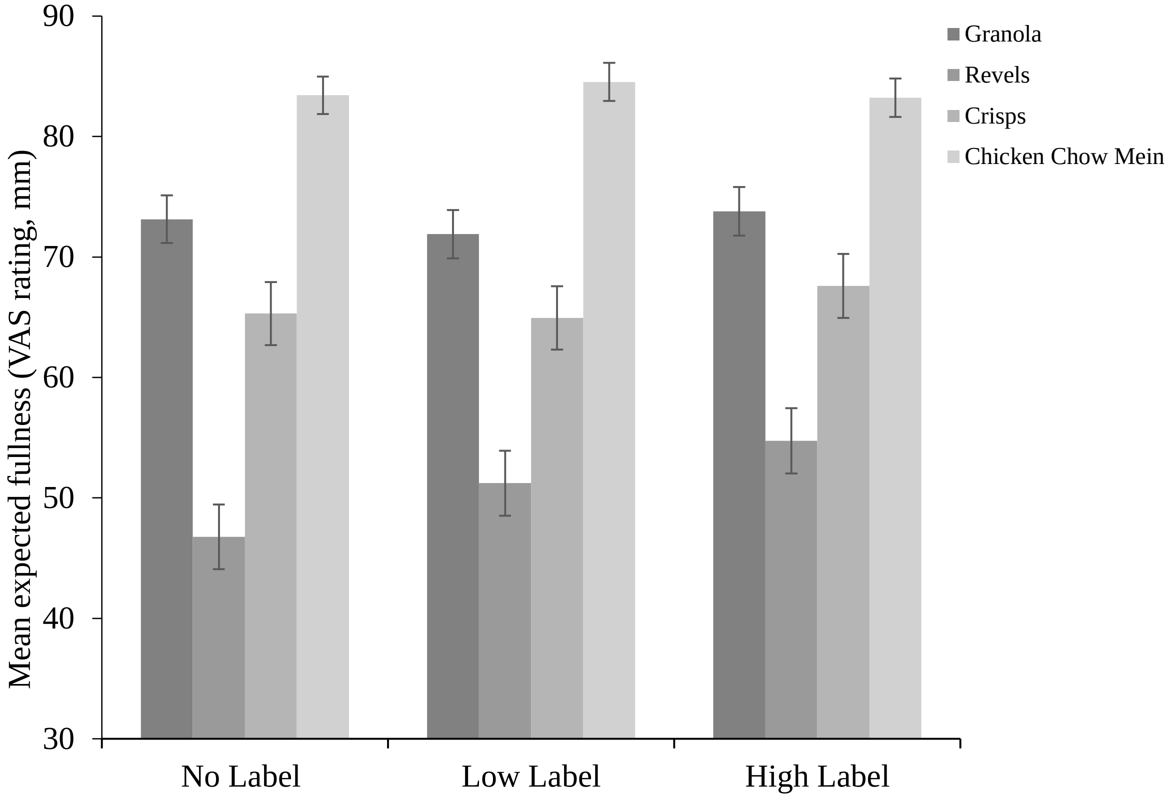

Fig. 3. *Mean expected fullness* across variety labelling conditions in Study 1. Error bars indicate standard error.

2.3. Interim discussion

Contrary to our predictions, we failed to find a significant effect of variety labelling on ideal portion size or expected fullness for a food. This suggests that a labelling manipulation that emphasises the level of food variety in a product does not influence the portion sizes that participants prefer, nor how satiating they expect a food to be. This fails to support Redden's (2008) finding that presenting a food with a label that draws attention to differences in flavour slows the decline in pleasantness for a food that is associated with dishabituation.

However, one concern is that this study used a Likert scale measure of ideal portion size that may have lessened the perceived contrast between photographs. In Brunstrom and Rogers (2009) original approach, each image was consecutively presented so that pressing a designated key would increase or decrease the portion size displayed onscreen accordingly. This meant that participants could see the portion size change with each image as though 'animated'. In our study, image size was significantly reduced for the online format, and all images of a given food were presented onscreen at once. The 'animated' effect achieved by moving through the images consecutively was then lost, and the difference in portion size between images closer together was more difficult to perceive. As such, it may be that potential effects of the labelling manipulation were missed. Therefore, in a second study, we included a more traditional measure of ideal portion size which provides a better level of 'food granularity' (in this instance, perceiving a food's individual components) to improve accuracy (Lewis & Earle, 2018).

A second concern is that an individual's ideal portion size may not always be representative of their actual consumption. Research generally supports estimates of ideal portion size as a strong predictor of actual food intake (Nguyen, Chern, & Tan, 2016; Wilkinson et al., 2012). However, one study reported poor congruence between measures that indicate disinhibition and portion size during expected and actual eating sessions, e.g. expected fullness and palatability (Guillocheau et al., 2018). In our study, some of our snack foods may be considered indulgent products that are likely to encourage overeating and a higher energy intake. This may also explain the disparity between our results using a photograph analogue and Redden's (2008), who assessed ratings of pleasantness during a single eating session. In Study 2, we therefore measured actual intake in the laboratory.

A third concern is that our measure of food familiarity was not ideal. The question used referred specifically to frequency of intake, meaning that ratings falling between the scale anchors are difficult to interpret using VAS. Therefore, in study 2, we removed reference to food frequency, asking participants to generally rate food familiarity using VAS (Not at all – Extremely).

3. Study 2

3.1. Method

3.1.1. Participants

Ninety-nine individuals from Swansea University (82 females; mean age 23 years, SD = 7.6) participated in the study. Sample size was determined using g*power. The mean BMI was 24.1 kg/m^2 (SD = 4.4). Exclusion criteria and information provided to participants about the aim of the study was the same as in Study 1. Participants were compensated for their time with a payment of £5 or course credit. The study was approved by the Department of Psychology's Research Ethics Committee, and pre-registered with the Open Science Framework (https://osf.io/vut6k/).

3.1.2. Foods

The foods used in the study were the same as those described in Study 1, with the addition of a fifth 'dessert' food (fruit strudel) that was sourced and photographed on a white dinner plate using an identical methodology as for the other foods (see Table 1 for macronutrient content and label information).

3.1.3. Measures

3.1.3.1. Ideal portion size

To address the limitations of the measure used in study 1, it was necessary to 1) increase image size to improve clarity of a food's individual components, and 2) present single images consecutively to maintain the 'animated' appearance of a portion gradually ‘growing’ with each new image. All images of a given food were then presented in succession using full screen mode in PowerPoint, beginning with the smallest and incrementally increasing to display the largest portion last (see Brunstrom & Rogers, 2009, for original task design). Participants were instructed to press the right arrow-key to increase the portion displayed and the left arrow-key to decrease the portion as needed to select their “ideal portion size for that particular food”. They were asked to view all images before making a decision. Each image was assigned a randomly-generated 3-digit code which the participant read aloud to the researcher to record their response. As participants may be uncomfortable sharing their chosen portion size directly with the researcher (e.g. they may feel ‘judged’ when choosing portions), codes were purposefully unrelated to portion size or caloric content. This was then translated to the calorie content of the selected portion by the researcher.

3.1.3.2. Snack food intake

Each participant was presented with a large serving (≈310 kcal) of crisps (savoury snack) in a white dinner bowl (233-mm diameter, 52-mm depth). Participants were informed that they would be given a taste test and were instructed to “eat as much or as little of the food as [they liked] to answer the questions afterwards”; the validity of the ‘bogus taste test’ to measure participant intake in the laboratory has been supported (Robinson et al., 2017). All participants were provided with a glass of water and were informed that more of the food was available should they wish to have another serving. Reflecting their assigned condition, a paper label was displayed with the serving in the low variety and high variety label conditions. The weight of the food eaten (g) was covertly recorded following the participant leaving the testing room and converted to kcal.

3.1.3.3. Rating scales

The rating scales for each food were presented in Qualtrics. Food familiarity was assessed by asking participants ‘How familiar are you with this food?’ (Not at all familiar–Extremely familiar). All other ratings were the same as those described in Study 1.

3.1.3.4. Questionnaires

As in Study 1, participants completed the TFEQ-R18 (Karlsson, Persson, Sjöström, & Sullivan, 2000), and the end-of-experiment questionnaire to check demand awareness.

3.1.4. Procedure

The procedure was the same as in Study 1 with the following exceptions. The presentation order of the first four foods (granola, revels, strudel and chow mein) was randomised using the randomiser function in Qualtrics; participants were instructed on-screen to inform the researcher that they had reached the next phase of the study, and a code was displayed by qualtrics to inform the researcher of which food images to present to participants in PowerPoint. After choosing their ideal portion size and providing ratings for the first four foods in Qualtrics, participants were presented with the savoury snack (crisps) to consume *ad libitum* in the laboratory. Participants then provided their ideal portion size and ratings for the crisps (the fifth food) in Qualtrics. Participants always selected their ideal portion size and rated the crisps after eating the food in the laboratory to ensure that their selection did not influence/prime their actual intake of the food. Dummy questions regarding the taste and healthiness of the food were also presented in line with instructions given to participants (i.e., the bogus taste test task). Height, weight and waist circumference were measured by the experimenter.

3.1.5. Data analysis

Confirmatory analyses – Preliminary analyses of the data were the same as described in Study 1. A one-way ANCOVA was used to investigate differences between groups for snack intake (controlling for significant effects of gender, restraint, emotional eating, food familiarity), and two 3 x 5 mixed MANCOVAs were used to assess differences in ideal portion size (controlling for significant effects of gender, baseline hunger and food wanting) and expected fullness (controlling for significant effects of age, gender, BMI, uncontrolled eating) respectively. As necessary, Bonferroni pairwise comparisons were used to explore significant main effects and/or interactions. Supplementary analyses showed that results were consistent when participants who were unfamiliar with the test foods (Familiarity VAS = 0) were removed from analyses (see Supplementary Table 4). Frequentist analyses were conducted in IBM SPSS v22.

Exploratory analyses – Exploratory analyses were the same as described in Study 1, with the addition of a Bayesian ANCOVA to further investigate effects on snack intake. For snack intake, the main effect model was adjusted for significant effects of gender, restraint, emotional eating and food familiarity. For ideal portion size, main effect and interaction models were adjusted for significant effects of gender, baseline hunger, food wanting and food liking. For expected fullness, main effect and interaction models were adjusted for significant effects of age, gender, BMI, baseline fullness and uncontrolled eating.

The full dataset has been made available on the Open Science Framework (https://osf.io/vut6k/).

3.2. Results

3.2.1. Participant characteristics

There were no significant differences in age, BMI, baseline hunger, baseline fullness, cognitive restraint, uncontrolled eating, or emotional eating between groups (see Table 5).

There was no significant difference in the allocation of males and females to conditions by gender; there were 5 males in the no label condition, 6 males in the low variety label condition, and 6 males in the high variety label condition (χ^2 (2, N = 99) = .142, p = .93). All participants were unaware of the study aims – no participant referred to food variety or labelling effects when asked at the end of the study. However, when the labelling conditions were revealed to participants, 28.1% of participants correctly guessed their allocation to the no label condition, 42.4% to the high variety label condition, and 72.7% to the low variety label condition. For mean food liking, food wanting, and food familiarity across groups, see Supplementary Figures 4-6.

Table 5

Establishing that sample characteristics were matched across high variety label (HL), low variety label (LL), and no label (NL) groups in Study 2. Mean (M) and standard error (SE) values are displayed.

Variable	Condition						Degrees of freedom	F-value	P-value
	NL		LL		HL				
	M	SE	M	SE	M	SE			
Age (years)	22.0	1.16	23.0	1.58	24.0	1.22	2, 96	.55	.58
BMI (kg/m^2)	24.4	.76	23.6	.72	24.2	.84	2, 96	.31	.74
Baseline hunger (mm)	51.1	3.77	56.3	4.0	53.7	3.8	2, 96	.45	.64
Baseline fullness (mm)	33.1	3.37	27.5	3.31	37.2	4.39	2, 96	1.74	.18
Time lapsed since eating (hours)	4.3	.83	4.6	.71	5.2	1.09	2, 95	.22	.80
Restraint	13.1	.47	12.1	.46	12.3	.54	2, 96	1.3	.28

Uncontrolled eating	22.6	.94	22.3	1.01	20.7	.73	2, 96	1.28	.28
Emotional eating	6.4	.4	6.5	.37	6.4	.44	2, 96	.01	.99

3.2.2. The effect of variety labelling on snack intake

Contrary to our predictions, there were no significant differences in snack intake between variety labelling conditions ($F(2, 88) = 1.13$, $p = .33$, $\eta_p^2 = .025$). Exploratory analyses showed that ideal portion size for the crisps significantly correlated with actual intake of crisps irrespective of condition, $r (97) = .51$, $p < .001$. See Fig. 4.

Bayesian comparisons revealed that the data infers ‘anecdotal’ evidence in favour of the null hypothesis that variety labelling condition does not influence snack intake (BF_{10} 0.523, Error = 1.997%).

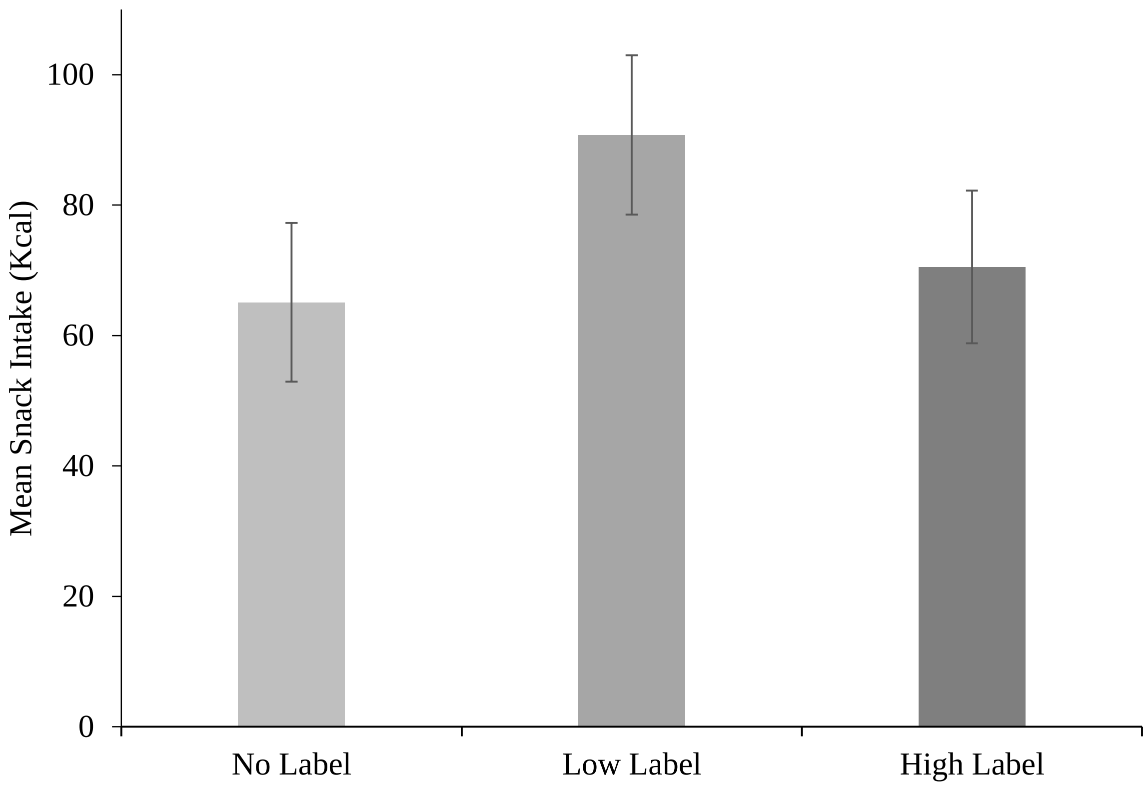

Fig. 4. *Mean snack intake* across variety labelling conditions in Study 2. Error bars indicate standard error.

3.2.3. The effect of variety labelling on ideal portion size

Reflecting results for snack intake, there was no significant between-subjects effect of variety labelling condition on ideal portion size ($F(2, 89) = .95$, $p = .39$, $\eta_p^2 = .021$). As Mauchly's test of sphericity was significant ($p < .001$), the Greenhouse-Geisser correction was applied to within-subjects effects. There was no significant interaction between food category and variety labelling condition ($F(6.76, 300.61) = .75$, $p = .63$, $\eta_p^2 = .016$). See Fig. 5.

Bayesian comparisons revealed that the data infers 'strong' evidence in favour of the null hypothesis that variety labelling does not influence ideal portion size (BF_{10} 0.081, Error = 1.351%). The data also infers 'strong' evidence in favour of the alternative hypothesis that food category and labelling condition do not interact to affect ideal portion size (BF_{10} 0.043, Error = 1.121%).

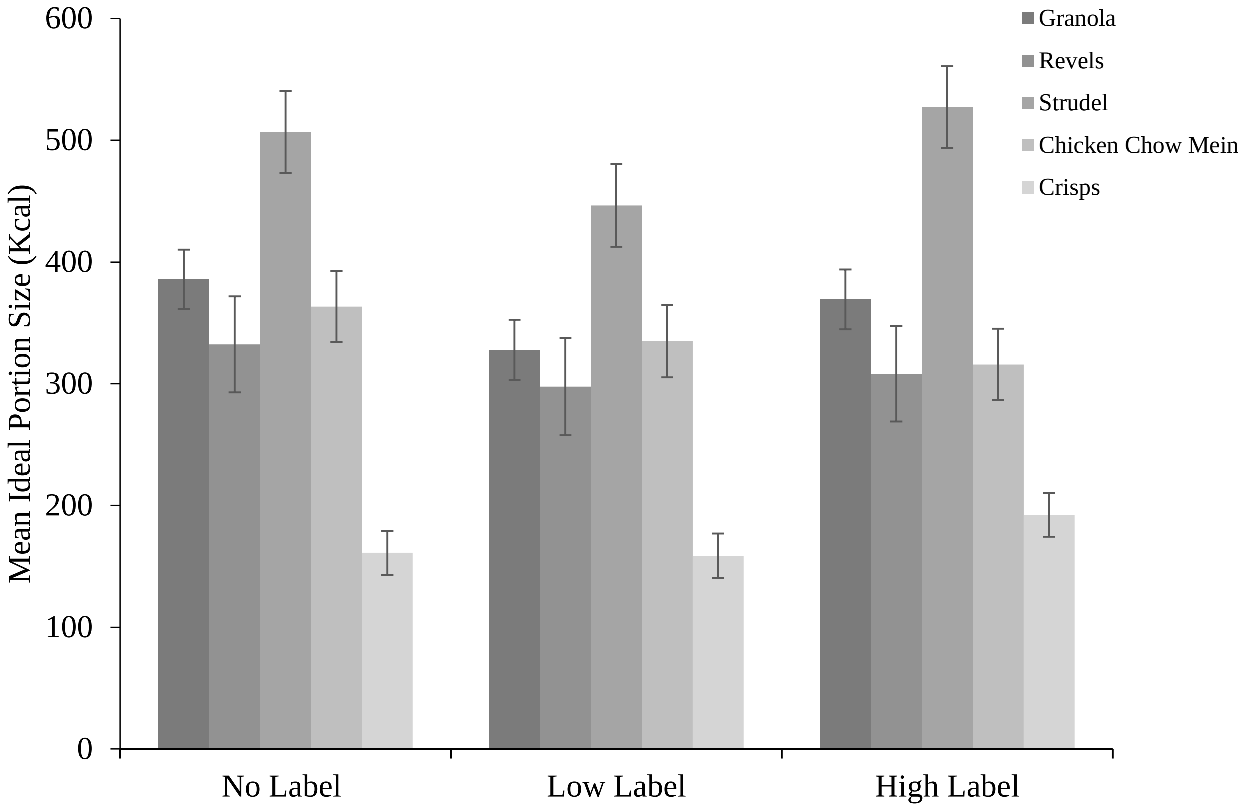

Fig. 5. *Mean ideal portion size* across variety labelling conditions for each food in Study 2. Error bars indicate standard error.

3.2.4. The effect of variety labelling on expected fullness

Like ideal portion size, there was no significant between-subjects effect of variety labelling on expected fullness ($F(2, 88) = .36$, $p = .70$, $\eta_p^2 = .008$). As Mauchly's test of sphericity was once again significant ($p < .001$), Greenhouse-Geisser corrected values are reported for within-subjects effects. As predicted, there was no significant interaction between food category and variety labelling condition ($F(6.82, 300.27) = 1.78$, $p = .09$, $\eta_p^2 = .039$). See Fig. 6.

Bayesian comparisons revealed that the data infers ‘strong’ evidence in favour of the null hypothesis that variety labelling does not influence expected fullness (BF_{10} 0.079, Error = 0.849%). The data also infers ‘substantial’ evidence in favour of the alternative hypothesis that food category and labelling condition do not interact to affect expected fullness (BF_{10} 0.107, Error = 0.121%).

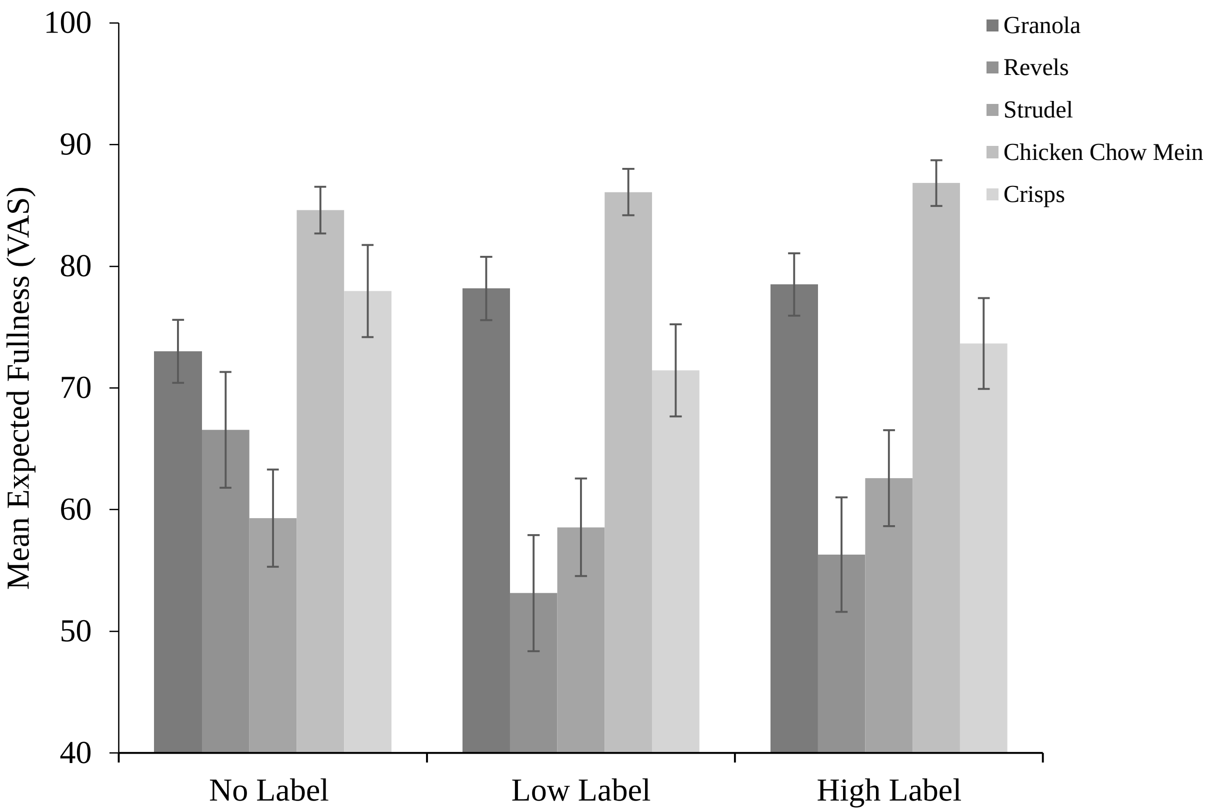

Fig. 6. *Mean expected fullness* across variety labelling conditions in Study 2. Error bars indicate standard error.

4. General Discussion

The aim of Study 2 was to explore whether a labelling manipulation that emphasised the level of food variety in a product would increase ideal portion size and decrease expected fullness, as well as increase participants’ snack intake. Contrary to our predictions, there was no significant difference between labelling conditions for snack intake, ideal portion size or expected fullness for foods. This was consistent with Study 1 which failed to find an effect of labelling condition on ideal portion size and expected fullness. Also reflecting the results of Study 1, there was again no significant interaction between variety labelling condition and food category, supporting the view that variety labelling effects were not dependent on the specific food presented. Across studies, Bayesian analyses confirmed that the data provides evidence in favour of no effect of labelling condition on ideal portion size, expected fullness, and snack intake. Bayesian analyses also confirmed that the data provides evidence against an interaction between labelling condition and food category.

These results contrast with those of Redden (2008) who found an effect of using labels to manipulate participants' perceptions of food variety on satiation. This may be explained by methodological differences. In Redden's study, participants perceived a reduced level of repetition when flavour labels were used. However, variety was limited (5 different jelly beans), and repetition of the food was emphasised by consecutively presenting each candy with a display count (e.g. 'Cherry #4'). In the present research, we asked participants to 'freely' select ideal portions and consume one food *ad libitum*, and it may be that effects on satiation and related measures do not persist when validated measures of portion size and intake are used.

Furthermore, participants did not perceive greater variety when flavour labels were presented in Redden's study. This appears to be consistent with our research, as less than half of participants in the high variety label group recognised their condition allocation in both our studies. Hale and Varakin (2016) is the only study to our knowledge that has directly investigated participants' awareness of variety within foods, reporting that participants who consumed more multicoloured chocolates (as opposed to a single colour) stated variety as a reason for their preference. However, no study has investigated participants' recognition of variety within more complex foods such as those used here.

Results may be explained by an assimilation-contrast model (Piqueras-Fiszman &

Spence, 2015). Labelling effects on sensory perceptions of a food occur as the result of assimilating the presented information into an expectation of what the food will be like (Piqueras-Fiszman & Spence, 2015). That is, if the label 'expectation' and the food 'experience' is congruent then the evaluation of the food shifts towards the expectation (assimilation effect), but a shift away from the expectation occurs if the two are incongruent (contrast effect). In our study, a high variety label may be viewed as congruent, and a low variety label comparatively incongruent given that both labels were presented with high variety foods. However, past research has shown that previous knowledge of a product can influence evaluations irrespective of congruency (Peracchio & Tybout, 1996). As foods in our study were selected on the basis that they were familiar to participants, this may have led to a redundancy of label information, particularly as neither label provided information that differed greatly from food images and foods themselves. Similar results have been found when assessing effects of health labels on the sensory evaluation, expected fullness, and intake of congruent and incongruent beverages (Hovard & Yeomans, 2015). Further research should explore whether presenting variety labels with unfamiliar/novel foods, or removing the sensory information provided by the food (e.g. presenting labels without sight of the food itself), would reflect our findings. Similarly, it would be interesting to see whether labels have no effect when presented on actual packaging. This is appropriate given that products on supermarket shelves are often judged on packaging alone.

Limitations of this research should be acknowledged. First, we measured participants' intake before asking them to select their ideal portion size of the food to prevent priming effects of the latter. However, consuming the food may have had similar effects on ideal portion size, particularly as the two were significantly correlated. Counterbalancing their presentation order may be a more effective control measure in future research.

Second, participants rated their expected fullness in response to the middle image of the range of photographs for each food (500kcal portion). However, as this is typically larger than a standard serving, it may have muted labelling effects given that portion size itself is a well-established influencing factor on consumption (English, Lasschuijt, & Keller, 2015). This relationship should be further explored in future research.

Third, Bayesian analyses revealed that the data inferred only ‘anecdotal’ evidence in favour of no effect of labelling condition on snack intake. However, as only a small to medium effect size was observed, any difference between groups is likely trivial, particularly as null results were consistent across measures in both studies.

Fourth, high variety labels tended to highlight differences in flavour within products, and differences in colour and texture were implied by ingredients rather than directly acknowledged. Some research suggests that variety within foods affects intake and satiation only when more than one sensory component is varied, such as colour and flavour (Rolls, Rowe et al., 1981). This may infer that our high variety labels insufficiently described the variety within products and minimised assimilation-contrast effects. We note an example where varying one sensory component alone within a food has exhibited the variety effect (Hale & Varakin, 2016), though we acknowledge the need for future research to further investigate what constitutes ‘variety’ in this context.

A notable implication of this research is that we examined participants’ perception of variety *within* foods. Redden (2008) proposed that flavour labels could encourage overeating by reducing satiation. Our results suggest caution when moving forward with a variety-focussed labelling strategy to influence consumption. A wealth of research has investigated the effects of variety (‘real’ not perceived) in other forms, particularly variety across the diet and variety within meals (Raynor & Vadiveloo, 2018). In contrast, few studies have investigated the influence of variety within foods. Raynor and Vadiveloo (2018) have recognised this as an area that warrants further investigation in the development of dietary guidelines for variety. We would add that this need extends to the understanding of the perception of variety within foods.

A second implication of our research is that it highlights the importance of understanding how consumers themselves perceive variety given that labelling had no effect on ideal portion size, expected fullness or intake. Promising interventions currently focus on providing dietary guidance to individuals that asks them to restrict and increase variety appropriately to help manage energy intake (Epstein et al., 2015; Meengs, Roe, & Rolls, 2012; Raynor & Osterholt, 2012; Raynor et al., 2012). Raynor and Vadiveloo (2018) recognise that the growing complexity of variety presents a challenge to individuals when monitoring their own intake, and this is a potential barrier to a dietary approach in the real world. We would add that this extends to the perception of variety when meal planning. To improve the accessibility of dietary guidance for variety, future research should first identify consumer knowledge of this topic.

Despite no significant effects being found, we have rigorously tested a potential cognitive intervention for the variety effect based on promising research in the literature. Specifically, results extend the literature by showing that effects reported by Redden (2008) of presenting a food with flavour-specific, ‘high variety’ labels do not persist when validated measures of portion size and intake are used. This research can also inform future studies with respect to the exploration and development of a variety-oriented intervention – in this case, information regarding an approach that was not effective.

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