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The pack size effect: influence on consumer perceptions of portion sizes

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The pack size effect: influence on consumer perceptions of portion sizes

Introduction

Recent evidence suggests that when people are faced with large portions they tend to give larger prospective consumption estimates (Wansink, 1996; Kral, Roe, & Rolls, 2004), serve themselves more food and ultimately consume more (Diliberti et al., 2004; Rolls et al., 2004b; Rolls, Roe & Meengs, 2006; Rolls, Roe & Meengs, 2007; Kral, Roe, & Rolls, 2004; Chandon & Wansink, 2011; Van Kleef, Shimizu, & Wansink, 2013; Raynor & Wing, 2007). This so-called 'portion size effect' (e.g. Jeffery et al., 2007) was found to be independent of several factors, such as food's palatability (Wansink & Kim, 2005), serving method (self-served or pre-served) (Rolls, Morris, & Roe, 2002), eating location (Wansink, 2004), or food type (Ello-Martin, Ledikwe, & Rolls, 2005. Notably, it has been shown that people do not compensate for such excess energy intake in subsequent meals (Diliberti et al., 2004; Kral, Roe, & Rolls, 2004; Kral, 2006) which may in part explain the co-occurrence of increase in obesity and sizes of portions over the past 30 years (Ledikwe, Ello-Martin, & Rolls, 2005).

Although the 'portion size effect' seems unaffected by so many factors, not all is lost: some stimuli have been found to act as modifying cues (Geier, Wansink, & Rozin, 2012, Brogden & Almiron-Roig, 2010). Notably, external cues on the pack (Versluis, Papies & Marchiori, 2015) or the serving plate (Van Ittersum & Wansink, 2013) were also found to influence perceptions of portion sizes, with the potential to adjust consumption (but see also Libotte, Siegrist, & Bucher, 2014; Robinson et al., 2014). In order to better understand the 'portion size effect', we thus propose to look more closely at how consumers' perception of portion sizes were influenced by pack sizes.

Portions sizes are defined as the quantity of food/drink that one can consume in one eating (Schwartz & Byrd-Bredbenner, 2006) whereas pack sizes refer to the size of the container the food. Similar to portion sizes, pack sizes are known to influence food consumption (e.g., Versluis,

Papies & Marchiori, 2015; Wansink, 2004) as well as content volume estimates (Wansink & Chandon, 2014) with increasing pack sizes leading to increasing portion size estimates and intakes. Indeed, some individuals show a tendency to finish a whole pack (e.g., Versluis, Papies & Marchiori, 2015) and do not seem to be able to differentiate between packs and portions in their consumption. It is important to note, however, that for experimental purposes, pack sizes and portion sizes can be manipulated independently (e.g., Wansink 1996). Some studies have used verbal descriptors of pack sizes also called 'size descriptors', e.g. terms like small, medium or large (e.g. Aydınoğlu & Krishna, 2011; Just & Wansink, 2014) and in some cases the pack size has been provided as a weight or volume (e.g. Aydınoğlu & Krishna, 2011). Relatively little work has been done exploring the links between the so-called 'portion size effect' and the 'pack size effect'. Indeed, portion and pack sizes in research are often used interchangeably and can be confounded (see Zlatevska, Dubelaar, & Holden, 2014). We thus argue that it is of relevance to distinguish between portion and pack size effects with the 'pack size effect' referring to the effect of increased consumption or increased portion size estimates with increasing container size in which the food or drink is presented (e.g. Zlatevska, Dubelaar & Holden, 2014); which can also be a plate or cup serving (Wansink, 1996; Rolls et al., 2004a).

In order to better understand modifying factors of the 'portion size effect', we propose to measure portion size estimates indirectly, by looking more closely at how portions sizes are visually affected by pack sizes. When participants are asked to state the number of portions to be contained in a pack, they provide indirect information on their representation of portion sizes. In other words, the fewer portions stated for a presented pack size, the larger the portions. Portion sizes are not defined a priori but rather by what the individuals perceive portions to be. We argue that there is no fixed portion size, as individuals have been found to be affected differently by pack sizes dependent on their personal portion size preferences (e.g., Versluis, Papies & Marchiori, 2015). This is important, as we argue that, in particular when comparing across different individuals and cultures, there is no such thing as an absolute portion size other than the individual estimates to

the actual presented packs. In fact, demographic as well as individual differences do not allow generalized consumer predictions (Ozen, Pons & Tur, 2012).

Notably, individuals across several cultures are exposed to increases in pack sizes (for increase in plates sizes in American culture since 1900, see Van Ittersum & Wansink 2013). Rozin and colleagues (2003) also found evidence for larger pack and portion sizes in the US compared to France. When comparing sweet drinks marketed in Australia, Canada, the Netherlands and New Zealand, Poelman and colleagues (2015) found substantial within and between country variation with respect to package and recommended serving sizes. Dietary patterns vary across Europe, with significant variations found in categories like beverages (Naska et al., 2006; Nissensohn, Castro-Quezada, & Serra-Majem, 2013) and processed foods (Fernández-Alvira et al., 2014). With the potential of changing pack sizes in parts of Europe, it is important to verify how portion estimates are influenced by different pack sizes across a diverse group of consumers and to identify the factors that potentially moderate pack size effects. Indeed, the role of cultural differences based on pack sizes is yet an element that remains to be determined as very few studies have looked at the role of cultural differences in estimating portions.

A modifying factor frequently reported is gender. Previous evidence suggests that women base their estimates on more appropriate portion sizes than men (Almiron-Roig et al., 2013; Yuhas, Bolland, & Bolland, 1989) and that the portion size effect is attenuated for women (Rolls, Roe & Meengs, 2006; Rolls et al. 2004a; Rolls et al., 2004b). In line with this, Burger, Kern and Coleman (2007), who evaluate the extent of deviations from predefined standard portions, found that male participants overestimated portions more than females, specifically for solid foods with high energy density.

Other factors that have received similar attention in research on portion size estimates are age (Fisher et al., 2007; Jeffery et al, 2007; Diliberti et al., 2004; Levitsky & Youn, 2004; Kral, Roe & Rolls, 2004; Fisher, Rolls & Birch 2003; Flood, Roe & Rolls, 1990) and Body Mass Index (BMI)

(Albar et al., 2014; Burger, Kern & Coleman, 2007; Fisher et al., 2007; Wansink, Payne & Chandon, 2007). However, as demonstrated in the meta-analytic review undertaken by Zlatevska and colleagues (2014), results for gender, age and BMI on portion size estimates are inconsistent and call for further research.

Factors that have received less attention in research but nevertheless appear to play a role in portion size estimation are relevance of portion information (Ayala, 2006), and an interest in health and knowledge of nutrition (Soederberg Miller & Cassady, 2015; Spronk et al., 2014). All of these factors are potentially interrelated. For example, research has shown that European consumers can differ in their healthfulness ratings of foods (Raats et al., 2014) and consequently in the healthfulness of their food choices (Aschemann-Witzel et al., 2013).

Portion information search behaviour is a further factor that potentially affects portion estimates significantly across cultures. It is thus assumed that different cultural backgrounds, due to their impact on the role of food, may influence how consumers estimate portion sizes but no clear body of evidence exists to date to answer this question.

To summarize, despite the consistency of the portion size effect, some factors were found to influence consumers' estimations of portion sizes, in particular external cues (i.e., context and situational cues) such as pack size and cultural background as well as individual characteristics such as gender or age. In the present study, applying a pan-European sample, we set out to examine how pack size and number of units of different food and drink products influence portion size estimates across different cultures. Portion size estimates were measured in response to a combined photographic and text-based description of different pack sizes. The main hypothesis was thus that the size of a presented pack has a general effect on people's internal representation of portion sizes, affecting their estimate on number of portions contained in a pack. We assumed that the direction of the effect will be that for foods and drinks presented in larger packs would

lead to relatively smaller number of stated portions based on representations of larger portion sizes contained in the pack.

Throughout the study, a large pack is defined as a pack that contains more food and has greater dimensions, compared to the small and medium packs of the same food. In addition to the main 'pack size effect', we further expected that gender would have a significant modifying effect on portion estimates (Versluis, Papies & Marchiori, 2015; Almiron-Roig et al., 2013; Burger, Kern & Coleman, 2007; Rolls, Roe & Meengs, 2006; Rolls et al., 2004a; Yuhas, Bolland, & Bolland, 1989). More specifically, we expected the effect of pack size to affect men more than women, meaning that men would base their estimates on larger portion sizes than women for larger packs compared to smaller packs. We also expected there to be country differences due to variations in eating cultures and nutrition policy environments (Rozin et al., 2003). Lastly, we explored whether individuals who find portion information on food and drink packages personally relevant differ in their portion estimates compared to those who do not find this packaging information relevant to them.

Method

Participants

A quota sample of 13,177 participants was obtained in six European countries: France (N=2,209), Germany (N=2,171), Poland (N=2,169), Spain (N=2,206), Sweden (N=2,207) and UK (N=2,155). Demographic quotas were set for gender, age, and educational attainment. Body Mass Index was calculated from participants' self-reported height and weight, as weight (in kg) divided by height squared (in m). Data from participants using different units (e.g. pounds, inches) were transformed to metric units prior to analysis. An overview of the study sample characteristics can be found in Table 1. In order to achieve the required total numbers in each country it was necessary to relax the education quota in Poland and the gender quota in Poland and Sweden. In order to compare

the distributions of gender, age, education, and BMI between countries, the Chi-square statistical test for equal distribution of the frequencies was applied to each set of categorical data.

General measures and Procedure

A web-based study was conducted with online research panels in each country via a market research company. It was first piloted in the UK with a sample of 200 participants (July 2010). The main fieldwork was conducted in July/August 2010 in the UK and in September 2010 in all other countries. The study consisted of three parts, each with different types of food (Part 1: solid foods, Part 2: liquid, Part 3: foods with distinct units of fixed size). Participants were asked to make portion-related judgments about the presented food products in all three parts of the study. For an overview of the design of each of the parts see Figure 1. In Parts 1 and 2 participants were asked *'How many portions (servings[1]) are contained in the product in the picture? Please move the slider up and down the scale until you are happy with your answer. You can select whole and part portions'.* Responses were recorded using a slider scale running from a minimum number of 0.25 portions to a maximum of 20 (with intermediate steps of 0.25). In Part 3 participants were asked 'How many of these [food name] make up a portion? Please write the number of [food name] that you think make up a portion'. While Parts 1 and 2 of the study focussed on differences in pack size, Part 3 investigated the effect of the number of units of a food on portion size estimates.

Prior to Parts 1-3, participants were asked to indicate their nationality, age, gender, education level, their portion information search behaviour ("During the last 6 months, how often have you looked for portion information on food and drink packages?", using a 5-point categorical response format from 1=never to 5=always) and whether portion information on food and drink packaging was relevant to them (Yes/No). After Parts 1-3, they were asked to report their satiety state

[1] A 'serving' is the equivalent term often used by food manufacturers, especially for foods that need to be divided or portioned by the consumer before consumption (Brogden & Almiron-Roig 2011). We clarified to participants that both terms are used interchangeably in this study, as some might be more familiar with one and others with the other term.

(hunger level) on a 10-point response format scale (1= not at all to 10= extremely). Also, interest in healthy eating was measured, using the General Health Interest scale, consisting of eight statements scored on a 7-point Likert-type categorical response format (1= strongly disagree, 7= strongly agree) (Roininen, Lähteenmäki & Tuorila, 1999). Finally, based on the Subjective Knowledge scale by Flynn & Goldsmith (1999), an adapted measure of Subjective Knowledge about healthy eating was developed, consisting of four items administered on 7-point Likert-type categorical response format (1= strongly disagree, 7= strongly agree).

Stimuli

We presented images of packaged food and drink products that are part of the food cultures in the participating countries and available in a variety of pack sizes. As the pack sizes were ones available in the market, external validity was high. Therefore, we did not standardise pack size increments artificially across products. We also sought to include products varying in state (solid and liquid products), type of food (snack, meal or drink) and whether or not they consisted of units. Notably, products were also chosen for their potential to impact on energy intake. Energy-dense foods were used, as a relatively small increase in intake of these foods can lead to a substantial increase in energy intake.

Part 1 on solid foods was conducted with crisps in two pack sizes: 34.5g (small), 120g (large), chocolate confectionery in three pack sizes: 18g (small), 45g (medium), 2 bars x 35g (together forming the large portion[2]) and lasagne ready meal in three pack sizes: 400g (small), 1000g (medium), 1600g (large). Part 2 on liquid foods was conducted with six sizes of a cola-type drink: two can sizes (150ml, 330ml) and four bottle sizes (250ml, 500ml, 1000ml, 1500ml). Part 3 on foods consisting of units was conducted with chicken nuggets in two pack sizes (4x10g, 9x10g), sweets in two pack sizes (10x4g, 60x4g) and biscuits in two pack sizes (2x20g or 15x20g).

[2] It should be noted that this may have introduced a potential confound, but only with regard to the second picture of the unwrapped food, as all other pack sizes consisted of single items.

In Part 1, for each product, pairs of pictures were shown– a packaged version of the product to the left and the contents of the packaging to the right. Both pictures displayed the product placed on a plate with cutlery either side, in order to provide additional references regarding the size (see Appendix 1 for the photographs). In Part 2, the bottles and cans were photographed next to a bank card in order to provide an additional size reference. In both Part 1 and 2, products were accompanied by the product name (crisps, chocolate confectionery, lasagne ready meal, cola-type soft drink) and the numerical description of the total pack weight (in grams) or volume (in millilitres (see Figure 1 for an overview of the stimuli used). In Part 3, the food photographs further entailed the number of items contained in the pack and the grams indicated each item's weight. The order of foods and pack sizes presented was randomised.

Design

Part 1 tested portion size estimates in a within-subjects design whereas Part 2 used an unbalanced blocked design in which one out of three possible smaller (products marketed as containing single portions: 150ml, 250ml, 330ml), followed by one out of three possible larger (products marketed as containing multiple portions: 500ml, 1000ml, 1500ml) cola type drink pack sizes was shown to each participant in randomized order. This design resulted in nine possible trials (150ml/500ml, 150ml/1000ml, 150ml/1500ml, 250ml/500ml, 250ml/1000ml, 250ml/1500ml, 330ml/500ml, 330ml/1000ml, 330ml/1500ml) with one trial shown to each participant. Part 3 used a 3x2 mixed design, with food (chicken nuggets, sweets and biscuits) as a within-subjects factor and pack size (small/large) as a between-subjects factor. For each food item, participants were randomly assigned to either the small or the large pack size condition.

Analysis

Data were analysed using SPSS (Version 20).

In Part 1, separate analyses were performed for each food product. The main dependent variable was the estimated portion size, calculated by dividing the food weight/drink volume by the

number of portions that participants indicated were included in each pack. Repeated measures ANOVA on estimated portion size were performed for each product, the within-subjects factor being pack size and the between-subjects factors comprising of gender, country and relevance of portion information. Age, BMI, hunger, General Health Interest, Subjective Knowledge about healthy eating, and portion information search behaviour were included as covariates. Regarding the effect of covariates, additional linear regression analyses were performed in order to investigate the influence of each covariate on the estimated portion sizes for each food and each pack size. Simple and adjusted models were used in order to take into account the role of each covariate.

In Part 2, two separate univariate General Linear Models were performed to test the effect of pack size on portion size estimates within each size set, i.e. within the small can/bottles (marketed as containing single portions: 150ml, 250ml, 330ml) and within the large bottles (marketed as containing multiple portions: 500ml, 1000ml, 1500ml). Due to the unbalanced design of Part 2, a comparison of all six pack sizes in one analysis was not feasible, therefore individual analyses were performed for each size set to explore the pack size effect even when slight increases in pack size occur (from 150ml to 330ml in the small set and from 500ml to 1500ml in the large set). The dependent variables for each analysis were ‘portion size estimate of the small pack’ and ‘portion size estimate of the large pack’, respectively. In both analyses, a separate between-subjects factor was used to indicate which of the small can/bottles and which of the large bottles each participant was shown. This allowed us to take any potential influence of judgement context, i.e. the combination of pack sizes each participant was assigned to, into account. Gender, country and relevance of portion information were included as additional between-subjects factors. We used the same covariates as in Part 1. Additionally, nine individual Bonferroni corrected paired *t*-tests were performed to investigate the differences in portion size estimates between the packs shown in each trial (small vs. large pack).

In Part 3, three univariate General Linear Models were performed on the number of estimated items per portion, one for each food, with pack size as the independent variable, gender, country and relevance of portion information as the between-subject factors. Age, BMI, hunger, General Health Interest, Subjective Knowledge about healthy eating, and portion information search behaviour were included as covariates. Linear regression analyses (simple and adjusted models) were performed in order to explore potential confounding effects.

Results

Part 1

Repeated measures ANOVAs showed a significant main effect of **pack size** on portion estimations, for all three products. When participants were presented with the large pack of a food they estimated on average a larger number of portions to be contained in the pack compared to when presented with the small pack, in all three food categories. Notably, the number of portions estimated in the larger packs did not follow a linear increase with the increase in pack size; leading to a 'pack size effect' with estimates of larger individual portions in larger packs compared to smaller packs (see Figure 2). For chocolate confectionery and lasagne, portion size estimates of the food in the medium pack were significantly larger than those in the small pack and smaller than those in the large pack (chocolate: medium-small MD = 17.1g, SE = 2.52, $p < .001$, large-medium MD = 6.4g, SE = .29, $p < .001$; lasagne: medium-small MD = 117.1g, SE = .24, $p < .001$, large-medium MD = 51.5g, SE = 3.31, $p < .001$)

Furthermore, **country** of residence had a significant effect on portion size estimates. For all three foods, participants from Sweden, Poland and Germany estimated individual portions to be larger compared to those from the UK, France and Spain. For lasagne, however, UK participants' portion size estimates were not significantly different to those from participants in Sweden (MD = 10.8g, SD = 7.8, p = .734), Poland (MD = 6.6g, SD = 7.8, p = .959) and Germany (MD = 3.2g, SD = 7.8, p = .999) (see Figure 3). The significant interaction between country of residence and pack

size indicated a stronger pack size effect in some countries (i.e., Sweden and Poland) compared to others. Mean values and standard deviations by country can be viewed in the online supplementary material (S1).

We also found a main effect of **gender**, with men estimating larger individual portions across all three products, compared to women. There was also a significant interaction between gender and pack size, indicating a stronger pack size effect for men than women. This finding was consistent across all three products[3].

Approximately half of the overall sample (46%) indicated that portion information on food and drink packages was relevant to them. Individuals who said that **portion information is not relevant** to them provided portion number estimates that indicated significantly larger portions to be contained in a pack compared to those who find it relevant across foods . A significant interaction with pack size was also observed with estimates indicating larger portions in the larger packs (i.e., the 'pack size effect') for those who do not find portion information relevant compared to those who do, across all food categories[4].

Covariates: Age, hunger, and General Health Interest had a significant effect on portion size estimates of crisps. For chocolate confectionery, portion size estimates were affected by the covariates age, General Health Interest, and portion information search behaviour. Hunger, General Health Interest, Subjective Knowledge about healthy eating, and portion information search behaviour had an effect on the portion size estimates of lasagne. Those effects were further investigated with regression analyses. In general, age, General Health Interest, and Subjective Knowledge about healthy eating were negatively related to portion size estimates (i.e., smaller portion size estimates in older people and in those participants with a higher General Health

[3] Mean values and standard deviations by gender can be viewed in the online supplementary material (S2).
[4] Mean values and standard deviations by relevance of portion information can be viewed in the online supplementary material (S2).

interest and Subjective Knowledge about healthy eating), while hunger and portion information search behaviour showed a positive association.

In general, all effect sizes were small, ranging from $\eta^2 < .001$ to .036 (see Table 2).

Part 2

No significant differences in baseline characteristics (gender, age, BMI, education level, hunger, General Health Interest, Subjective Knowledge about healthy eating, relevance of portion information and portion information search behaviour) were observed between participants assigned to different trials.

GLM analyses revealed a significant main effect of **pack size** on portion size estimates, for both size sets of cola-type drink. When participants were presented with larger packs (as opposed to the smaller packs within each size set), they estimated the individual portions to be larger (small set: $MD_{330\text{-}250}$ = 63.5ml, SD = 3.3, $p < .001$, $MD_{330\text{-}150}$ = 133ml, SD = 3.3, $p < .001$, $MD_{250\text{-}150}$ = 69.5ml, SD = 3.4, $p < .001$; large set: $MD_{1500\text{-}1000}$ = 13.9ml, SD = 8.1, $p = .254$, $MD_{1500\text{-}500}$ = 36.5ml, SD = 8.1, $p < .001$, $MD_{1000\text{-}500}$ = 22.6ml, SD = 8.1, $p = .016$). An exception was the pairing 1000ml/1500ml in the set of large packs, where no difference could be observed. Means and standard errors of portion size estimates for each pack size are presented in Figure 2.

Paired samples *t*-tests (Bonferroni corrected) showed that for all nine pairings of cola-type drinks shown (nine trials), individuals tended to estimate portions to be significantly larger when they saw the large pack compared to the estimates they gave for the small packs. The only exception was the pairing 330ml/500ml, where no significant difference was observed in portion size estimates between the two pack sizes (MD = 1.9ml, SE = 4.82, $p = .689$). See Table 3 for an overview.

Country of residence also had a significant effect on liquid portion size estimates, in both pack sizes. On average, participants in France estimated the smallest portion sizes, followed by those in

Spain, the UK, Germany, and Poland. Participants in Sweden, on the other hand, estimated largest portion sizes when shown both small and large packs of cola-type drink (see Figure 3). An interaction effect of country of residence and pack size could only be found for the set of large packs ($F (5, 11809) = 4.951$, $p < .001$) indicating that in some countries (i.e., Poland and Sweden) the pack size effect (larger portion sizes for larger packs) was stronger than in others for pack sizes in the range of 500ml to 1500ml.

Gender had a significant effect on cola drinks' portion size estimates; men tended to estimate liquid portions to be larger compared to women, for both the smaller and the larger size sets[5]. However, interaction with pack size was not significant, meaning that the magnitude of the pack size effect did not differ significantly between men and women.

Individuals who **find portion information on food packages relevant** tended to estimate larger liquid portions compared to those who do not find this information relevant. For the set of small packs, this main effect was statistically significant (MD = 8ml, SD = 2.9, $p = .006$), while for the set of large packs the effect did not reach significance (MD = 8g, SD = 6.9, $p = .247$). There was no interaction effect of relevance of portion information with pack size.

The **interaction** between the particular combination of the small and the large pack shown to each respondent was significant for both small packs and large packs. The larger the difference between the two sizes of cola-type drinks shown to participants, the smaller the portion size estimates of the small-sized packs were. For the set of large packs, no specific pattern could be observed.

Covariates: For the set of small packs, only age, General Health Interest, and Subjective Knowledge about healthy eating had a significant effect on portion size estimations. For larger packs, however, hunger and portion information search behaviour also showed a significant effect on portion size estimates. When applying individual regression analyses, it became clear that

[5] Mean values and standard deviations by gender can be viewed in the online supplementary material (S2).

316 higher age, General Health Interest, and Subjective Knowledge about healthy eating are
317 associated with smaller portion size estimates while hunger and portion information search
318 behaviour are associated with larger estimated portions.

319 In general, all effect sizes were small, ranging from $\eta^2 < .001$ to .09. The only exception was the
320 pack size effect across the small packs of cola-type drink where an effect size of $\eta^2 = .118$ was
321 obtained (see Table 3).

322 ***Part 3***

323 No significant differences in baseline characteristics (gender, age, BMI, educational level, hunger,
324 General Health Interest, Subjective Knowledge about healthy eating, relevance of portion
325 information, and portion information search behaviour) were observed between participants
326 assigned to the different pack size conditions (small versus large), except for chicken nuggets
327 where more people with no education, secondary education, and college/undergraduate education
328 were assigned to the large pack condition compared to the small pack condition.

329 GLM analysis on the estimated number of items that make up a portion resulted in a significant
330 main effect of **pack size** for each of the three food products. Across all foods, respondents
331 reported more items to make up a portion when they were presented with the large packs
332 compared to when they saw the small packs. Means and standard errors of portion size estimates
333 for each food and pack size are presented in Figure 4.

334 **Country of residence** also had a significant effect on portion size estimates, across all products.
335 Similar to previous results, respondents from Spain, UK and France estimated smaller portion
336 sizes compared with respondents from Sweden, Poland and Germany. See Figure 5 for a graphical
337 illustration. The interaction effect between country and pack size was significant only for sweets

and biscuits (but not chicken nuggets), indicating a stronger pack size effect for some of the countries (i.e., Poland, Sweden and Germany) compared to others[6].

Regarding the effect of **gender**, men estimated significantly larger portions compared with women, across different foods. A significant interaction effect of gender with pack size was evident only for sweets, meaning that the pack size effect in sweets was stronger for men than for women[7].

No significant main effect for **relevance of portion information** or interaction effect with pack size was observed for any of the foods (see Table 4).

Covariates: Age, hunger, and General Health Interest had a significant effect on portion size estimates of chicken nuggets, and sweets, while for biscuits only hunger had a significant effect. Those effects were further investigated with regression analyses. In general, higher age and General Health Interest were associated with smaller portion size estimates while higher levels of hunger were associated with larger estimated portions.

In general, all effect sizes were small, ranging from <.001 to .023 (see Table 4)

By way of summary across all parts (data not presented) showed that participants in this study reported significantly more portions to be included in the large packs compared to the smaller packs of the same food, which, as it stands, should result in smaller individual portions. However, this increase in reported number of portions was not proportionate to the actual increase in pack size, illustrating thus an increase in the stated portion sizes when shown large packs compared to smaller packs. This indicates that even though people realise that large packs contain more portions, it is likely that they unintentionally end up serving and consuming larger portions.

Discussion

[6] Mean values and standard deviations by country can be viewed in the online supplementary material (S1).
[7] Mean values and standard deviations by gender can be viewed in the online supplementary material (S2).

In the present study, we investigated the effect of pack size on portion size related estimates. In Parts 1 and 2, participants' portion size assumptions were measured indirectly via the number of portions they perceive to be contained in packs. In Part 3 we assessed participants' portion estimates via the number of items they think make up a portion based on different pack sizes. Estimates of larger individual portions in larger packs compared to smaller packs (Parts 1 and 2) as well as estimates of larger number of items to make up a portion based on presentations of larger compared to smaller packs (Part 3) indicate larger portions estimates for larger packs, the so-called 'pack size effect'. Our results indicate a small but significant 'pack size effect' across all countries, though to a different extent.

When participants were presented with large packs of food/containers of drink, they tended to estimate the number of portions contained in a pack based on the portions being larger with larger packs compared to when presented with smaller packs. All products tested in Parts 1 and 2 of the study (crisps, chocolate confectionery, lasagne and a cola-type drink) showed such a 'pack size effect'.

A similar effect was found in Part 3 where participants were asked to indicate how many items of a multi-item food make up a portion. Across all three food categories (chicken nuggets, sweets and biscuits), those participants who were shown the large pack reported more items to make up a portion compared to participants who were shown the small pack, hence, estimating larger portions when presented with larger packs. These results are in line with Madzharov and Block (2010) who reported an increase in portion size estimates when more food items were displayed on pack.

We found demographic effects of gender, with men tending to state larger portions across all food types. While a likely explanation may be the higher energy requirement for men compared to women, the range of differences (4-29%) between men and women in stating portions was not consistent with the 25% more energy intake that is recommended for men (i.e. 2,000 kcal for

385 women versus 2,500 kcal for men). When presented with larger packs of food and drink, both men
386 and women reported larger portions. However, for most of the foods tested in this study, an
387 increase in pack size affected men more strongly than women; when shown larger packs, men's
388 portion estimates led to larger portion size increases than women. This is in line with previous
389 research (Almiron-Roig et al., 2013; Burger, Kern & Coleman, 2007; Rolls, Morris & Roe, 2002;
390 Yuhas, Bolland & Bolland, 1989, for a meta-analysis see also Zlatevska, Dubelaar & Holden,
391 2014).

392 We further found significant country differences. In general, participants from Sweden, Poland
393 and Germany indicated larger portion sizes compared to participants from Spain, France and the
394 UK. These differences may be related to the different food environments and eating habits in each
395 country (Jenab et al., 2006). However, there is as of yet limited reported evidence on the role that
396 national eating habits may have in how portions are perceived which calls for further research.
397 More interestingly, the pack size effect seemed to be stronger in some countries than others. For
398 example, for the majority of the foods tested in this study, participants from Poland were found to
399 be influenced to a greater extent by the pack size effect, compared to participants from the UK
400 who seemed to be less influenced. This could be in part a result of differing levels of nutritional
401 knowledge as Grunert and colleagues (2010) found in their cross-national study, including Poland
402 and the UK, the UK to have the highest knowledge scores on most types of knowledge.
403 Differences could also relate to the dietary patterns that vary across Europe (Naska et al., 2006;
404 Nissensohn, Castro-Quezada, & Serra-Majem, 2013). This finding is particularly interesting in
405 light of the sample at hand showing significant differences in the country-to-country composition
406 (see Table 1 where distributions of gender, age, education and BMI sharing the same letter are not
407 significantly different between countries). There were significantly more women in the Polish and
408 the Swedish sample compared to all other countries. Nevertheless, the pack size effect was
409 greatest for these two countries. This would imply an even stronger pack size effect for Swedish
410 and Polish men.

We also investigated whether perceived relevance of portion size information has an effect on portion size estimates. Those participants who did not regard portion information on food and drink packages to be personally relevant displayed a general tendency to estimate larger portions, compared to those who said it was relevant. In Part 1 it was further shown that pack size affected those for whom portion information is not relevant more strongly than those to whom it is; participants who do not find portion information relevant estimated larger portion sizes than those who find portion information relevant.

Finally, we have shown that participants' portion size estimates decrease with increasing age (this held true despite significant differences in the age composition of the country samples, Table 1), a higher General Health Interest and a higher Subjective Knowledge about healthy eating. On the other hand, portion size estimates are larger in hungrier participants but also for those who said they look for portion information on food packaging more often. These associations were not significant across all foods tested but the direction of each association (positive or negative) was consistent, except for age.

Our findings are consistent with findings from previous literature. In a similar study, Almiron-Roig and colleagues (2013) presented participants with a variety of foods in portions that were either larger or smaller than a fixed reference amount and report that for most of the foods that were presented in large portions (larger than reference amount), participants stated fewer (but larger) portions to be included in the serving they were shown. The opposite was the case for foods that were presented in small portions (smaller than reference amount). In another study, participants were asked to imagine being served either a small or a large amount of food (half or double the average amount of food consumed per person per eating occasion, respectively) and had to indicate how much of this food they would consume (Marchiori, Papies & Klein, 2014). It was shown that the size of the portion can serve as a reference point (anchor) on which people base their estimations of what is an appropriate amount to consume. The authors suggest that

other factors such as hunger or liking of the food may also play a role, but that the amount finally consumed is nevertheless biased by the size of the portion. How exactly the size of the portion can influence food intake was also studied by Kerameas and colleagues (2015) who were able to show that the unit bias (a unit as considered the appropriate amount to eat, see Geier, Rozin & Doros, 2006) may in fact be a segmentation bias: when served multiple smaller units, participants ate less than when served a single larger unit. Applying this notion of a segmentation bias to our study findings, it seems that participants have a predisposition for a limited number of segmentations, independent of pack sizes.

In general, effect sizes for each fixed factor were small. In part, such small effect sizes can be significant due to the large sample sizes in each country (Hodgkins et al., 2015). However, even small differences in portion size estimates can equate to significant intake differences over time and thus have an impact in the long term. Based on the portion estimations provided by the study participants, the corresponding amount of calories per portion was calculated. Given the significant increase in stated portion sizes from small to large packs of food and drink, the difference in calories for each of these portions increased anywhere from 66 to 233 kcal. If people were to actually consume the portions they stated in this study, this would result in a substantial increase in energy intake, even over a short period of time (Geier, Wansink & Rozin, 2012; Hill et al., 2003; Rolls, Morris & Roe, 2002; Rolls et al., 2004a; Rolls et al., 2004b; Kral et al., 2003). However, as the current study did not measure actual intake, this calls for further research to test whether increased portion size estimates will also lead to the predicted increase in caloric intake.

Albeit this is a widespread practice in food research (Foster et al., 2006, Cameron & Van Staveren, 1998), another limitation of the study is the use of food photographs instead of real foods as it could cause inaccuracies in the assessment of portion sizes (Nelson, Atkinson, & Darbyshire, 1994). For this reason, reference objects such as plates, cutlery and the bank card next

to the can or bottle of cola type drink were introduced to the design of this online study to help participants put the food photographs into perspective.

The study findings have a number of implications. As shown, large packs may lead to increased portion sizes across various countries. Making smaller instead of larger packs of foods available to people may support their efforts to control their eating and maintain a healthy body weight.

However, further studies are needed to explore whether calling attention to pack size and its potential to lead to larger portions may be sufficient to control portion size and consumption frequency. The results of studies with a similar approach on the effects of portion size on food intake, however, show a tendency for increased control mechanisms through body awareness and mindfulness exercises over educational information (see Cavanagh et al. 2014).

On a different note, possible effects of portion size on consumption should be investigated as well. It has, for example, been shown that smaller portions can satisfy hunger and craving similarly to large portions (van Kleef, Shimizu, & Wansink, 2013). More research on the topic would help better understand this relationship.

Conclusions

This study has shown that pack size has an effect on stated portion size. Larger packs of food or drink can lead people to unintentionally estimate larger portions. Considering that these stated portions are likely to be consumed (e.g., Marchiori, Papies & Klein, 2014), this has implications for energy intake and weight status. Hence, more research is needed in order to better understand how people estimate portions, e.g. by studying whether people see portions and portions mentioned on food packs as a realistic amount of food or drink someone is likely to consume in one sitting as opposed to something someone should consume in one sitting. Answering this question would give us insight into the conceptualisation of food portions in people's minds and the rationale behind the ratings people give in portion size experiments.

Communication of portion information to people and educating them on their use should receive greater attention from public and private authorities. In addition, food companies should focus more on the provision of portion information on food packs similarly to what they have done in the past for nutrition information.

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Table 1. Participant characteristics (as percentages of the total samples)

		France *n*= 2209	Germany *n*= 2171	Poland *n*= 2169	Spain *n*= 2206	Sweden *n*= 2207	UK *n*= 2155	Total *n*= 13117
Gender	Male	45.5 a	47.0 a	42.4 b	45.9 a	38.2 c	47.0 a	44.3
	Female	54.5 a	53.0 a	57.6 b	54.1 a	61.8 c	53.0 a	55.7
Age	18-29	24.8 a	22.2 b	32.1 c	27.5 d	21.9 e	20.0 f	24.7
	30-39	21.9 a	20.9 b	24.5 c	30.8 d	25.4 e	24.4 f	24.7
	40-49	23.2 a	28.1 b	22.0 c	25.9 d	25.0 e	25.8 f	25.0
	50-64	30.1 a	28.9 b	21.4 c	15.9 d	27.6 e	29.7 f	25.6
Education	None	1.6 a	0.5 b	0.1 c	0.4 d	0.2 e	0.7 f	0.6
	Primary school	1.7 a	13.4 b	2.7 c	3.8 d	6.5 e	.1 f	4.7
	Secondary school to age 15/16	20.1 a	35.4 b	3.1 c	11.7 d	3.0 e	28.4 f	16.9
	Secondary school to age 17/18	47.2 a	21.7 b	64.8 c	43.7 d	49.3 e	48.5 f	45.9
	College/Undergraduate	15.5 a	8.2 b	8.3 c	20.4 d	20.5 e	14.3 f	14.6
	University/Post graduate	14.0 a	20.9 b	20.9 c	20.1 d	20.4 e	8.0 f	17.4
Body Mass Index (BMI)[a]	Underweight (BMI≤18)	4.6 a	2.7 b	3.5 c	2.9 d	2.5 b	3.1 e	3.2
	Normal weight (18<BMI<25)	52.4 a	46.8 b	49.0 c	50.5 d	48.0 b	42.2 e	48.2
	Overweight (25≤BMI<30)	30.3 a	32.8 b	32.0 c	34.3 d	32.4 b	32.1 e	32.3
	Obese (BMI(BMI>30)	12.7 a	17.7 b	15.5 c	12.3 d	17.1 b	22.7 e	16.3

[a] 1,086 participants (8.3%) did not provide sufficient data for classification

In order to compare the distributions of gender, age, education, and BMI between countries, the Chi-square statistical test for equal distribution of the frequencies was applied to each set of categorical data. Country distributions for each of gender, age, education, and BMI sharing the same letter are not significantly different from each other.

$^{*}p < .05$

Part 1: Portion size estimates (within-subjects design)

Products (within-subjects factor)	**Pack sizes (within-subjects factor)**			**Stimuli**
Crisps	Small (34.5g)	Not applicable	Large (120g)	• Product name and weight • Photos of the contents of the pack and the pack itself, each on a plate with cutlery (product size reference)
Chocolate confectionery	Small (18g)	Medium (45g)	Large (2x35g)	
Lasagne	Small (400g)	Medium (1000g)	Large (1600g)	

Question: How many portions (servings) are contained in the product in this picture?
Scale: Vertical slider scale with endpoints of 0.25 and 20

Part 2: Portion size estimates (unbalanced block design)

Products	**Pack sizes (within-subjects factor)**					**Stimuli**
	Smaller*		**Larger***			
Cola type soft drink can	Very small (150 ml)	Small (330ml)	Not applicable	Not applicable	Not applicable	• Photo of the product with a bank card (product size reference) • Product name and volume
Cola type soft drink bottle	Not applicable	Small (250ml)	Medium (500ml)	Large (1000ml)	Large (1500ml)	

*Each participant saw one small and one large pack
Question: How many portions (servings) are contained in the product in this picture?
Scale: Vertical slider scale with endpoints of 0.25 and 20

Part 3: Portion item number estimates (3x2 mixed design)

Products (within-subjects factor)	**Pack sizes (between-subjects factor)**		**Stimuli**
Chicken nuggets	Small (4x10g)	Large (9x10g)	• Product name • Product in packaging on plate with cutlery (product size reference) • Statement describing number of items and weight per item contained in pack
Sweets	Small (10x4g)	Large (60x4g)	
Biscuits	Small (2x20g)	Large (15x20g)	

Task: Please write the number of [product name] that you think make up a portion.

Figure 1. Overview of the design, stimuli, questions asked and the scales or task used.

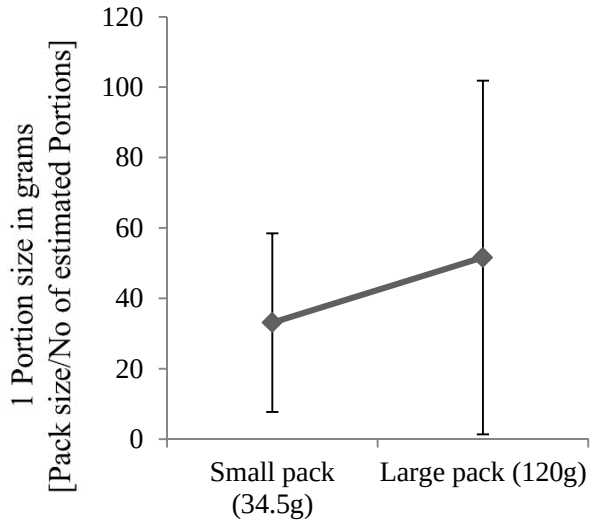
675 **Table 2. Part 1 - Repeated measures ANOVA with covariates for each food product**

	Crisps			***Chocolate confectionery***			***Lasagne***		
	F (df)	*p*	η^2	*F (df)*	*p*	η^2	*F (df)*	*p*	η^2
Size	46.082 (1, 12001)	< .001***	.004	111.396 (2, 24002)	< .001***	.009	43.26 (2, 24002)	< .001***	.004
Gender	158.387 (1, 12001)	< .001***	.013	89.911 (1, 24002)	< .001***	.007	22.646 (1, 24002)	< .001***	.002
Country	89.885 (5, 12001)	< .001***	.036	75.785 (5, 24002)	< .001***	.031	71.939 (5, 24002)	< .001***	.029
Relevance of portion information	14.792 (1, 12001)	< .001***	.005	31.586 (1, 24002)	< .001***	.003	23.367 (1, 24002)	< .001***	.002
Size*Gender	48.505 (2, 12001)	< .001***	.004	35.716 (2, 24002)	< .001***	.003	8.342 (2, 24002)	< .001***	.001
Size*Country	52.198 (5, 12001)	< .001***	.021	33.272 (10, 24002)	< .001***	.014	23.818 (10, 24002)	< .001***	.01
Size*Relevance of portion information	12.848 (1, 12001)	< .001***	.001	5.424 (2, 24002)	.006**	.000	4.526 (2, 24002)	.015*	.000
Covariate: Age	402.528 (1, 12001)	< .001***	.001	37.706 (1, 12001)	< .001***	.003	1.822 (1, 12001)	.177	.000
Covariate: BMI	.578 (1, 12001)	.444	.000	.743 (1, 12001)	.389	.000	1.961 (1, 12001)	.161	.000
Covariate: Hunger	24.795 (1, 12001)	< .001***	.002	1.808 (1, 12001)	.179	.000	27.511 (1, 12001)	< .001***	.002
Covariate: General Health Interest	52.436 (1, 12001)	< .001***	.004	71.393 (1, 12001)	< .001***	.006	35.083 (1, 12001)	< .001***	.003
Covariate: Subjective Knowledge about Healthy Eating	.017 (1, 12001)	.898	.000	.381 (1, 12001)	.537	.000	5.98 (1, 12001)	.014*	.000
Covariate: Portion information search behaviour	.597 (1, 12001)	.44	.000	4.471 (1, 12001)	.035*	.000	8.215 (1, 12001)	.004**	.001

676 *p <.05, **p < .01, ***p <.001

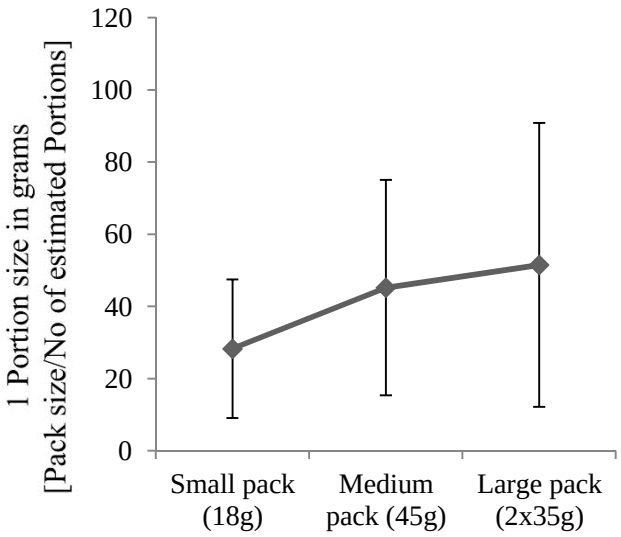
Crisps

	Mean (g) ± SD	*Mean (Nr)* ± SD
Small pack (34.5g)	33.1 ± 25.4	2.1 ± 3.1
Large pack (120g)	51.6 ± 50.3	4.1 ± 3.5



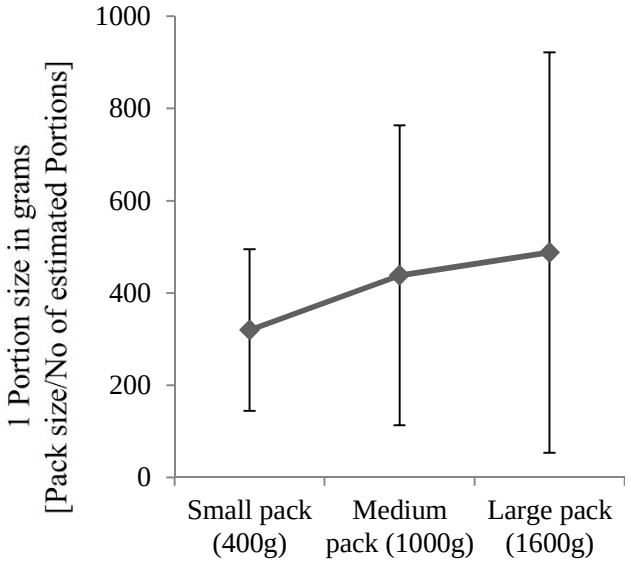
Chocolate confectionery

	Mean (g) ± SD	*Mean (Nr)* ± SD
Small pack (18g)	28.3 ± 19.2	1.4 ± 2.7
Medium pack (45g)	45.2 ± 29.8	1.8 ± 2.7
Large pack (2x35g)	51.5 ± 39.3	2.3 ± 2.8



Lasagne ready meal

	Mean (g) ± SD	*Mean (Nr)* ± SD
Small pack (400g)	319.7 ± 175.2	2.1 ± 2.7
Medium pack (1000g)	438.2 ± 325.1	3.5 ± 3
Large pack (1600g)	487.7 ± 434.2	5 ± 3.4



Cola drink

		Mean (g) ± SD	*Mean (Nr)* ± SD
Smaller packs	150ml	164.3 ± 103.9	1.7 ± 2.8
	250ml	235.4 ± 155.3	1.9 ± 2.8
	330ml	299.5 ± 171.2	1.9 ± 2.8
Larger packs	500ml	303.0 ± 222.7	2.9 ± 3.1
	1000ml	327.1 ± 387.7	5.2 ± 3.6
	1500ml	337.6 ± 426.4	7.1 ± 4.2

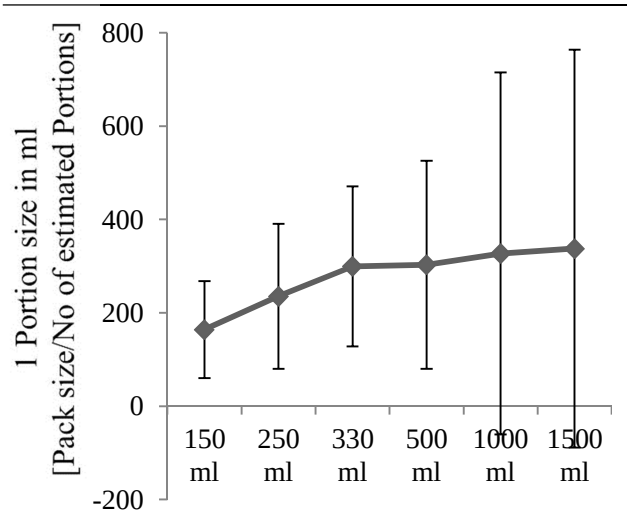


Figure 2. Perception of portion sizes, measured indirectly by means of the number of portion estimates. Depicted are the stated sizes of 1 portion (in gram or ml), based on different pack sizes for each food product (Parts 1 and 2).

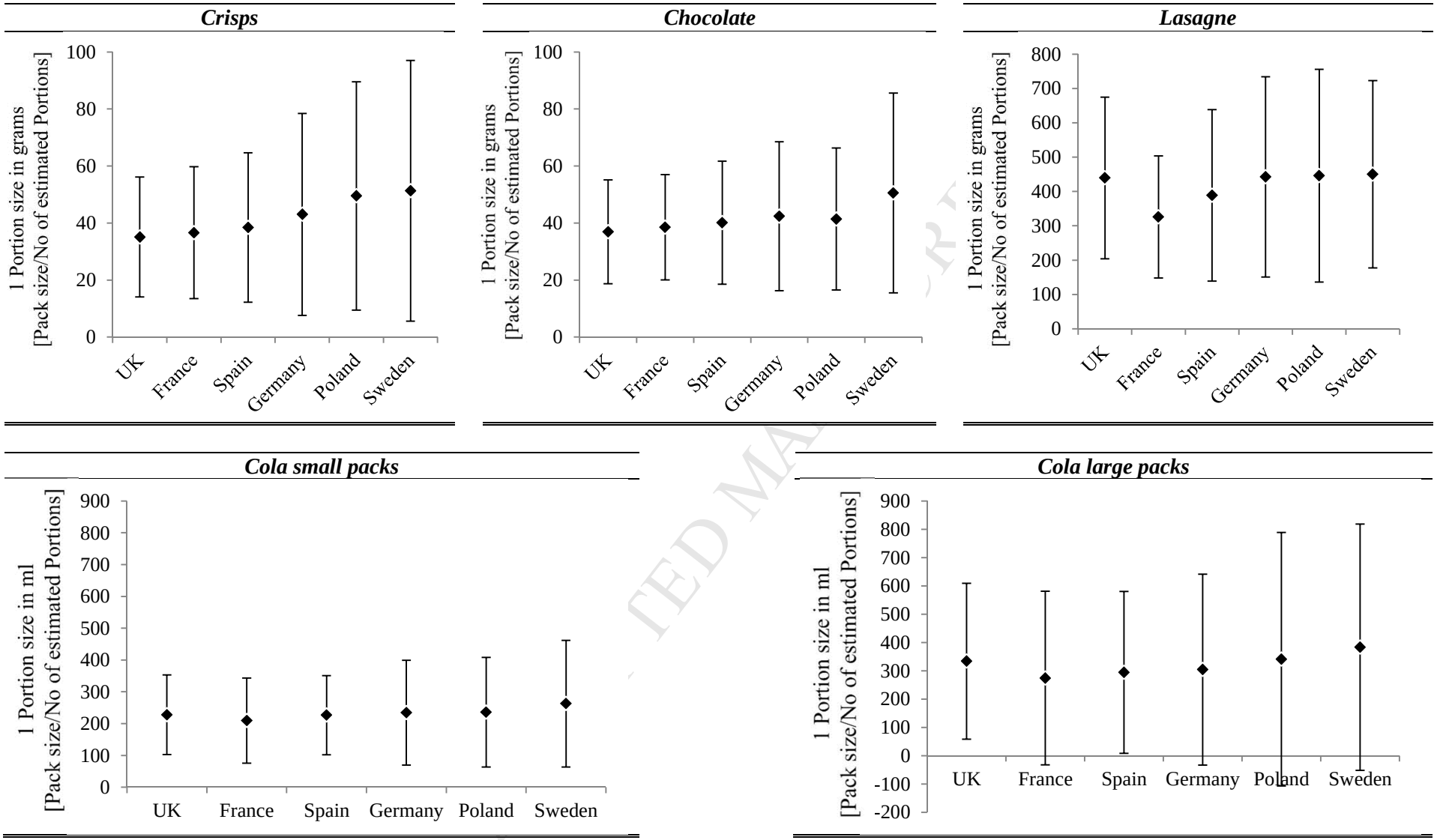


Figure 3. Country differences in the perception of portion sizes, measured indirectly by means of the number of portion estimates. Depicted are the stated sizes of 1 portion (in gram), across all pack sizes for each food product (Part 1) and (in ml) across the small and the large pack sizes for the cola type drink product (Part 2).

685 **Table 3. Part 2 - General Linear Model with covariates for small and large packs of cola type drink**

	Cola drink					
	Small packs			***Large packs***		
	F (df)	*p*	η^2	*F (df)*	*p*	η^2
Size	791.524 (1, 11809)	< .001***	.118	10.329 (1, 11809)	< .001***	.002
Gender	41.703 (2, 11809)	< .001***	.004	34.328 (2, 11809)	< .001***	.003
Country	22.117 (5, 11809)	< .001***	.009	22.632 (5, 11809)	< .001***	.009
Relevance of portion information	7.685 (1, 11809)	.006**	.001	1.339 (1, 11809)	.247	.000
Small pack	-	-	-	2.91 (2, 11809)	.055	.000
Large pack	23.595 (2, 11809)	< .001***	.004	-	-	-
Small size*Large size	3.189 (4, 11809)	.013*	.001	2.573 (4, 11809)	.036*	.001
Size*Gender	2.288 (2, 11809)	.102	.000	.500 (2, 11809)	.607	.000
Size*Country	1.553 (10, 11809)	.114	.001	4.951 (10, 11809)	< .001***	.004
Size*Relevance of portion information	1.865 (2, 11809)	.155	.000	1.197 (2, 11809)	.302	.000
Covariate: Age	13.326 (1, 11809)	< .001***	.001	8.002 (1, 11809)	.005**	.001
Covariate: BMI	1.413 (1, 11809)	.235	.000	.006 (1, 11809)	.939	.000
Covariate: Hunger	1.82 (1, 11809)	.117	.000	6.138 (1, 11809)	.013*	.001
Covariate: General Health Interest	75.163 (1, 11809)	< .001***	.006	30.922 (1, 11809)	< .001***	.003
Covariate: Subjective Knowledge about Healthy Eating	8.095 (1, 11809)	.004**	.001	4.047 (1, 11809)	.044*	.000
Covariate: Portion information search behaviour	.074 (1, 11809)	.786	.000	6.949 (1, 11809)	.008**	.001

Paired samples *t*-tests for differences in portion size estimates (in ml) of all pairings of cola drinks shown			
	Mean difference	*SE*	*p value*
150ml - 500ml	131.7	5.08	< .001***
150ml - 1000ml	153.4	9.28	< .001***
150ml - 1500ml	147.3	7.20	< .001***
250ml - 500ml	44.1	4.53	< .001***
250ml - 1000ml	102.9	10.25	< .001***
250ml - 1500ml	133.9	11.90	< .001***
330ml - 500ml	1.9	4.82	.689
330ml - 1000ml	20.0	7.83	.011*
330ml - 1500ml	59.8	11.08	< .001***

686 *$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$*

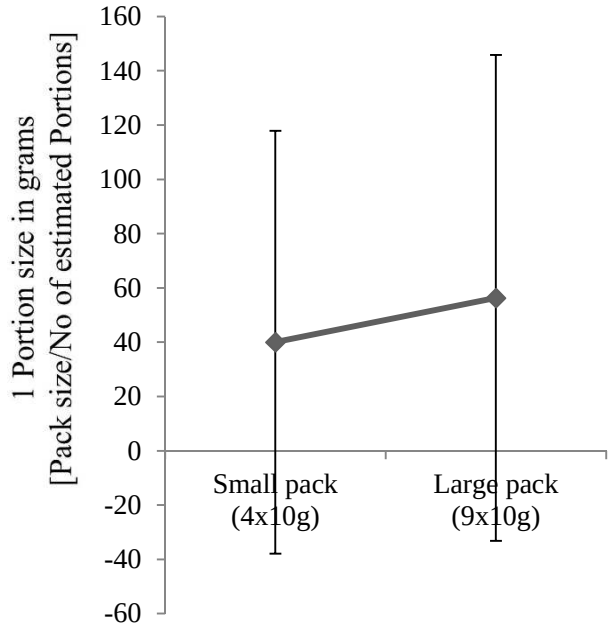
687 *Paired t-tests were adjusted with Bonferroni correction*

688 **Table 4. Part 3 - General Linear Model with covariates for each food product**

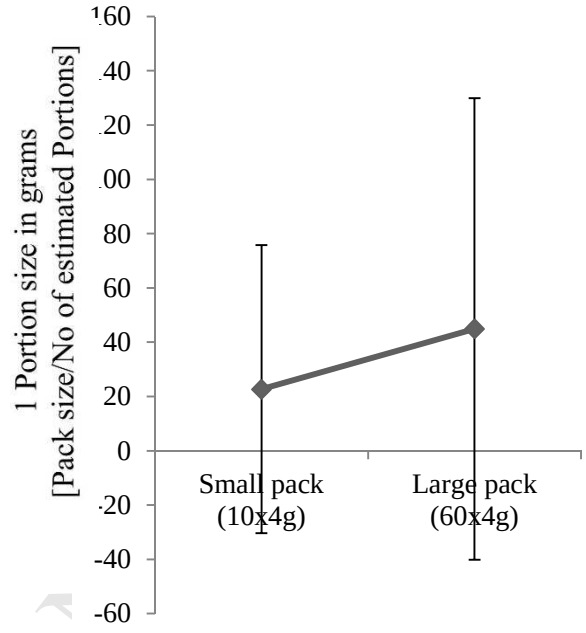
	Chicken nuggets			***Sweets***			***Biscuits***		
	F (df)	*p*	η^2	*F (df)*	*p*	η^2	*F (df)*	*p*	η^2
Size	129.694	<.001***	.011	275.371	<.001***	.023	71.901	<.001***	.006
	(1, 11960)			(1, 11965)			(1, 11965)		
Gender	12.791	<.001***	.001	19.487	<.001***	.002	3.916	.048*	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Country	12.165	<.001***	.005	50.213	<.001***	.004	9.811	<.001***	.004
	(5, 11960)			(5, 11965)			(5, 11965)		
Relevance of portion information	2.653	.103	.000	1.842	.175	.000	2.399	.121	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Size*Gender	.517	.472	.000	10.401	.001**	.001	1.345	.246	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Size*Country	1.409	.218	.001	21.055	<.001***	.009	10.452	<.001***	.004
	(5, 11960)			(5, 11965)			(5, 11965)		
Size*Relevance of portion information	.245	.620	.000	1.202	.273	.000	.41	.522	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: Age	10.662	.001**	.001	10.851	.001**	.001	2.453	.111	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: BMI	.043	.836	.000	2.519	.112	.000	2.643	.104	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: Hunger	5.746	.017*	.000	11.649	.001**	.001	13.223	<.001***	.001
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: General Health Interest	6.698	.01*	.001	20.281	<.001***	.002	.299	.585	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: Subjective Knowledge about Healthy Eating	1.728	.189	.000	.197	.657	.000	2.23	.135	.000
	(1, 11960)			(1, 11965)			(1, 11965)		
Covariate: Portion information search behaviour	2.034	.154	.000	2.367	.124	.000	.328	.567	.000
	(1, 11960)			(1, 11965)			(1, 11965)		

689 *$p < .05$, **$p < .01$, ***$p < .001$

Chicken nuggets	*Mean (Nr)* ± SD	*Mean (g)* ± *SD*
Small pack (4x10g)	4 ± 7.8	40 ± 77.9
Large pack (9x10g)	5.6 ± 8.9	56.3 ± 89.5



Sweets	*Mean (Nr)* ± SD	*Mean (g)* ± *SD*
Small pack (10x4g)	5.7 ± 13.3	22.7 ± 53.1
Large pack (60x4g)	11.2 ± 21.3	44.9 ± 85



Biscuits	*Mean (Nr)* ± SD	*Mean (g)* ± *SD*
Small pack (2x20g)	3.2 ± 13.1	64.1 ± 263
Large pack (15x20g)	5.6 ± 15.2	111.5 ± 303.2

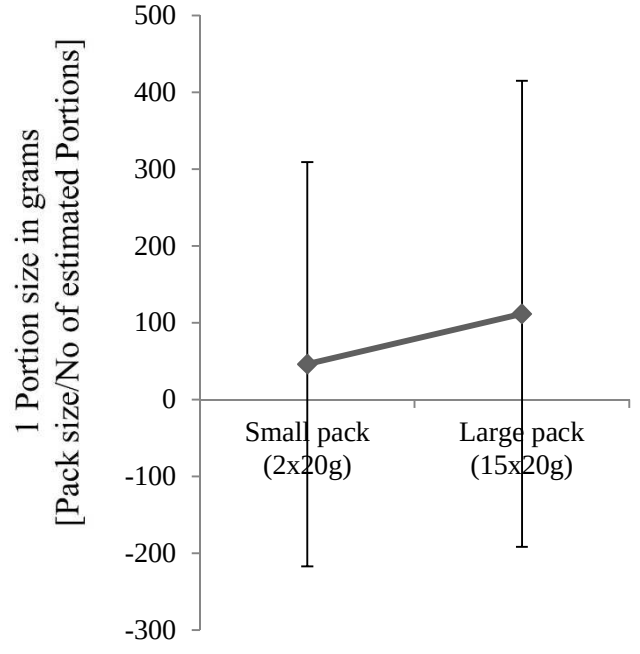
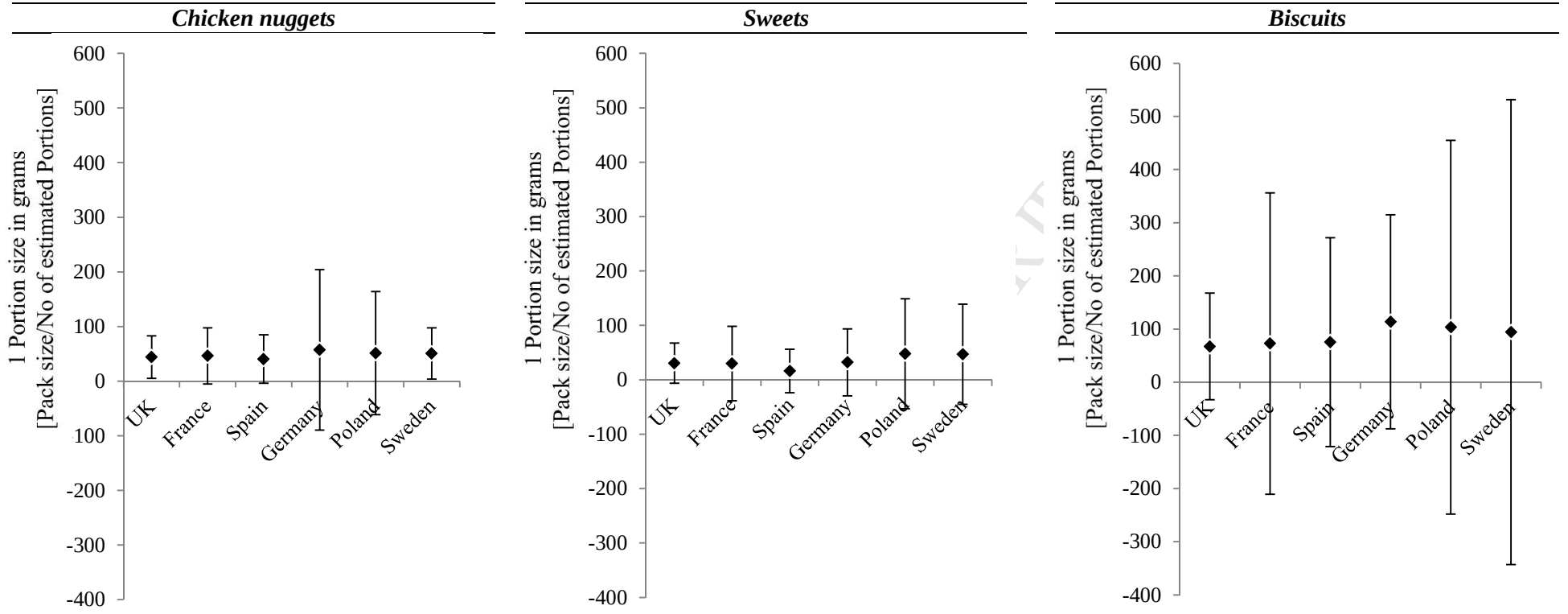


Figure 4. Perception of portion sizes, measured indirectly by means of the number of items that make up a portion. Depicted is the stated size of 1 portion (in gram), based on different pack sizes for each food product (Part 3).



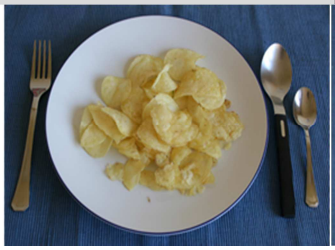
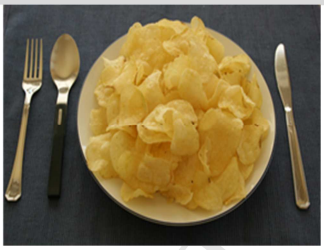
	Mean (g) ± SD
UK	44.0 ± 39.0
France	46.1 ± 51.6
Spain	40.3 ± 44.3
Germany	57.1 ± 146.8
Poland	51.2 ± 112.6
Sweden	50.5 ± 47.0

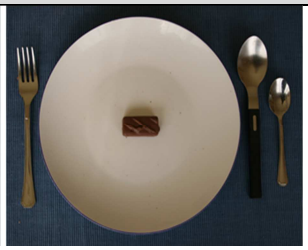
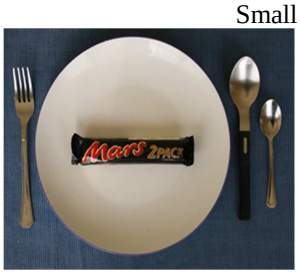
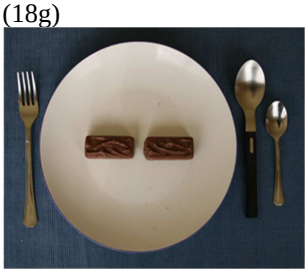
	Mean (g) SD
UK	30.5 ± 36.8
France	29.7 ± 68.5
Spain	16.0 ± 40.0
Germany	32.0 ± 61.8
Poland	47.8 ± 101.1
Sweden	46.9 ± 92.0

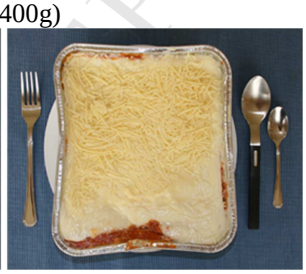
	Mean (g) ± SD
UK	67.3 ± 100.2
France	72.8 ± 283.4
Spain	75.5 ± 196.4
Germany	113.6 ± 201.5
Poland	103.6 ± 351.4
Sweden	94.2 ± 437.2

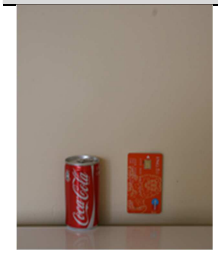
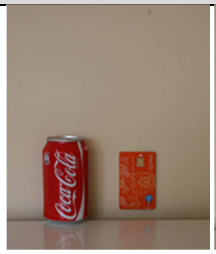
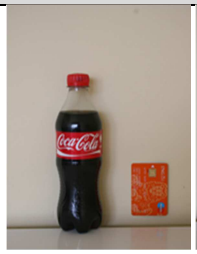
Figure 5. Country differences in the perception of portion sizes, measured indirectly by means of the number of items that make up a portion. Depicted is the stated size of 1 portion (in gram), across all pack sizes for each food product (Part 3).

699 **Appendix 1. Test food products and package size portfolios in Part 1 (rows 1-5) and 2 (row 6)**

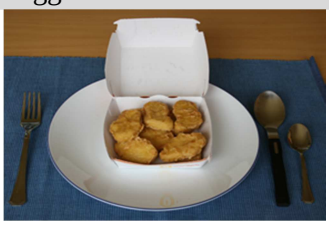
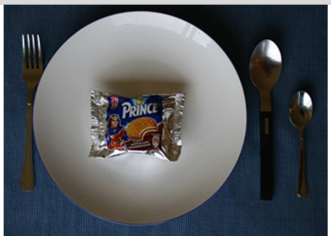
Crisps			
			
Small (34.5g)		Large (120g)	

Chocolate bar			
			
Small (18g)		Medium (45g)	
			
Large (2 x 35g)			

Lasagne ready meal			
			
Small (400g)		Medium (1000g)	
			
Large (1600g)			

Cola type soft drink					
					
150ml	250ml	330ml	500ml	1000ml	1500ml
	Small set			Large set	

700 **Appendix 2. Test food products and pack sizes in Part 3**

Chicken nuggets	
	
Small (4 x 10g)	Large (9 x 10g)
Sweets	
	
Small (10 x 4g)	Large (60 x 4g)
Biscuits	
	
Small (2 x 20g)	Large (15 x 20g)

Highlights

- Consumers estimate larger portions when presented with large food/drink packs.
- Consumers report more items to make up a portion from large multi-item packs.
- Men are influenced by the pack size effect to a greater extent than women.
- Countries across Europe differ in their portion size estimates.
- Whether portion information on food/drink packs is personally relevant to someone plays a role in estimating portions.

Supplementary material for: "The pack size effect: influence on consumer estimates of portion sizes"

Table S1. Means, standard deviations, mean differences (MD) and standard errors (SE) of portion size estimates across countries

			France	*Germany*	*Poland*	*Spain*	*Sweden*	*UK*
Part 1[e]	Crisps	Small	30.1 ± 19.3 [a]	34.2 ± 28.5 [b]	35.0 ± 30.2 [b]	30.5 ± 20.6 [a]	39.7 ± 32.6 [c]	29.1 ± 14.6 [a]
		Large	43.1 ± 32.8 [ab]	51.9 ± 51.4 [c]	64.0 ± 60.3 [d]	46.4 ± 39.5 [b]	62.9 ± 68.1 [d]	41.1 ± 33.6 [a]
		MD large-small ± SE	13.0 ± .6 [ab]	17.7 ± .9 [c]	29.0 ± 1.1 [e]	16.0 ± .7 [bc]	23.2 ± 1.2 [d]	12.0 ± .6 [a]
	Chocolate confec-tionary	Small	25.2 ± 16.0 [a]	29.2 ± 20.1 [b]	27.9 ± 19.5 [b]	25.8 ± 17.2 [a]	33.1 ± 22.6 [c]	28.7 ± 18.3 [b]
		Medium	40.1 ± 19.4 [a]	45.8 ± 31.0 [b]	44.8 ± 29.0 [b]	43.8 ± 25.4 [b]	56.5 ± 43.6 [c]	39.5 ± 20.7 [a]
		Large	49.7 ± 30.7 [b]	52.2 ± 40.7 [b]	51.5 ± 38.9 [b]	50.8 ± 34.6 [b]	62.2 ± 55.5 [c]	42.5 ± 25.4 [a]
		MD large-small ± SE	24.5 ± .6 [b]	23.0 ± .8 [b]	23.6 ± .7 [b]	25.0 ± .6 [b]	29.1 ± 1.0 [c]	13.8 ± .5 [a]
	Lasagne	Small	274.5 ± 144.2 [a]	328.0 ± 175.4 [c]	323.3 ± 206.0 [c]	291.6 ± 158.4 [b]	370.1 ± 192.8 [d]	330.9 ± 149.9 [c]
		Medium	338.0 ± 250.0 [a]	468.2 ± 367.0 [c]	465.6 ± 357.5 [c]	401.1 ± 304.2 [b]	480.2 ± 328.2 [c]	478.0 ± 305.8 [c]
		Large	365.3 ± 256.0 [a]	531.4 ± 484.3 [cd]	548.0 ± 525.0 [d]	473.6 ± 409.6 [b]	500.1 ± 436.7 [bc]	509.1 ± 422.2 [bc]
		MD large-small ± SE	90.9 ± 5.0 [a]	203.4 ± 9.2 [c]	225.6 ± 10.0 [d]	182.0 ± 7.7 [c]	130.0 ± 8.1[b]	178.2 ± 8.6 [c]
Part 2[e]	Cola small packs	150ml	147.9 ± 90.5 [a]	169.1 ± 111.6 [bc]	162.6 ± 101.3 [ab]	156.8 ± 84.4 [ab]	184 ± 127.5 [c]	167.4 ± 101.3 [b]
		250ml	212.3 ± 142.0 [a]	236.1 ± 162.6 [b]	234.6 ± 170.1 [b]	230.6 ± 129.3 [ab]	270.6 ± 189.5 [c]	228.5 ± 121.1 [ab]
		330ml	270.5 ± 134.8 [a]	299.9 ± 185.2 [b]	310.5 ± 196.6 [ab]	292.7 ± 114.7 [ab]	336.1 ± 231.9 [c]	287.7 ± 121.5 [ab]
	Cola large packs	500ml	264.8 ± 214.2 [a]	299.0 ± 231.5 [bc]	278.6 ± 207.6 [ab]	290.0 ± 171.1 [abc]	366.1 ± 295.1 [d]	319.4 ± 177.9 [c]
		1000ml	277.3 ± 295.0 [a]	281.1 ± 319.0 [b]	339 ± 434.4 [bc]	291.8 ± 245.2 [ab]	422.2 ± 568.0 [d]	350.3 ± 352.6 [c]
		1500ml	281.5 ± 388.8 [a]	334.2 ± 429.6 [ab]	407.4 ± 603.2 [c]	301.6 ± 395.0 [a]	369.1 ± 393.8 [bc]	333.4 ± 267.9 [ab]
		MD 1500ml-150ml ± SE	121.5 ± 15.0 [ab]	128.1 ± 12.8 [ab]	188.6 ± 20.6 [b]	100.2 ± 12.7 [a]	188.4 ± 26.1 [b]	165.1 ± 17.0 [ab]
Part 3[f]	Chicken nuggets	Small	3.7 ± 3.0 [a]	4.7 ± 10.1 [b]	4.0 ± 13.7 [ab]	3.5 ± 5.0 [a]	4.2 ± 4.7 [ab]	3.8 ± 4.2 [a]
		Large	5.5 ± 6.5 [abc]	6.7 ± 18.1 [d]	6.2 ± 8.0 [cd]	4.5 ± 3.7 [a]	5.9 ± 4.5 [bcd]	5.0 ± 3.7 [ab]
		MD large-small ± SE	1.7 ± .2	1.9 ± .6	2.1 ± .5	1.0 ± .2	1.7 ± .2	1.3 ± .2
	Sweets	Small	4.5 ± 4.8 [ab]	5.0 ± 10.2 [abc]	6.3 ± 18.3 [c]	3.7 ± 10.9 [a]	8.9 ± 20.9 [d]	5.8 ± 5.5 [bc]
		Large	10.4 ± 23.4 [b]	11.1 ± 18.9 [b]	17.7 ± 29.7 [d]	4.3 ± 9.1 [a]	14.5 ± 24.6 [c]	9.5 ± 11.5 [b]
		MD large-small ± SE	6.0 ± .7	6.1 ± .7	11.4 ± 1.1	.6 ± .4	5.6 ± 1.0	3.8 ± .4
	Biscuits	Small	2.0 ± 1.7 [a]	6.0 ± 8.7 [c]	2.3 ± 3.3 [ab]	2.9 ± 13.2 [ab]	3.8 ± 27.2 [b]	2.2 ± 4.1 [ab]
		Large	5.3 ± 19.7 [a]	5.3 ± 11.3 [a]	8.1 ± 24.4 [b]	4.6 ± 4.2 [a]	5.7 ± 14.6 [a]	4.6 ± 5.5 [a]
		MD large-small ± SE	3.3 ± .6	.7 ± .4	5.8 ± .7	1.7 ± .4	2.0 ± 1.0	2.4 ± .2

[e] Estimated portions in grams/ml

[f] Number of items that make up a portion

Countries with different superscript letters across lines differ significantly in terms of their portion size estimates within each pack size (white lines) or the magnitude of the pack size effect (mean differences calculated as the portion size estimate of the large minus the small pack of each food) (grey lines). For Part 3, no *significance tests* are reported because a between-subjects design was used.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table S2. Means, standard deviations, mean differences (MD) and standard errors (SE) of portion size estimates by gender and relevance of portion information

			Men	***Women***		***Portion information relevant***	***Portion information not relevant***	
			n= 5812	n= 7305	*MD Men-Women* ± SD	n= 6071	n= 7046	*MD Not relevant-Relevant* ± SD
Part 1[e]	Crisps	Small	36.2 ± 29.6	30.6 ± 21.3	5.6 ± .4***	31.6 ± 23.8	34.4 ± 26.7	2.7 ± .4***
		Large	59.0 ± 59.2	45.6 ± 40.9	13.4 ± .9***	48.5 ± 45.8	54.2 ± 53.7	5.7 ± .9***
		MD large-small ± SE	22.8 ± .7***	15.0 ± .4***	-	16.9 ± .5 ***	19.9 ± .5***	-
	Chocolate confec-tionary	Small	29.6 ± 20.9	27.3 ± 17.7	2.3 ± .3***	26.4 ± 17.8	29.9 ± 20.2	3.5 ± .3***
		Medium	47.6 ± 34.2	43.3 ± 25.7	4.3 ± .5***	43.1 ± 27.2	46.9 ± 31.9	3.8 ± .5***
		Large	55.7 ± 45.9	48.2 ± 32.8	7.5 ± .7***	48.3 ± 35.3	54.3 ± 42.2	6.0 ± .7***
		MD large-small ± SE	26.1 ± .5***	20.9 ± .3***	-	21.9 ± .4***	24.4 ± .4***	-
	Lasagne	Small	327.0 ± 197.3	313.8 ± 155.2	13.1 ± 3.1***	304.2 ± 165.1	332.9 ± 182.5	28.7 ± 3.1***
		Medium	457.9 ± 359.7	422.5 ± 293.9	35.3 ± 5.7***	410.0 ± 292.4	462.5 ± 349.1	52.6 ± 5.7***
		Large	522.0 ± 493.3	460.4 ± 378.5	61.5 ± 7.6***	468.7 ± 418.2	504.0 ± 446.9	35.3 ± 7.6***
		MD large-small ± SE	195.0 ± 5.8***	146.6 ± 4.0***	-	164.5 ± 4.8***	171.1 ± 4.7***	-
Part 2[e]	Cola small packs	150ml	175.3 ± 120.2	155.7 ± 88.2	19.6 ± 3.2***	158.8 ± 96.3	169.2 ± 109.9	10.4 ± 3.2***
		250ml	243.7 ± 169.2	229.2 ± 143.4	14.5 ± 4.7***	226.1 ± 146.1	243.7 ± 162.4	17.6 ± 4.7***
		330ml	312.7 ± 195.6	289.1 ± 147.1	23.7 ± 5.2***	290.2 ± 158.8	308.1 ± 180.9	17.9 ± 5.2***
	Cola large packs	500ml	323.7 ± 242.5	286.7 ± 204.4	37.0 ± 6.8***	285.8 ± 190.1	317.8 ± 246.4	32.0 ± 6.7***
		1000ml	359.0 ± 399.4	301.2 ± 376.1	57.8 ± 11.8***	303.4 ± 359.5	347.5 ± 409.4	44.1 ± 11.7***
		1500ml	367.4 ± 460.5	314.3 ± 396.1	53.1 ± 13.0***	329.0 ± 442.3	345.1 ± 412.1	16.1 ± 13.0 [ns]
		MD 1500ml-150ml ± SE	165.6 ± 12.1***	132.7 ± 8.6***	-	261.0 ± 10.1***	279.3 ± 10.2***	-
Part 3[f]	Chicken nuggets	Small	4.3 ± 9.7	3.7 ± 5.8	.6 ± .2***	3.9 ± 7.2	4.1 ± 8.3	.2 ± .2 [ns]
		Large	6.1 ± 11.8	5.3 ± 5.6	.8 ± .2***	5.4 ± 11.3	5.8 ± 6.3	.3 ± .2 [ns]
		MD ± SE	1.8 ± .3***	1.5 ± .1***	-	1.5 ± .2***	1.7 ± .2***	-
	Sweets	Small	6.1 ± 14.2	5.3 ± 12.5	.8 ± .3*	5.4 ± 13.8	5.9 ± 12.8	.4 ± .3 [ns]
		Large	12.8 ± 23.7	10.0 ± 18.9	2.8 ± .5***	10.8 ± 22.9	11.6 ± 19.7	.9 ± .5 [ns]
		MD ± SE	6.6 ± .5***	4.6 ± .4***	-	5.3 ± .5***	5.8 ± .4***	-
	Biscuits	Small	3.6 ± 9.7	2.9 ± 15.3	.7 ± .3*	3.2 ± 16.9	3.2 ± 8.6	.04 ± .3 [ns]
		Large	6.3 ± 15.8	5.0 ± 14.6	1.2 ± .4***	5.7 ± 17.8	5.4 ± 12.4	.3 ± .4 [ns]
		MD ± SE	2.7 ± .3***	2.1 ± .4***	-	2.5 ± .4***	2.2 ± .3***	-

[e] Estimated portions in grams/ml

[f] Number of items that make up a portion

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$