

Bachelor thesis

The effect of unit size on snack intake

Is it really that robust?



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Preface

This bachelor thesis is a product of my education in Management and Consumer studies at Wageningen University & Research. Within this study I have chosen the consumer side, since I find consumer behaviour very interesting. I find it especially interesting how insights into consumer behaviour can be used to steer people towards healthy behaviour or towards choices that are beneficial for the society or for the consumer himself. The opportunity to write my thesis for the Marketing and Consumer Behaviour group was a pleasant experience, since it connected with my interests very well.

I would like to thank the people that have helped and supported me during the period of writing this thesis. First of all, I want to thank my supervisor Ellen van Kleef for her useful and constructive feedback. Moreover, she gave me enough freedom in writing but also thought along with my thesis which helped to get most out of my bachelor thesis. Also, I want to thank my second supervisor, Betina Piqueras Fiszman for reading and evaluating this thesis. Furthermore, I would like to thank my friend Lotte for her advice and support from a distance. Additionally, I would like to thank Marianne and Femke for staying in my experiment room for one afternoon, so that I could leave the room to recruit participants.

Enjoy reading.

Hanneke Bolster

Wageningen, April

Summary

Background: Obesity is a world rising problem and is most likely caused by increased food intake. To tackle obesity food intake should be reduced. Previous research shows that people tend to reduce food consumption when the food is presented in smaller units. This phenomenon is called the unit size effect. This research focuses on the effect of food unit size on food intake while taking multiple unit sizes into account. It was hypothesized that cake that is served in larger units leads to an increase in cake intake, compared to cake that is served in smaller units. This relationship between unit size and food intake was expected to be curvilinear. The presence of decision points is brought forward as an explanation this effect. Decision points are moments of reflection that occur during consumption, which slows consumption. It was hypothesized that eating cake that is served in larger units induces less decision points compared to eating cake that is served in smaller units. Moreover, it was hypothesized that cake intake would decrease when more decision points are present. A second explanation is that of perceived own impulsiveness. Eating smaller sized units is to a larger extent seen as an act of impulsiveness than eating larger sized units, leading to a lower food intake. It was hypothesized that eating cake that is served in larger units leads to lower perceived impulsiveness compared to eating cake that is served in smaller units. Moreover, it was hypothesized that higher perceived impulsiveness leads to a decrease in gram weight intake of cake.

Method: Students of Wageningen University & Research (n = 65) participated in a between-subjects experimental design. All participants were offered the same portion of cake but the unit size of cake differed across conditions. Depending on the condition, cake was served in either whole slices, half slices or one third slices to participants while they had to watch a movie. Gram weight intake of cake was measured by subtracting the grams of leftovers of cake from the total gram weight that was served to the participant. The mediators were measured with different items in a questionnaire that participants had to fill in after consumption.

Results: No unit size effect was found. Perceived number of decision points was significantly higher in the small unit size condition than in the large unit size condition. There was no correlation between perceived number of decision points and gram weight intake of cake. No difference was found in perceived own impulsiveness across conditions. There was a positive correlation between perceived own impulsiveness and cake intake.

Discussion: Reducing the unit size of cake did not lead to reduced cake intake. This finding should be interpreted carefully, since only 65 participants participated in this study. It might be that the unit size of cake does not have an influence on cake intake because cake has naturally only the unit size of a whole slice. The focus on the movie and that cake was presented as a reward could also have contributed to the unexpected results. Future research should investigate the unit size effect in a more natural setting with participants of different ages and of different geographical areas. Also, research that takes multiple unit sizes into account should be extended.

Content

Preface..... 1

Summary 2

Introduction..... 4

Theoretical background..... 6

Method..... 19

Results 24

Discussion 26

References..... 30

Appendix 1 – Questionnaire..... 34

Introduction

Overweight and obesity are worldwide rising problems. In 2016 39% of the world's adult population were overweight, of which 13% were obese (World Health Organisation, 2018). If current trends continue, 58% of the adults worldwide will be overweight or obese by 2030 (Kelly, Yang, Chen, Reynolds & He, 2008). Obesity increases the risk for noncommunicable diseases such as diabetes and therefore is a serious problem (World Health Organisation, 2018). Although obesity is influenced by both eating behaviour and physical activity, it is argued that obesity is most likely caused by food intake (Westerterp & Speakman, 2008). The increased food intake and the rise in obesity can partly be explained by the so called 'portion size effect'. The portion size effect can be defined as the effect of people consuming more when the portion size is larger (Herman, Polivy, Pliner & Vartanian, 2015). Food portion sizes have increased considerably over the past decades (Duffey & Popkin, 2011; Steenhuis, Leeuwis & Vermeer, 2009; Young & Nestle, 2002). With this increase in portion sizes, people should compensate elsewhere to achieve an energy balance and to maintain weight over time. However, this compensation is not made and as a result people have a daily additional energy intake (Hetherington & Blundell-Birtill, 2018).

Next to this, energy intake might also be influenced by the units in which a portion is split. Unit size describes the number of units the portion is divided into and this is different from portion size since portion size refers to the total weight of a portion (van Kleef, Kavvouris & van Trijp, 2014). The use of different unit sizes induces another phenomenon, namely the unit size effect. When observing this effect, the overall amount of food that is served to participants is kept constant but the units in which the food is divided are differentiated (Marchiori, Waroquier & Klein, 2011; van Kleef et al., 2014). The unit size effect is "the phenomenon that smaller units of food tend to reduce consumption" (van Kleef et al., 2014, p.1098). This indicates that when food is served in smaller units, the energy intake of people will be lower. The unit size of food might thus also be of influence on overweight and obesity.

This research focuses on the effect of different unit sizes on food intake. Various studies have already demonstrated that the unit size effect exists in a range of different types of foods, such as cookies (Marchiori, Waroquier & Klein, 2012), chocolate (van Kleef et al., 2014), candies (Marchiori et al., 2011), fried rice (Chang et al., 2012) and carrots (Liem & Russell, 2019). The participants in all these studies consumed significantly less of the foods when it was served in smaller units than in larger units. There are several underlying mechanisms suggested that could explain this effect such as the unit bias (Geier, Rozin & Doros, 2006), consumption monitoring (van Kleef et al., 2014), decision points (Cheema & Soman, 2008), perceived impulsiveness (van Kleef et al., 2014) and bite size (Liem & Russel, 2019). In this research the unit size effect is tested for cake and therefore decision points and perceived impulsiveness are of particular interest as underlying mechanisms. Participants who are served multiple smaller units of cake might switch from an automatic mode to a conscious mode due to partition during consumption. Next to this, participants who are served multiple smaller units of cake might perceive taking another unit as more impulsive than participants in the condition with the larger cake units. Consequently, both could lead to a lower intake of cake in smaller units compared to larger units.

What remains unknown is whether the unit size effect is affected by changes in relative differences between the unit sizes and whether there are boundaries to this effect. Spill, Birch, Roe and Rolls (2010) found that doubling a portion of carrots increased carrot consumption significantly but that

tripling the portion size of carrots did not lead to a further increase in intake. The use of relative differences of 1:2 or 1:3 thus does not make a difference for the portion size of carrots. Whether this effect of the relative differences occurs in the same way for the unit size effect still needs to be researched.

This research implements different ratios while investigating the unit size effect and therefore fulfils a knowledge gap and adds-on existing knowledge. In this research cake is used to test the unit size effect. Therefore it broadens the existing knowledge since this is a food product that is not used before in the unit size effect studies. Furthermore, this research makes use of three different unit sizes instead of only a small and a large unit size. Slices of cake are presented to the participants as either whole slices, half slices or slices that are divided into three pieces. Other studies on the unit size effect mainly made use of only a small and a large unit and this research thus fulfils a knowledge gap by making use of diverse relative differences between different unit sizes.

Besides, research on the unit size effect is of interest because the outcomes might be used to partly tackle obesity. Obesity is not only a health problem, but it has also economic burden. According to Yusefzadeh, Rashidi and Rahimi (2019) much of the cost on the health-care system are caused by overweight and obesity. In 2012 obesity costed the global economy roughly 2 trillion dollar, which was 2.8% of the global GDP (McKinsey & Company, 2015). Although the insights of this research would not resolve this problem of extra health costs, it might still be helpful to use these insights as a step in the right direction. Hence this research is of importance for the government because the government carries this economic burden. Insights of the effect of the unit size on food consumption can help the government with interventions to steer the food intake of consumers. This can be a helpful step for the government in their attempt to reduce obesity and the associated economic burden.

Aim

The aim of this research is to gain insights into part of the cause of obesity by investigating the effect of unit sizes in different ratios on unhealthy snack consumption of adults. As previous research shows, serving portions in smaller units decreases consumption (Chang et al., 2012; Liem & Russel, 2019; Marchiori et al., 2011, 2012; van Kleef et al., 2014). Whether this decrease in consumption continues if the ratio gets larger is still unknown. Insights into the strength of the unit size effect on food consumption can help people in reducing their food consumption.

Research question

The central research question is: *'What is the effect of different ratios between unit sizes on the food consumption of unhealthy snacks by adults?'*

Theoretical background

People consume less food when the food is offered in smaller units. This phenomenon is called the unit size effect. It is important to note that studies on the unit size effect vary the units in which the food is split, while keeping the amount of food that is provided equal (van Kleef et al., 2014). Even though participants are offered the same amount of food, food consumption still differs due to the difference in unit size of the food. Theories and studies about this behaviour are discussed in this literature review. First, the effects of the unit size of food on consumption are debated. Thereafter, the strength of the effect is investigated. Subsequently, supposed explanations for the unit size effect are elaborated upon. Lastly, the hypotheses and the conceptual model are presented.

The unit size effect

Empirical evidence shows for different food domains that people reduce food consumption when the food is presented in smaller units.

Snacks

One of the food domains for which the unit size effect is shown are snacks. Geier et al. (2006) compared snack intake of small versus large Tootsie Rolls, half versus whole pretzels and M&M's with a tablespoon versus a quarter-cup scoop size. They found for all three snacks that the amount consumed was significantly greater for the larger units than the smaller units. However, actual consumption was not measured and the results were based on the selected amount. Therefore it is unsure whether the actual consumption of larger units was also significantly greater than of the smaller units in this study, or that there was only a significant difference in the selected amount. Fortunately, this knowledge gap is filled by other studies that did measure the actual consumption. One of these studies is the study by Weijzen, Liem, Zandstra and de Graaf (2008), which looked at the consumption of nibble-size and bar-size biscuits. The participants attended four sections, of which two sections with nibbles and two with bars. The sections also differed in consumption condition; participants were either instructed to pay more attention to their satiety or they got a less extensive instruction. A significant difference between intake of nibbles and bars was found in the condition with the less extensive instruction. The intake of nibbles was 12% lower than that of the bars. No difference was found for the intake in the attention condition.

Another snack for which the unit effect is shown are candies. In a study by Marchiori et al. (2011) candies were cut in half and intake of these were compared with the intake of whole candies. The number of consumed candies was approximately the same between conditions, but the participants with the larger candies consumed twice as much in gram weight because of the difference in size. For this reason, participants with the larger candies increased energy intake with almost 60 kilo calories. A corresponding increase in kilo calories consumed was found when children were presented with whole cookies instead of half-sized cookies (Marchiori et al., 2012). However, in this case number of units consumed did differ between conditions. A greater number of cookies was consumed by the children who were offered the smaller cookies. Despite this, children in the large cookie condition still consumed 25% more gram weight of the cookies than the children in the small cookies condition (Marchiori et al., 2012). A similar result was found for the cookie intake of adults (Kerameas, Vartanian, Herman & Polivy, 2015). Moreover, the unit size effect was found for chocolates as well. In the study of van Kleef et al. (2014) participants were either offered three large Mars chocolate bars or 15 small Mars chocolate bars, both being equal to a total of approximately 150 grams. This

difference in unit size resulted in a 23% lower intake of chocolates for participants in the small unit size condition compared to those in the large unit size condition. Lastly, Bui, Davis, Payne & Scott (2016) found that the unit size effect exists for cinnamon rolls, pizza, cheese filled Ritz crackers and donuts. In their studies people selected the same number of units irrespective of unit size, leading to a higher calorie consumption for the larger units. Another result of the study of Bui et al. (2016) was that the unit size effect especially occurs in social settings.

Breakfast and lunch products

Another food domain for which the unit size effect is found is the domain of breakfast and lunch products. Raynor, van Walleghen, Niemeier, Butryn and Wing (2009) studied the effect of providing different breakfast foods in single-serving packages compared to nonportioned standard packages on intake of the provided foods. In an 8-week intervention they provided participants with cereal, canned peaches, applesauce, and cheddar cheese which were either packed in single servings or in nonportioned packages. The outcome of this intervention was that providing foods in single-serving packages resulted in a reduction in energy intake of these foods compared to the food intake in the nonportioned condition. However, this effect was only found for the amorphous foods (cereal and applesauce) and not for the foods with a distinct shape (peaches and cheese). Interestingly, this reduction in energy intake did not lead to an increased weight loss because there was no significant difference of weight loss during the 8 weeks between conditions. Furthermore, the influence of the unit size of bread rolls on the bread intake by children was investigated by van Kleef et al. (2016). Whole wheat and white bread rolls were offered in different unit sizes during lunch. The primary result was that children ate more bread when white rolls were larger-sized. However, this effect of unit size did not have an impact on the total calories consumed during lunch, indicating that the consumption of toppings was reduced when white rolls were larger-sized.

Fried rice

For fried rice it was also found that participants ate significant less of smaller units than of larger units (Chang et al., 2012). In this study, the difference in unit size was created by serving the fried rice either in small balls or in large balls. A significant effect of unit size on rice intake was found in that participants in the small unit condition consumed less grams of rice than the ones in the large unit condition. This smaller gram intake resulted in an energy intake that was approximately 90 kilo calories lower than the energy intake for the large unit condition.

Carrots

The unit size effect is also proven for a healthier food, namely carrots. Goh, Russell and Liem (2017) let children eat as many of the either diced or whole carrots as they liked for 10 minutes. They found that children who finished eating before the end of the 10 minutes, ate more of the whole carrots compared to the diced carrots. However, no significant effect on intake was found when looking at the whole group of participants. In another study Liem and Russell (2019) let children eat carrots, either diced or whole, while watching a movie for 90 minutes. The total amount of carrots that the children consumed was higher for the whole carrots than for the diced carrots. This effect was the strongest and significant in the first 10 minutes, with a mean difference of 13 grams in these 10 minutes.

Unit size effect not found

Although the unit size effect is proven in all these studies and for all these different kinds of food, there are also studies in which the unit size effect was not found. One of these studies is the study by Devitt and Mattes (2004) in which they explored the effects of food unit size and energy density on food consumption. In this study participants consumed breakfast, lunch and dinner in the laboratory, all differing in unit size and energy density. Four conditions were used: one in which small unit size with low energy density was combined, a second where small unit size was combined with high energy density, a third combining customary unit size with low energy density and finally a condition where customary unit size was combined with high energy density. The unit size effect was tested by comparing the small unit, low energy condition with the customary unit, low energy condition and by comparing the small unit, high energy condition with the customary unit, high energy condition. Outcomes were that the total daily gram weight consumed did not differ between treatments and that kilocalorie consumption was only influenced by energy density. Thus, no effect of food unit size was found in this study. Raynor and Wing (2007) did neither find the unit size effect in their study which looked at both portion size and unit size. Participants in this study received a box of food containing four different snack items to take home and consume over a 3-day period. The snacks were either packed in single-serving packages or in packages that were at least 5 times the size of the single-serving. Although the portion size influenced food intake, no effect of unit size was found. Furthermore, in a study on the influence of portion and unit size on cucumber intake among children, van Kleef, Bruggers and de Vet (2015) did not find an effect of unit size on cucumber consumption. Moreover, the study of Langlet, Bach, Odegi, Fagerberg and Ioakimidis (2018) did not find an influence of unit size of food served at lunch on food consumption.

A summary of the studies can be found in Table 1.

Table 1. Summary of unit size effect studies

Study	Type of product	Design of study	Ratio used	Outcome measure	Studied sample	Result
Geier et al. (2006)	Tootsie Rolls, pretzels and M&M's.	In an office building a large bowl of Tootsie Rolls was placed on the first floor. On the alternating days, the bowl was filled with 80 small or 20 large Tootsie Rolls. Pretzels were left for tenants in an apartment building either served as whole or as half pretzels. At the same building, a bowl with M&M's was placed with either a tablespoon or a quarter-cup scoop.	1:4 (Tootsie Rolls and M &M's). 1:2 (Pretzels).	Selected amount.	Visitors of the building.	The amount of snacks selected increased when it was offered in larger units.
Weijzen et al. (2008)	Biscuits with a chocolate-hazelnut cream filling.	Subjects attended four different sections. In each session participants were offered either nibble-size or bar-size snacks with either an attention or a normal instruction.	1:11.	Ad libitum intake of the snacks: left-overs on the plate were weighted.	Adults.	Intake of nibbles was significantly lower compared to bars in the normal instruction condition.
Marchiori et al. (2011)	Candies.	During an unrelated computerized experiment, participants were offered 20 normal-sized candies in one condition while the participants in the other condition were offered 40 half-sized candies. It was told to participants that candies were offered for free consumption.	1:2.	Amount consumed: plate was weighted before and after the experiment. Energy intake: determined by data from the manufacturer.	Students.	Same number of candies consumed in both conditions, leading to an increase in energy intake of 60 kcal for participants with the large candies.
Marchiori et al. (2012)	Cookies.	Children were offered either 36 half-sized or 18 normal-sized cookies and were told that they could eat as much or little as desired.	1:2.	Amount of cookies consumed: initial count – number of cookies left. Energy intake: based on data of the manufacturer.	Children.	Children consumed 25% more gram weight in the large cookie condition.

Table 1. Continuation

Kerameas et al. (2015)	Cookies.	In study 1 participants were either served a small (30 gram) or large (90 gram) portion of cookies that was presented either as single unit or as three smaller units. In study 2 participants were served either one 60 gram cookie or three 20 gram cookies.	1:3.	Cookie consumption.	Students.	Participants ate less when three cookies were given than when given a single cookie.
Van Kleef et al. (2014)	Chocolate bars.	Chocolates were placed in front of participants either in fifteen small or three large units and either wrapped or unwrapped. It was explained that the chocolates would be topic of later questions but that they already could start eating as much as they wanted. Participants had to rate commercials for ten minutes and answer 'taste test' questions. After finishing this, the chocolates were taken away by the experimenter.	1:5.	Total amount of chocolates consumed in grams: weighted after the taste test. Impulsiveness. Expected satiety.	Students.	23% lower intake of chocolates for participants in the small unit size condition compared to the large unit size condition.
Bui et al. (2016)	Cinnamon rolls, pizza, cheese filled Ritz crackers and donuts.	In the first study, either small or large cinnamon rolls were offered for free at a farmer's market. Participants in the second study were invited to a pizza taste testing with either all small slices or all large slices. They ate either alone or at a table with 3-4 persons. The third study was at a social networking event where people could put cheese filled Ritz crackers on their plates, differing in unit size. Either small donuts or large donuts were offered to participants in the fourth study.	Unknown: only small and large units were mentioned but not their actual sizes.	-	Adults.	Same number of units was selected regardless of unit size, resulting in an increase in total calories consumed.
Raynor et al. (2009)	Breakfast products (cereal, canned peaches, applesauce and cheddar).	An 8-week behavioural weight-control intervention was conducted. Participants received either single-serve packages or nonportioned standard packages of foods to consume at breakfast.	1:22 (cereal). 1:4 (peaches and applesauce). 1:8 (cheese).	Food consumption: postconsumption weight - preconsumption weight. Energy intake: multiplying calories per gram of food by grams of food consumed.	Adults.	Reduction in energy intake of amorphous foods (cereal and applesauce).

Table 1. Continuation

Van Kleef et al. (2016)	Bread rolls.	During a free to choose lunch, bread rolls, toppings and drinks were provided to children. Bread rolls differed in unit size (small versus large).	Unknown: only small and large units were mentioned but not their actual sizes.	-	Children.	Children ate more bread when white rolls were larger-sized.
Chang et al. (2012)	Fried rice.	During lunch, amorphous fried rice was offered to participants in the first test week, distinct large fried rice balls in the second week and distinct small fried rice balls in the third week.	1:5.	Consumption in grams of rice. Energy intake.	Women aged between 20-30 years.	90 kcal lower energy intake for the smaller balls compared to the larger balls.
Liem & Russel (2019)	Carrots.	A box of 500 grams of either diced or whole carrots was given to children while they watched a movie of 90 minutes. The box was closed and sealed after 10 minutes. A second box with also 500 grams of either diced or whole carrots was given to the children for the rest of the movie.	1:7.	Carrot consumption after 10 and 90 minutes.	Children.	In the first 10 minutes, participants ate 13 gram more carrots when offered with the whole carrot instead of diced.
Devitt & Mattes (2004)	Breakfast (omelettes), lunch (wrap sandwiches) and dinner (pizzas) products.	Participants consumed breakfast, lunch and dinner in the laboratory on four days. They were instructed to eat as much as they wanted. Recipes of the foods were manipulated to control energy density (low or high) and food unit size (small or customary).	1:12 (omelettes). 1:8 (wraps sandwiches).	Gram weight intake. Kilocalorie intake.	Adults.	No unit size effect was found.

Table 1. Continuation

Raynor & Wing (2007)	Potato chips, cheese crackers, cookies and candies.	Participants received a box with four different snack items to take home and consume over a 3-day period. In one condition the snacks were served in single-serving packages, while in the other condition the units were packaged in units that were at least 5 times the size of the single-serving packages. After the 3-days participants had to write down everything they had eaten and drunk in the time period since receiving the box.	At least 1:5.	Food intake: based on what participants wrote down.	Men and women aged between 18 and 30 years.	No effect of unit size was found.
Van Kleef et al. (2015)	Cucumber.	Cucumber was served in either small or large portions and in either small or large unit size. In the large unit size conditions, the cucumbers were served in one piece, while in the small unit size conditions the portion was cut in either six pieces for the small portion or twelve pieces for the large portion. The study was presented as a taste test and children were told that they could decide for themselves how much they wanted to eat.	1:6 (small portion conditions). 1:12 (large portion conditions).	Consumption of cucumber in grams: leftovers were weighed.	Children.	Consumption was not impacted by unit size.
Langlet et al. (2018)	Vegetables and chicken. & Meat and potato.	Participants were served lunch in a meal laboratory. In study 1 the lunch consisted of vegetables and chicken that were cut in small units (0.5 cm ³), medium units (1.0 cm ³) or large units (1.5 cm ³). In the second study the lunch contained minced meat and puréed potatoes in the small unit condition and meatballs and potatoes as a whole in the large unit condition.	1:2 (small and medium conditions study 1). 1:3 (small and large conditions study 1). 2:3 (medium and large conditions study 1).	Food intake: weight reduction of the food on the plate. Meal duration. Number of bites. Number of chews.	Women aged between 18 and 35 years.	No effect of unit size was found.

Although there exists a lot of knowledge about the unit size effect, the question remains whether the strength of the effect is influenced by diverse relative differences between unit sizes. It is also unknown whether there is a limit to the effect or that the increase in food intake keeps continuing with increasing unit sizes. It is possible that when the difference between the small and large unit gets too small or large, the effect will diminish or will not be found. Therefore, in the next section existing knowledge about the strength of the effect will be discussed.

The strength of the unit size effect

To measure the strength of the unit size effect, studies should take different ratios between unit sizes into account. By comparing different ratios, one can find out (1) what the minimum relative difference is that is needed for the effect to occur, (2) whether food intake keeps increasing when the relative difference between units keeps increasing, and (3) whether there is a limit to the effect. Most of the studies on the unit size effect only compared a small unit with a large unit, only a few studies investigated the unit size effect using different ratios. In Table 1 it can be found that the unit size effect was found for different kinds of foods in different ratios. However, the use of different ratios for the same food product was not tested in these studies and the strength of the unit size effect thus could not be determined.

Use of different ratios in unit size studies

Table 1 shows only one study that made use of different ratios for the same food product. The study of Langlet et al. (2018) made use of different ratios, namely a small, medium and large unit size. Vegetables and chicken were cut in cube sizes of either 0.5 cm³, 1.0 cm³ or 1.5 cm³. The ratio between the small and large unit was thus 1:3 while a ratio of 1:2 existed between the small and medium unit and a ratio of 2:3 between medium and large unit. However, across all conditions no evidence for the unit size effect was found. It might be that the unit size effect does not work for the ratios used in this study. However, in other studies the unit effect was found for the ratio 1:2 (Geier et al., 2006; Marchiori et al., 2011, 2012) and the ratio 1:3 (Kerameas et al., 2015). For this reason, it cannot be concluded that the absence of the unit size effect is due to the ratios used.

Another way to look at the influence of different ratios on the unit size effect is to compare the studies of Marchiori et al. (2012) and Kerameas et al. (2015). Both studies namely made use of cookies, but they used different ratios. In the study of Marchiori et al. (2012) cookies were split in half while the study of Kerameas et al. (2015) had a ratio of 1:3. In both studies the unit size effect was found indicating that the existence of the unit size effect is not influenced by these different ratios. However, no conclusions can be drawn about the difference in degree (e.g. differences in grams or kilocalories consumed) in which the unit size effect between different ratios occurs since the studies differ in studied sample (children versus students) and study design.

Use of different ratios in related domains

Since little is known about the influence of different ratios on the unit size effect, knowledge about the influence of different ratios in similar domains might be helpful to investigate this topic. First of all, different ratios were used in the research on the effect of different units on expected satiety (Oldman-Cooper, Wilkinson, Hardman, Rogers & Brunstrom, 2017). Different foods were presented in one, three or six units. Single unit foods were expected to deliver significantly less satiety than when the foods

were segmented into three or six units. However, the foods in the three and six units did not differ significantly in expected satiety. This indicates that both ratios 1:3 and 1:6 lead to an increase in expected satiety but it makes no difference for expected satiety whether ratio 1:3 or 1:6 is used. These ratios might influence the unit size effect in the same way since expected satiety is of influence on the unit size effect through consumption monitoring.

Secondly, Spill et al. (2010) tested the influence of doubling or tripling a portion of carrots on food consumption. Both doubling and tripling the portion size led to a significant increase in carrot consumption. However, increasing portion size from the doubled portion to the tripled portion did not make a significant difference in carrot consumption. Thus, both ratios 1:2 and 1:3 results in a portion size effect but the use of ratio 1:2 or ratio 1:3 does not make a difference for the consumption of carrots. Moreover, a meta-analysis on portion size studies revealed that the portion size effect is curvilinear (Zlatevska, Dubelaar & Holden, 2014). The portion size effect thus diminishes when portions becomes increasingly larger. This indicates that larger ratios do not necessarily lead to significantly higher increases of intake compared to smaller ratios. The curvilinear relationship between portion size and food intake was also found for broccoli, grapes, garlic bread, tomatoes, cake and pasta with sauce (Roe, Kling & Rolls, 2016). Increasing the portions of those foods by 33% increased meal intake by 25%, while increasing the portions by 67% or 100% led to an equal increased intake of 34%. Moreover, Cahayadi, Geng, Miroso and Peng (2019) found that food intake exhibits a non-linear relationship with portion size. These studies thus all show that effects on food intake are found for different ratios but that increase in intake diminishes when the ratio gets larger.

From Table 1 it becomes clear that eating food that are served in smaller units leads, in most cases, to a lower food consumption than eating foods that are served in larger units. Several underlying processes have been suggested to explain these differences in food consumption given different unit sizes. In the next sections, the supposed underlying factors for the unit size effect are described.

Unit bias

First of all, the unit size effect might be explained by the unit bias. The unit bias is “a sense that a single entity is the appropriate amount to engage, consume, or consider” (Geier et al., 2006, p.521). Geier et al. (2006) hypothesized that if the unit bias is the only principle of consumption, the same number of entities would be consumed regardless of unit size and that this would lead to an increase in amount consumed. They indeed found that the amount of food people selected increased when the size of the unit presented increased and these results are thus evidence for the unit bias. Also, in line with the unit bias, the same number of candies were consumed regardless of unit size in the study of Marchiori et al. (2011) and the same number of cinnamon rolls, pizza slices, crackers and donuts were consumed regardless of unit size in the study of Bui et al. (2016) (see Table 1).

Unit bias or segmentation effect?

Alternatively, Kerameas et al. (2015) propose that it is not the unit bias that explains the unit size effect but that it is rather a segmentation effect that is cause of the unit size effect. They argue that the unit size effect can only be explained by the unit bias when people consume a single unit of food, nothing more and nothing less, regardless of unit size. On the other hand, they argue that the unit size effect is caused by the segmentation effect when people eat more than a single unit but still eat less of a portion of food when it is presented in multiple smaller units compared to one large unit. To test this assumption they served participants either one large cookie or three smaller cookies, both

equalling the same total gram weight. Most participants consumed more or less than a single unit, indicating that the unit bias is not supported by these results. The segmentation effect, however, was supported since the participants consumed less grams of cookies when given multiple smaller cookies.

Consumption monitoring

Moreover, different unit sizes impact consumption monitoring, which might be another reason for the unit size effect. Monitoring is reduced with larger portions because they are seen as consumption units and people tend to finish the unit that they start eating (van Kleef et al., 2014). Incorrectly estimating food portion size, calorie content or expected satiety is also of influence on consumption monitoring.

Food portion estimation

Almiron-Roig, Solis-Trapala, Dodd and Jebb (2013) tested the influence of unit number on food portion estimation. In their study participants had to rate the number of portions for 11 different kinds of foods, some being single-unit foods while others were multi-unit foods. The number of portions that participants estimated was compared with the reference number of portions. They found that the number of portions for multi-unit foods were better estimated than for single unit foods. This indicates that people are better able to monitor consumption when the portion is divided into multiple units compared to a portion that is one large unit.

Estimation calorie content and grams consumed

With regard to calorie content, Geier & Rozin (2009) discovered that people are better able to estimate the calorie content of large meals than that of small meals. In their study people overestimated the calorie content of the large meal by only 53 calories while they overestimated the calorie content of the small meal by 315 calories. Similarly, the study of van Kleef et al. (2014) showed that participants in the small unit condition estimated higher calorie consumption than those in the large unit size condition. In the small unit condition calorie consumption was overestimated by 49.1%, while in the large unit condition the overestimation was only 19.6%. They also found that the participants in the small unit size condition estimated more grams consumed than those in the large unit size condition. The overestimation of gram consumed in the small unit size condition was 39.1% higher than the overestimation of the large unit size condition. Taking this into account, it might be possible that people eat less of smaller units because they highly overestimate the calorie content and grams consumed of the smaller units.

Expected satiety

Another reason why monitoring is reduced with larger units might be due to expected satiety. The study conducted by Oldman-Cooper et al. (2017) revealed a significant effect of unit size on expected satiety. Foods segmented in six units resulted in an increase in expected satiety of 28% compared to the single-unit format. Therefore, it might be the case that people consume less of smaller units because they expect to be more saturated with smaller units compared to the larger unit.

Decision points

A third explanation that is suggested to explain the unit size effect is the presence of decision points. A portion that is divided in more units encounters a partition during consumption which shifts the consumption decision from an automatic mode to a conscious mode (Cheema & Soman, 2008). This could lead to a moment of reflection and therefore the consumer might decide to stop or postpone consumption. Cheema & Soman (2008) tested this assumption with two food studies. In the first study they gave participants a box with chocolates which were either partitioned or aggregate. Participants had to fill in a response sheet after eating each piece of chocolate and were asked to return the response sheets after finishing all chocolates. The result of this study was that participants with the partitioned pieces ate the chocolates more slowly. In the other study they gave participants cookies with no partitions, with white partitions or with partitions of varying colours and they monitored cookie consumption in 10-minute intervals. The outcome of this study was that participants with coloured partitions took significantly longer to eat the cookies than those with no partitions or those with white partitions. Thus, Cheema & Soman (2008) showed that clear partitions indeed slowed consumption. However, only the rate of consumption was measured in this study. It still needs to be researched if decision points can also explain the reduction in food intake for smaller units compared to larger units.

Perceived impulsiveness

Furthermore, van Kleef et al. (2014) proved that perceptions of impulsiveness are biased by unit size. They conducted different studies which examined the perceived impulsiveness of the eating behaviour of another person, the perceived impulsiveness of own eating behaviour and the effects of this perceived own impulsiveness on food consumption.

Perceived impulsiveness of another person

In their first study, participants had to rate the impulsiveness of a person in a movie eating a similar amount of grams of either one large Mars chocolate bar or five small Mars chocolate bars. Participants in the small unit size condition evaluated the person in the movie as more impulsive than those in the large unit size condition.

Perceived own impulsiveness

Moreover, in the second study of van Kleef et al. (2014) participants were requested to consume the entire portion of chocolates that was provided to them. The portion either contained one large chocolate bar or five small chocolate bars, both being equal in gram weight. The outcome of this study was that participants in the small unit size condition perceived themselves as more impulsive than those in the large unit size condition.

Perceived own impulsiveness and food intake

Additionally, the influence of perceived own impulsiveness on food intake was investigated with the third study of van Kleef et al. (2014). A total of 150 gram chocolate was presented to the participants and they could freely select the amount of chocolate they wanted to consume. In the large unit size condition participants were served three Mars chocolate bars, while the participants in the small unit size condition were served 15 small Mars chocolate bars. The result of this study was that perceived own impulsiveness was not impacted by unit size. However, people in the small unit condition

consumed less than people in the large unit size condition and this reduced consumption is likely due to the feelings of impulsiveness.

So, these studies reveal that eating smaller sized units are to a larger extent seen as an act of impulsiveness than eating the same amount of large sized units. Moreover, impressions of impulsiveness lead to a lower food intake of smaller units compared to larger units. Thus, perceived impulsiveness explains the unit size effect as well.

Bite size

Another explanation for the unit size effect is put forward by Liem and Russel (2019). They suggest that larger units are consumed with larger bite sizes than smaller units. Larger bite sizes lead to a faster food consumption (Spiegel, 2000) which leads to higher food and energy intake (Viskaal-van Dongen, Kok & de Graaf, 2011). Hence, larger bite sizes can also explain the unit size effect.

Sensory specific satiety

Finally, different studies investigated the role of sensory specific satiety as a possible explanation for the unit size effect (Goh et al., 2017; Liem & Russell, 2019; Weijzen et al., 2008). Sensory specific satiety is the change in hedonic response of a food that has been consumed relative to the hedonic response of a food that has not been consumed (Rolls, 1986). In these studies it was hypothesized that consumption of smaller units would lead to more sensory specific satiety and that this would result in a lower intake in the small unit condition. Weijzen et al. (2008) found that the consumption was lower in the small unit condition, but against expectations, sensory specific satiety scores tended to be higher after the consumption of the larger units. This result is declared by the fact that the ratings of indulgence may have been lower as a result of the higher intake in the large unit condition, which resulted in a higher sensory specific satiety score. Moreover, regardless of food unit size, children's liking of the consumed food (carrots) did not decrease during consumption compared to the food that was not consumed (cucumber) (Goh et al., 2017). Sensory specific satiety did thus not occur in this study. The same result was found in the study of Liem and Russel (2019). Thus, the unit size effect cannot be explained by sensory specific satiety, despite of the multiple times that it is suggested as an explanation for the unit size effect.

Hypotheses

Based on the theoretical background, three hypotheses are formulated. First of all, studies on the unit size effect show that food consumption increases when the food is presented in larger units (see Table 1). In this research the unit size effect is tested for cake, which is a product in the food domain of unhealthy snacks. For unhealthy snacks it is also proven that people consume more grams and kilocalories of the snacks that are presented in larger units than of the snacks presented in smaller units (Geier et al., 2006; Kerameas et al., 2015; Marchiori et al., 2011, 2012; van Kleef et al., 2014; Weijzen et al., 2008). Therefore, it is hypothesized that

H1a: Cake that is served in larger units leads to an increase in gram weight intake of cake compared to cake that is served in smaller units.

However, different studies in related domains show that the strength of the effect does not increase significantly anymore when the relative difference gets larger. Additionally, the effect of portion size on food intake is curvilinear (Cahayadi et al., 2019; Roe et al., 2016; Zlatevska et al., 2014). The

increase in food intake diminishes as the ratio between portion sizes gets larger. A similar effect is expected for the ratios between the unit sizes and therefore it is hypothesized that

H1b: The relationship between the unit size of cake and cake intake is curvilinear.

Moreover, because cake is an unhealthy snack, it is expected that in this case the presence of decision points and the perceived impulsiveness are the most relevant underlying mechanisms to explain the unit size effect. A portion that is divided into more units encounters a partition during consumption and this could lead to a moment of reflection, the so-called decision point (Cheema & Soman, 2008). Based on this fact, it is hypothesized that

H2a: Eating cake that is served in larger units induces less decision points compared to eating cake that is served in smaller units.

Decision points slow consumption (Cheema & Soman, 2008) and therefore it is hypothesized that

H2b: The presence of more decision points leads to a decrease in gram weight intake of cake compared to when less decision points are present.

Furthermore, van Kleef et al. (2014) showed that eating smaller units are to a larger extent seen as an act of impulsiveness than eating the same amount of large sized units. Based on this fact, it is hypothesized that

H3a: Eating cake that is served in larger units is to a lesser extent seen as an act of impulsiveness compared to eating cake that is served in smaller units.

These impressions of impulsiveness lead to a lower food intake of smaller units compared to larger units (van Kleef et al., 2014). Therefore, it is hypothesized that

H3b: Higher perceived own impulsiveness leads to a decrease in gram weight intake of cake compared to lower perceived own impulsiveness.

Conceptual model

Figure 1 shows the conceptual model and visualizes the hypotheses of this research. The black box represents the independent variable, namely the unit size of the cake. The mediators are represented in the blue boxes and the dependent variable in the green box.

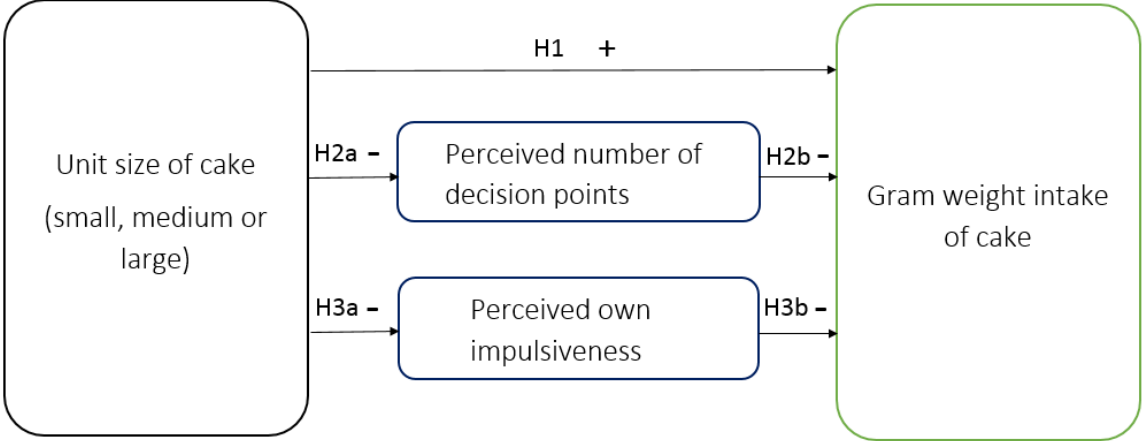


Figure 1 – Conceptual model

Method

Design

A between-subject experiment was conducted to measure the effect of different unit sizes on gram weight intake. Participants were randomly assigned to one of the three conditions (see Table 2). Conditions differed in unit size of cake but the total portion of cake that was provided to participants was equal across conditions. The gram weight intake of cake was measured and the unit size of the cake was manipulated (see Figure 2). Cake was selected as food product because it can easily be served in different unit sizes and because the unit size effect was not tested for this product yet. The experiment was conducted in the same setting all the time, to make sure that the results of the experiment were not affected by external influences.

Condition	Unit size	Number of units served	Average total weight served	Portion size
1 (n = 22)	Whole slice of cake	2	72.6 grams	2 slices of cake with a width of 1.5 cm
2 (n = 22)	Half slice of cake	4	74.4 grams	2 slices of cake with a width of 1.5 cm
3 (n = 21)	One third slice of cake	6	73.2 grams	2 slices of cake with a width of 1.5 cm

Participants

In total 78 students participated in the study, of which 13 had to be deleted. Some participants had to be deleted because they did not answer 'Strongly agree' on the attention question, indicating that they did not read the questions thoroughly. Others had to be deleted because they indicated that their cake consumption was restricted for another reason than a cake related allergy. These participants wrote that their cake consumption was restricted due to not liking cake, fasting, not wanting to eat during the experiment or because the person was suspecting the nature of the study. None of the participants had to be excluded because of the exclusion criteria of having a cake related allergy. The analysis was done with the remaining 65 participants. Of these 65 participants, 54 were female and 11 were male. The average age of the participants was 20.43 (SD = 1.88). 93.8 percent of the participants had a Dutch nationality. All participants were students at Wageningen University & Research, as the experiment took place in a building of the Wageningen University. Participants were recruited via social media, mail, flyers and via a slide in the pause of a college at Wageningen University. The cake was used as an incentive for participants to participate in the experiment.

Procedure

The study was conducted in a medium-sized computer room at Wageningen University where different students could participate at the same time. A plastic plate with cake was placed next to the computer. The plate had either whole slices, half slices or one third slices of cake on it (see Figure 2). Participants were told that they first had to watch a movie and that after watching the movie they had to fill in a questionnaire about the movie. It was also told to them that as appreciation for their participation, they could eat as much or little of the cake as they wanted while watching the movie and answering the questions.

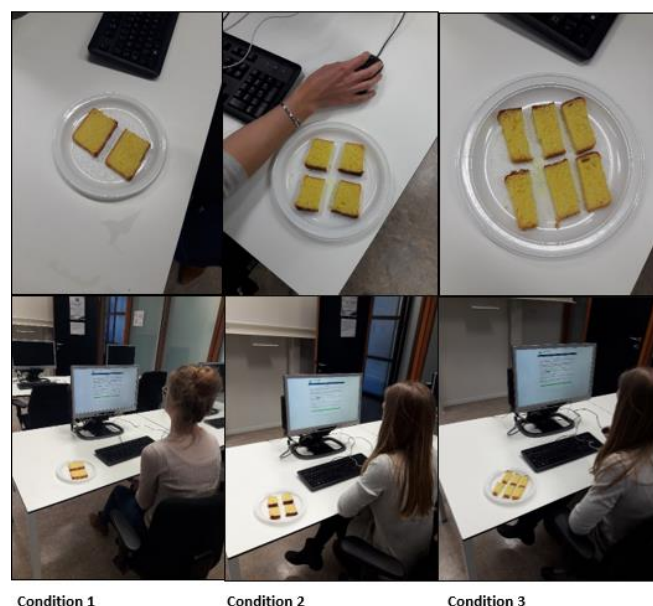


Figure 2 – Conditions experiment

Participants were asked not to take any cake out of the room. Furthermore, participants were given the opportunity to withdraw from the study at any time they wanted. A large part of this instruction was also shown on the computer before the movie started. However, not all the instructions about the cake were repeated in the survey to make sure that the actual goal of the study was not obvious for the participants.

The length of the movie was 4 minutes. A movie of this length was chosen because in this way the duration of the experiment was not too long, giving the chance to recruit enough participants, but still long enough to give participants the time and opportunity to eat. Moreover, this movie was chosen because it did not contain any food or eating related images, so that consumption would not be influenced by the movie. The movie and questions about the movie were unrelated to the actual study.

After answering questions about the movie, an instruction was shown to participants that they finished the first part of the questionnaire and that they had to call the experimenter. The experimenter then took away the plate of cake and gave the participant a number. The participant had to fill in this number in the questionnaire, so that the answers of the questionnaire could be linked to the right condition and to the corresponding gram weight intake of cake. Subsequently, the experimenter told the participants that they could continue with the questionnaire.

In the second part of the questionnaire it was first explained to participants that the cake was actually part of an experiment about eating habits. Thereafter they had to fill in the second part of the questionnaire which contained questions about perceived own impulsiveness, decision points, taste evaluation of the cake, dietary restraint and the demographic characteristics of the participant. The questionnaire can be found in Appendix 1. After the participant left the room, the gram weight of cake that was left on the plate was measured.

Movie

The movie that was shown to the participants was a short-animated movie called Pip. It was a movie presented by Southeastern Guide Dogs. Statements about the movie were asked to make the experiment believable and to give the participants more time to eat the cake.

Measures

Cake intake

The dependent variable, cake intake, was measured by subtracting the grams of the leftovers of cake from the total gram weight that was served to the participant. The plate with cake of every participant was measured before and after the experiment to determine the amount of cake that was consumed by the participant.

Perceived impulsiveness

To test the effect of the mediator, it was inferred with some questions to what extent the participants perceived themselves as impulsive. First participants were asked to think about the amount of cake they ate during the movie and questionnaire and thereafter they needed to answer different statements about their own perceived impulsiveness (see Appendix 1). The statements used to measure perceived impulsiveness were based on previously developed scales measuring impulsivity in general (Puri, 1996) and measuring impulsive eating (Kidwell, Hardesty & Childers,

2008; van Kleef et al., 2014). The statements needed to be answered on a 7-point Likert scale ranging from totally disagree till totally agree. The perceived own impulsiveness of the participants was measured with the following statements:

- With regard to my cake consumption I felt self-controlled.
- With regard to my cake consumption I felt responsible.
- With regard to my cake consumption I did have a lot of self-discipline.
- I could not resist the temptation of cake.
- I had trouble stopping to eat cake.
- I felt like I was eating on the spur of the moment.
- I ate cake according to how I felt at the moment.

Reliability of these seven items for measuring the construct perceived own impulsiveness had a value of $\alpha = .81$. Although this is already a good reliability, deleting the item 'I ate cake according to how I felt at the moment' would even increase the reliability to a value of $\alpha = .85$. Therefore this item was deleted. Participants' responses to the remaining six items were averaged as a measure for own perceived impulsiveness. The statements 'With regard to my cake consumption I felt self-controlled', 'With regard to my cake consumption I felt responsible', and 'With regard to my cake consumption I did have a lot of self-discipline' were reversed.

Decision points

The number of decision points as another mediator is tested by asking some questions about the deliberate attention during consumption. Cheema & Soman (2008) argue that the consumption decision shifts in the decision point from an automatic mode to a deliberative mode. Therefore some questions were asked about this change from automatic mode to deliberative mode. These statements are based on an existing scale for change in general (White, Breazeale & Collier, 2012), and are as following:

- During consumption thoughtful thinking _____ compared to before consumption.
- During consumption I used the automatic mode _____ than before consumption.

For these statement participants had to indicate what would fit best on the gap in the statement. The first statement needed to be answered on a 7-point Likert scale ranging from decreased a lot till increased a lot. The second statement needed to be answered on a 7-point Likert scale ranging from much less till much more. Furthermore, a few new statements were formulated to measure decision points based on the fact that a decision point is a moment of reflection. The following statements were also used to measure the extent to which decision points are present:

- During consumption I was wondering if I should continue eating.
- During consumption I reflected about my eating behaviour a lot.
- During consumption I was very aware of the amount of cake I was eating.

From the reliability analysis it became clear that the reliability of the items measuring decision points had a value of $\alpha = .47$. Deleting the reversed item 'During consumption I used the automatic mode _____ than before consumption' increased the reliability to $\alpha = .59$. A second deletion of the item 'During consumption thoughtful thinking _____ compared to before consumption' increased the

reliability further to a good reliability ($\alpha = .74$). The extent to which decision points were present for each participant was calculated as the mean of the ratings on the three remaining statements.

Control variables

Feelings of hunger of the participant, taste evaluation of the cake and dietary restraint of the participant were measured to rule out reasons why cake consumption may (not) be influenced by the manipulation.

First of all, feelings of hunger of the participant were measured by the following three items (Blundell et al., 2010):

- How hungry are you?
- How full are you?
- How satiated are you?

Participants could answer these questions on a slider ranging from not at all till extremely. The participants had to answer these questions at the start of the experiment. Feelings of hunger were thus measured before consumption of the cake. The item 'How hungry are you?' was reversed. Participants' responses on the three items were averaged to create a satiation-index ($\alpha = .85$).

Moreover, the taste evaluation of the cake was measured with two statements. The first statement was based on an item from an existing scale for food product evaluation (Allen, Gupta & Monnier, 2008). The statements needed to be answered on a 7-point Likert scale ranging from strongly disagree till strongly agree. Participants had to answer the following statements which measured the taste evaluation of the participant:

- The cake had a pleasant taste.
- The cake tasted delicious.

The scale for taste evaluation has good reliability ($\alpha = .85$).

In addition, dietary restraint of the participants was retrieved with ten statements on a 5-point Likert scale ranging from never till very often. Whether a person is on a diet is measured based on the restrained eating subscale of the Dutch Eating Behaviour Questionnaire (van Strien, Frijters, Bergers & Defares, 1986). Dietary restraint of the participants was measured with the following statements:

- When you have put on weight do you eat less than you usually do?
- When you have eaten too much, do you eat less than usual the following day?
- Do you try to eat less at mealtimes than you would like to eat?
- How often do you refuse food or drinks offered because you are concerned about your weight?
- Do you watch exactly what you eat?
- Do you deliberately eat foods that are slimming?
- Do you deliberately eat less in order not to become heavier?
- How often do you try not to eat between meals because you are watching your weight?
- How often in the evenings do you try not to eat because you are watching your weight?
- Do you take into account your weight with what you eat?

A not relevant response category was added to the first two items because these items contain a conditional format. Participants' responses to these ten items were averaged as a measure for dietary restraint ($\alpha = .78$).

Attention question

An attention question was added to make sure that participants read the questions thoroughly. Participants had to click on 'Strongly agree' in this question. The following question was added between the questions about decision points:

- To show that you are reading this sentence, please click on 'Strongly Agree'. Thank you.

Background variables

Lastly, questions were asked about the gender, age and nationality of the participants. For the question about nationality, participants could indicate if they had a Dutch or another nationality. If participants had another nationality than Dutch, they could indicate which nationality they have. These questions were asked to be able to make an accurate description of the participants used in this study.

Data analysis

The data was analysed using SPSS. A p-value of $p \leq 0.05$ was used as indicator of statistical significance. First of all, the data was checked whether it is correct. Frequency tables were made as an overview of the distribution of the answers. From the frequency tables it became clear that 6 participants did not answer 'Strongly agree' on the attention question. Data from these participants were deleted. One participant that had a Dutch nationality indicated to have a non-Dutch nationality, namely Frisian. The data on the nationality question was adjusted for this participant.

Secondly, the successfulness of randomisation between the different conditions was checked with chi-square tests for gender and nationality and an ANOVA for age. Moreover, the randomisation with regard to feelings of hunger, taste evaluation of the cake and dietary restraint was checked using different ANOVAs.

Furthermore, the effect of unit size of cake on gram weight intake was measured using a one-way independent ANOVA to compare the means of the different conditions. The means were the average gram weight intake of cake of each condition. Another one-way independent ANOVA was conducted as second main analysis to check whether eating larger units are indeed perceived as less impulsive than eating smaller units. The means of perceived impulsiveness of the different conditions were compared. Thereafter, a Pearson correlation was used to measure the cohesion between perceived own impulsiveness and cake intake.

Moreover, a one-way independent ANOVA was used to measure whether the number of decision points differed between the conditions. With this analysis, the means of the decision point scores of the different conditions were compared. The Games-Howell procedure was used to compare the different combinations of conditions and to find out which conditions differed significantly from each other on degree to which decision points were present. The Games-Howell procedure was chosen for this comparison because sample sizes of the conditions are slightly different and because it is unknown whether population variances are equal or not. Subsequently, a Pearson correlation was used to measure the cohesion between decision points and cake intake.

Results

In this section the results of this study are discussed. An experiment was conducted to test three hypotheses. The unit size of cake was manipulated by serving some participants two whole slices of cake while other participants were served two slices that were cut in half or two slices that were cut in one thirds.

Randomisation check

For the basic demographic variables it was examined whether the randomisation between the three conditions was successful. First of all, a chi-square test was conducted to test the randomisation of gender. Although more females than males participated in the experiment, they were equally divided in all three conditions. The chi-square test did not reveal significant differences between the conditions regarding gender ($\chi^2(2) = 0.15$, $p = 0.926$). Furthermore, the distribution of Dutch and other nationalities was similar in all three conditions, which is confirmed by a chi-square test ($\chi^2(2) = 0.50$, $p = 0.780$). Lastly, the ANOVA for age showed no significant effect for condition ($F(2,62) = 0.02$, $p = 0.977$). The randomisation was thus successful regarding the basic demographic variables.

Moreover, it was checked whether the randomisation of feelings of hunger, taste evaluation of cake or dietary restraint between the three conditions was successful. An ANOVA showed that participants in the different conditions did not differ regarding their feelings of hunger ($F(2, 62) = 1.60$, $p = 0.212$). Furthermore, the ANOVA for taste evaluation of the cake showed no significant effect for condition ($F(2, 62) = 0.13$, $p = 0.881$). There were also no significant differences across conditions in restrained eating scores ($F(2, 62) = 1.56$, $p = 0.218$). The overall randomisation was thus successful.

Cake intake

Figure 3 shows the mean gram weight intake of cake per condition. Participants in large unit size condition ate on average 26.86 grams of cake (SD = 19.54). The medium unit size condition had the highest average gram intake of cake, with an average of 34.18 grams (SD = 29.06). In the small unit size condition the

participants had a mean gram weight intake of cake of 27.90 grams (SD = 17.05).

A one-way independent ANOVA with unit size as independent variable and grams of cake consumed as dependent variable revealed no significant effect of unit size ($F(2, 62) = 0.67$, $p = 0.513$). Gram weight intake of cake did thus not differ significantly between the conditions. Hypothesis one is rejected, because food served in larger units did not lead to a higher food consumption

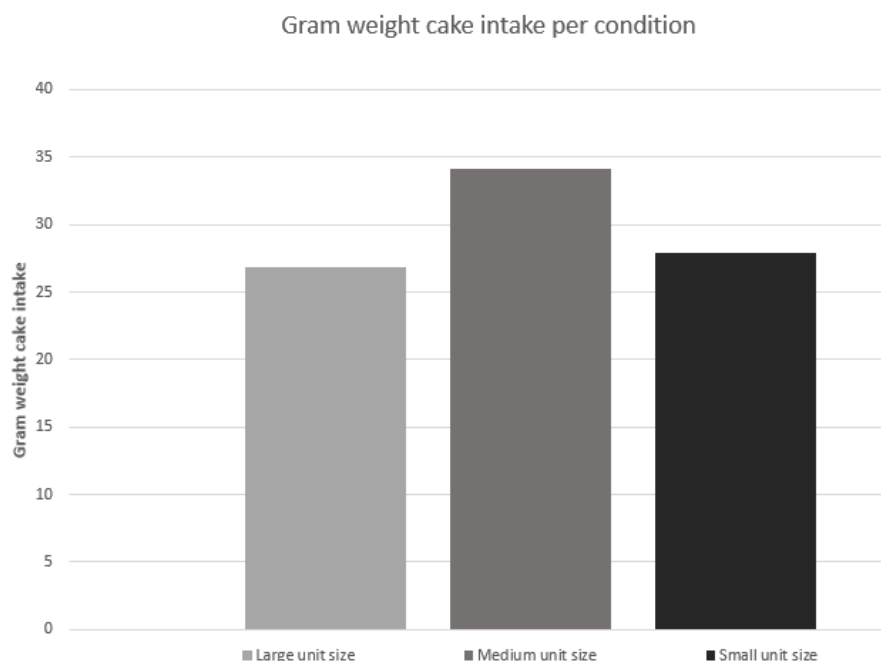


Figure 3 – Mean grams of cake consumed as a function of unit size

compared to foods served in smaller units.

Decision points

A one-way independent ANOVA with unit size as independent variable and the index for the perceived number of decision points as dependent variable revealed a significant main effect ($F(2, 62) = 3.21, p = 0.047$) with participants in the small unit condition experiencing a higher degree of decision points ($M = 4.92, SD = 1.16$) than participants in the medium unit size condition ($M = 4.02, SD = 1.66$) and the large unit size condition ($M = 3.95, SD = 1.30$). The Games-Howell procedure revealed that eating cake in the small unit size increased the degree to which decision points were present significantly compared to eating cake in the large unit size ($p = 0.037$, Table 3), but that eating cake in the medium unit size did not change the degree to which decision points were present significantly compared to eating the small unit size cake ($p = 0.108$) or eating cake in the large unit size ($p = 0.990$). Hypothesis 2a is thus partly confirmed, because larger units indeed induce less decision points if it is compared to the smallest units but it does not induce less decision points if it is compared to the medium sized units. A Pearson correlation revealed no significant correlation between decision points and gram weight intake of cake ($r = 0.15, p = 0.239$). Gram weight intake of cake is thus not influenced by the degree to which decision points were present and hypothesis 2b is therefore also rejected.

Perceived impulsiveness

To test whether perceived own impulsiveness was influenced by the unit size of cake, a one-way independent ANOVA with unit size as independent variable and the perceived own impulsiveness as dependent variable was conducted. The test revealed no significant main effect ($F(2, 62) = 0.36, p = 0.697$), indicating that there was no significant difference in perceived own impulsiveness across conditions. Hypothesis 3a is rejected because the unit size in which the food is presented does not affect perceived own impulsiveness. Furthermore, a Pearson correlation was conducted to test whether cake intake was influenced by perceived impulsiveness. Analysis of the correlation showed that perceived own impulsiveness is positively correlated to gram weight intake of cake ($r = 0.65, p < 0.001$), indicating that perceived own impulsiveness and gram weight intake of cake have a large effect on each other. However, a negative relationship between perceived own impulsiveness and gram weight intake of cake was expected and hypothesis 3b is therefore rejected.

An overview of the results can be found in Table 3.

	<i>Gram weight intake</i>	<i>Decision points</i>	<i>Perceived own impulsiveness</i>
Small unit size (n = 21)**	27.90 (17.05)	4.92 (1.16)	3.10 (1.01)
Medium unit size (n = 22)**	34.18 (29.06)	4.02 (1.66)	3.26 (1.36)
Large unit size (n = 22)**	26.86 (19.54)	3.95 (1.30)	2.96 (1.04)
Difference small – medium***	-6.28	0.90	-0.16
Difference small – large***	1.04	0.97*	0.14
Difference medium – large***	7.32	0.07	0.30
Correlation with intake****	-	0.15	0.65*

* $p < 0.05$.

**Numbers represent mean scores and standard deviations.

***Numbers represent the difference in mean scores between the mentioned conditions.

****Numbers represent the correlation coefficient (r).

Discussion

The aim of this study was to gain insights into the effect of unit size of food on food consumption. This effect was tested with the use of cake as the food product. It was hypothesized that cake that is served in larger units leads to higher food consumption than cake that is served in smaller units. This relationship between the unit size of cake and cake consumption was expected to be curvilinear. Furthermore, the unit size effect was expected to be mediated by decision points and perceived own impulsiveness. It was hypothesized that eating cake in larger units leads both to less decision points and to lower perceived own impulsiveness. The decision points and perceived own impulsiveness were both expected to have a negative relationship with cake consumption. However, it can be concluded that there is no effect of unit size on food intake and that the mediators did not operate in the predicted way. These findings thus contradict the hypotheses and expectations in this study. However, outcomes of this research should be interpreted cautiously because the analysis was only done with 65 participants. It is questionable whether this number of participants is enough to draw conclusions. With a larger sample, the effect might have been found.

The findings of this study also contradict results from other research. In earlier studies, it was shown that the eating foods in larger units leads to an increase in food intake. There is especially a lot of evidence of this effect of unit size on food intake in the domain of snacks (Bui et al., 2016; Geier et al., 2006; Kerameas et al., 2015; Marchiori et al., 2011, 2012; van Kleef et al., 2014; Weijzen et al., 2008). Contradicting to all these studies, snack intake in this study did not increase when the snacks were presented in larger units compared to snacks presented in smaller units.

On the other hand, the findings of this study are in line with the studies of Devitt and Mattes (2004), Langlet et al. (2018), Raynor and Wing (2007) and van Kleef et al. (2015), which neither found an effect of unit size on food consumption. Especially, the similarity of findings of this study and the study of Raynor and Wing (2007) is of interest since their study also tested the unit size effect for snacks. The absence of the effect in the study of Raynor and Wing (2007) can possibly be attributed to the fact that their sample consisted only of non-obese, non-dieting, unrestraint students. They argue that the unit size effect might not have occurred because consumption monitoring is less important for this group of participants and therefore the expected influence of changing accuracy in monitoring on food intake did not occur. This reasoning cannot be applied to the unexpected findings of this study because from the dietary restraint scores it became clear that the sample consisted of both restrained and unrestraint eaters. Moreover, the dietary restraint scores were normally distributed, indicating that there are approximately the same number of restraint eaters as unrestraint eaters in this study.

Possible explanations for the findings

The unexpected result that no unit size effect was found can possibly be explained by the fact that cake was used in this study. Cake was never used before in unit size effect studies and it might be that the unit size of cake has a different influence on consumption than with other snacks. The influence of unit size on snack intake can be different for cake because cake is naturally often only presented in whole slices. It might therefore be that in the mind of participants, a whole slice of cake is seen as a consumption unit instead of the half or one third slices. When this is the case, there is no real difference in perceived number of units between conditions, with an equal cake intake as result. For other snacks for which the unit size effect was found, such as Mars bars, it is more natural that there

are different unit sizes of the snacks and therefore the difference in unit size lead to differences in snack intake.

The contradictions of the findings of this study with the findings of other published studies might also be caused by publication bias. Publication bias is “the bias that is created when publication of study results is based on the direction or significance of the findings” (Dickersin, 1990, p. 1385). If significant results are more likely to be published, then information that is available is biased. In social sciences there is a higher change of 40 percentage points that strong results are going to be published compared to null results. Furthermore, null results are 60 percentage points less likely to be written up compared to strong results (Franco, Malhotra & Simonovits, 2014). It is therefore possible that there are more studies on the unit size effect that did not find significant results but that these studies are not published because of the publication bias. When there are possibly more studies on the unit size effect with null results, although unpublished, then the findings of this study are not that contradicting to previous studies. However, whether the publication bias is present in this domain is unsure.

Furthermore, the absence of the unit size effect might be explained the fact that cake was presented to participants as a reward. The incentive to participate in the experiment was probably the cake for a lot of participants. Participants that came for the cake would probably eat the same amount of cake regardless of unit size. The results might have been different if more participants had participated in the study that did not have cake as the reason to participate.

Another interesting finding is that there is a difference in the extent to which decision points were present between the small and the large unit size condition but that no difference in decision points is found for the medium unit size condition compared to either the small or the large unit size condition. This means that the difference between the small and the medium unit size and the difference between the medium and large unit size are not large enough for noticing a difference in conscious thinking. A minimum relative difference of 1:3 is thus needed for a difference in perceived number of decision points to occur. Apparently, food should be very small before people become aware of their eating behaviour. This might be because eating can be characterized as automatic behaviour. It takes a substantially amount of effort to refrain from eating when food is presented. Moreover, it is nearly impossible to sustain in refraining over the long term (Cohen & Farley, 2008). Participants who wanted to refrain from eating had to try this for every new unit. With very small units, it takes a lot of effort to restrain from eating because this choice for restraining has to be made for more units. It might be that decision points are only noticed when enough effort is needed to make this choice and that with large units not enough effort is needed.

Lastly, the results showed a positive relationship between perceived own impulsiveness and food consumption, although a negative relationship was expected. This is likely because people with a higher gram weight intake perceive themselves as more impulsive because they have eaten more. So, against expectation, the food intake probably influences perceived own impulsiveness instead of that perceived own impulsiveness influences gram weight intake.

New insights

Although the results of this study were against expectations, the insights of this study still contribute to the existing knowledge. First of all, this study takes multiple unit sizes into account. Previous studies on the unit size effect in the domain of snacks only looked at the extremes in unit sizes and

this study thus adds-on the knowledge on the unit size effect by providing knowledge about different unit sizes. That no effect was found in this study suggests that the differences between the unit sizes might have been too small for the effect to occur, since the unit size effect did occur in studies where only extremes were used. Moreover, this study showed that a ratio of at least 1:3 is needed to notice the change from automatic mode to deliberate mode more in the small unit size condition than in the large unit size condition. This difference in decision points did not lead to a decrease in food intake but it might be that in a natural setting decision points do influence food intake. Therefore, the insight that foods should be very small to notice decision points, is useful because this can be applied to food products when it turns out that in a natural setting decision points do influence food intake.

Limitations and future research

There are some limitations in this study, which should be taken into account in future research. First of all, the focus in the experiment was too much on the movie. The focus on the movie might have influenced the results, although a focus on the movie was needed as a cover story for the actual goal of the study. Some participants indicated that they were too focused on the movie. It might be that participants eat less than they usually would eat because they were too focused on the movie. The effect of unit size of snacks might be different when people are watching a movie in a more natural setting because then they have less a feeling of having to focus on the movie because they do not have to answer questions about it afterwards. In a more natural setting, people might have more focus left for the food or they use the automatic mode more because they do not have to focus on the movie. Future research should therefore examine whether a natural setting leads to different findings.

Moreover, only students from Wageningen University participated in the experiment. Food consumption might be different in different geographical regions and for different age segments. Therefore, the results of this study might not be representative for a broader population. Future research that investigates the unit size effect should focus on different age groups from different geographical regions. On the other hand, external validity is positively influenced by the fact that real consumption behaviour was measured and that participants did not know that the study was about consumption.

Furthermore, the time span to eat was a bit short. Participants might have thought that they had longer to eat, because on the flyers and social media it was indicated that the experiment would take about ten minutes. However, the time that participants could eat was only approximately five minutes, since after these five minutes the cake was taken away so that the real purpose of the study could be announced. From the reactions of the participants when the plate was taken away, it became clear that some of them thought that they had longer to eat. Results might have been different when participants knew the exact time span that they could eat, even though it was clearly indicated to participants that the cake could only be consumed during the movie and the questions about the movie.

So, future research regarding the unit size effect should investigate the effect in a more natural setting and with participants of different ages and geographical areas. Furthermore, research on the unit size effect that takes multiple unit sizes into account should be extended. This is one of the first researches that takes multiple unit sizes into account and further research is needed to investigate

whether the absence of the unit size effect can be attributed to too small differences between unit sizes. Especially research with use of multiple units is needed for foods for which the unit size effect is already found but for which only extremes are used. When no unit size effect is found in such a study, then the absence of the unit size effect can be assigned to too small differences between units and the particular food product can be excluded as explanation for this absence since the unit size effect was already found for that food product in an earlier study.

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Appendix 1 – Questionnaire



Welcome!

Thank you for participating in this study. This study is part of my bachelor thesis for the Marketing and Consumer Behaviour group of Wageningen University.

Everything will be reported truthfully and your anonymity is guaranteed. Participation in this study should take about 10 minutes. There are no right or wrong answers, try to be as sincere as possible. You can decide to stop participating at any moment of the study.

If you have any questions you can contact me at hanneke.bolster@wur.nl.

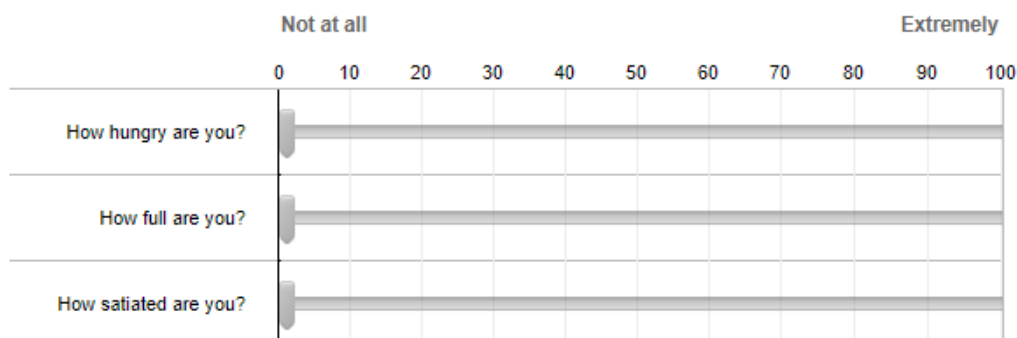
By clicking on the **highlighted** text below you give your consent to participate in this research and you acknowledge the following:

- I have read and understood the information above.
- I understand all personal data relating to my participation in this study is held and processed in the strictest confidence.
- I understand that I am free to withdraw from this study at any time without the need to justify my decision and without prejudice.

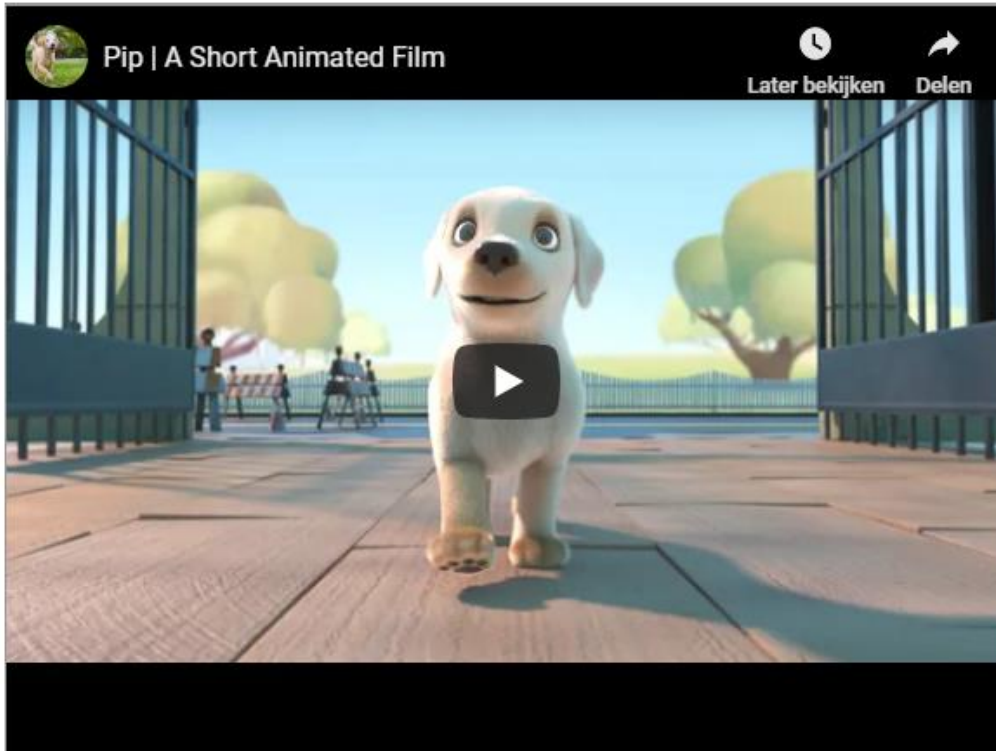
I herewith confirm that I have read and understood the above information and voluntarily agree to take part in this research



Please indicate for each question which answer fits best for you by sliding left or right.



In the next page a movie will be shown to you. After watching the movie, a series of questions will be asked about this movie. As an appreciation for your participation in this study, cake is offered to you. Click on the arrow to go to the next page to watch the movie. Start the movie and watch it till the last second. You should **not** fast forward the movie!



Indicate for the following statements what is most applicable for you

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I had sympathy for the dog.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The movie made me realize that you should chase your goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The movie made me realize that you should never give up.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The dog was heroic.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
This would be a good commercial for the Southeastern Guide Dogs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would donate money to the Southeastern Guide Dogs after seeing this movie.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



This was the first part of the questionnaire. Call the experimenter and tell her that you are finished with the first part of the questionnaire. The experimenter will give further instructions for the second part of the questionnaire.



Please type in the number the experimenter just gave you.



In the second part of the questionnaire, a series of questions will be asked about your cake consumption. The cake was actually part of an experiment about eating habits and the movie was just used as a cover.

Before you proceed to the questions, first think about the amount of cake that you just ate. With this consumed amount of cake in mind, you can continue with the questions.



Please read carefully each of the statements, and indicate for each statement what is most applicable for you.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
With regard to my cake consumption I felt self-controlled.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
With regard to my cake consumption I felt responsible.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
With regard to my cake consumption I did have a lot of self-discipline.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I could not resist the temptation of cake.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I had trouble stopping to eat cake.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt like I was eating on the spur of the moment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I ate cake according to how I felt at the moment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Please read carefully each of the statements and indicate what would fit the best on the gap in the statements.

	Decreased a lot	Decreased	Somewhat decreased	Neither increased nor decreased	Somewhat increased	Increased	Increased a lot
During consumption thoughtful thinking _____ compared to before consumption.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Much less	Moderately less	Slightly less	About the same	Slightly more	Moderately more	Much more
During consumption I used the automatic mode _____ than before consumption.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Please read carefully each of the statements and indicate for each statement what is most applicable for you.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
During consumption I was wondering if I should continue eating.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
During consumption I reflected about my eating behaviour a lot.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
To show that you are reading this sentence, please click on 'Strongly Agree'. Thank you.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
During consumption I was very aware of the amount of cake I was eating.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Was your cake consumption restricted as a consequence of a food allergy that you have?

- Yes
 No

Was your cake consumption restricted for another reason?

- Yes, namely

- No



Please read carefully each of the statements and indicate for each statement what is most applicable for you.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
The cake had a pleasant taste.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The cake tasted delicious.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



Please read carefully each of the questions and indicate for each question what is most applicable for you.

	Never	Seldom	Sometimes	Often	Very often	Not relevant
When you have put on weight do you eat less than you usually do?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When you have eaten too much, do you eat less than usual the following day?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Never	Seldom	Sometimes	Often	Very often
Do you try to eat less at mealtimes than you would like to eat?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How often do you refuse food or drinks offered because you are concerned about your weight?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you watch exactly what you eat?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you deliberately eat foods that are slimming?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you deliberately eat less in order not to become heavier?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How often do you try not to eat between meals because you are watching your weight?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How often in the evenings do you try not to eat because you are watching your weight?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you take into account your weight with what you eat?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



What is your gender?

- Male
- Female
- Neutral

What is your age?

What is your nationality?

- Dutch
- Other, namely

In case you have any comments, please write them down in the field below.

Would you like to receive email invitations for our coming experiments and studies?
If so, please fill in your email below.

email



Thank you for participating in this study. If you have any questions or remarks, do not hesitate to contact me via hanneke.bolster@wur.nl. If you want to receive information about the purpose or outcomes of the study, you can leave your e-mail address here.

