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Plate size or plating? Effects of visual food presentation on liking, appetite, and food-evoked emotions in online and real-life contexts

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ABSTRACT

The way food is presented can significantly influence liking, satiation, and emotional responses to food. This study explored these effects across two separate experiments by examining the impact of plate size (small vs. large) and plating style (high-stacked vs. spread) on participants' liking, satisfaction, fullness, and food-evoked emotions when consuming chicken salad. In the first experiment, conducted online (n = 192), we used interactive 360-degree videos to simulate real-life experiences of chicken salads under the different conditions. The second experiment expanded this research into a real-life cafeteria setting (n = 176) where participants actually consumed the chicken salads. In this setting, salads served on a large plate with high-stacked plating received the highest ratings for liking, compared to the other conditions: small plate-high-stacked, small plate-spread, and large plate-spread. This condition also evoked the most positive food-related emotions, such as happiness, satisfaction, and relaxation, and was perceived as closest to the "ideal portion size." Notably, the real-life experiment provided a better discrimination between the experimental conditions, with more intense and higher ratings on food-evoked emotions, liking, and willingness to pay compared to the online context. Real-life eating encompasses social interactions, sensory stimulation and post-ingestive effects, offering a richer and more accurate representation of actual eating experiences. These findings highlight the importance of real-life multimodal measurement environments for obtaining accurate measures of food perception, acceptance and eating behaviours.

1. Introduction

This research focuses on the effects of visual food arrangements (plate size, plating) on liking, appetitive responses and food-evoked emotions. The study was conducted in two contexts: online using interactive 360-degree videos of a chicken salad as a stimulus, and in a real-life situation where participants actually consumed a chicken salad."

The impact of dishware size and shape on food intake has been widely explored. A number of studies has shown that the use of larger plates and bowls is linked to greater food intake (Pratt et al., 2012; Rolls et al., 2004; Sim & Cheon, 2022; Van Ittersum & Wansink, 2012; Wansink et al., 2006). This could be due to the plate's capacity to hold more food (Rozin et al., 2003), or to optical illusions such as the Delboeuf illusion (McClain et al., 2014; Petit et al., 2018; Van Ittersum & Wansink, 2012; Wansink et al., 2006). This optical illusion involves two identical circles appearing to differ in size due to the influence of the surrounding rings' proximity (Daneyko et al., 2014; McCarthy et al., 2013). When the gap between the circle and the surrounding ring is relatively small, both ring and circle are seen as one percept (assimilation effect), and when the gap is larger, the circle and ring are perceived as two separate objects (contrast effect) (Gentaz & Hatwell, 2004; Girgus & Coren, 1982). The Delboeuf illusion illustrates how the size of dinnerware can create two opposing biases, affecting how people perceive portion size and how much people serve themselves. On large plates and bowls, the substantial gap between the edge of the food and the edge of the dish may lead to contrast effects, causing people to perceive the portion of food as smaller. Conversely, on smaller plates, the narrow gap between the edge of the food and the plate's edge leads to assimilation effects, creating an illusion of greater quantity. Differences in perceived portion size can affect food intake, hunger and satiation (Abeywickrema & Peng, 2023; McClain et al., 2014; Peng, 2017;

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Pratt et al., 2012; Van Ittersum & Wansink, 2012).

However, not all studies report clear dishware size effects on food intake: Rolls et al. (2007) found no significant effect of plate size on food intake, hunger, or satiation across three experiments where participants either self-served or were served (fixed portion) main dishes, e.g., macaroni and cheese, salads and casseroles, on plates of different sizes. Robinson et al. (2014) conducted a systematic review that highlighted inconsistent findings regarding the impact of plate size on food intake. These inconsistencies are often attributed to factors such as small, unrepresentative samples or flawed study designs (Kosīte et al., 2019), moderating factors such as individual differences in cognitive and perceptual styles (Sim & Cheon, 2022), the nature of the food (whether it consists of distinct units or is amorphous), and the context in which eating occurs. To illustrate the latter, the studies from Rolls et al. (2007) were conducted in a laboratory setting, whereas Wansink et al. (2006) conducted their study in a social context. It seems plausible that distractions, as part of realistic eating contexts, can influence consumer's attention for or susceptibility to plate size effects on portion size perception and food intake.

In addition to plate size, the visual arrangement of food — such as its artistic presentation, the neatness or 'messiness' of its layout, and the way it is oriented or stacked — affects people's hedonic evaluation of the dish, their preference for it, their willingness to pay, and their perception of portion size (Michel et al., 2014; 2015a, 2015b; Ordabayeva & Chandon, 2016; Rowley & Spence, 2018; Spence et al., 2014; 2019; Spence, 2020; 2022; Szocs & Lefebvre, 2017; Velasco & Veflen, 2021; Zampollo et al., 2011; Zellner et al., 2011; 2014). To illustrate, Szocs and Lefebvre (2017) showed that vertically-stacked food was perceived as a smaller portion and led to more food intake than the same volumes of food presented horizontally.

Rowley and Spence (2018) observed that food portions were perceived as smaller when the components were stacked vertically instead of spread horizontally, both in online assessments and in a real-world dining scenario. This suggests that consumers gauge portion size based on the surface area covered by the food. Additionally, the horizontally-arranged food was more liked and participants were willing to pay more for it. Interestingly, in their real-life experiment, the vertically-stacked food was perceived as more artistic compared to the horizontal arrangement (Rowley & Spence, 2018).

To summarize, dishware size and visual food presentation can influence portion size perception, i.e., perceiving the same amount of food as relatively more or less, which may affect food intake. Little is known, however, on how these dishware size – and food arrangement effects influence people's affective responses to food. It is widely accepted that food-evoked emotions play an important role in the overall product experience (Dalenberg et al., 2014; Dijksterhuis, 2016; Gutjar et al., 2014; 2015; Ng et al., 2013; Porcherot et al., 2010; Thomson et al., 2010). There is some evidence that consumers subconsciously perceive portions to be smaller when the food is presented vertically-stacked, in contrast to horizontally-spread, with smaller perceived portion size resulting in increased food intake without experiencing negative feelings such as disappointment and guilt (Szocs & Lefebvre, 2017). However, the implications are broader than this. Manipulating portion size perception, via visual food arrangements, also has the potential in nudging people into healthier eating behaviours, such as presenting vegetables in a manner that facilitates higher intake without sacrificing pleasure.

The abovementioned research on food-evoked emotions, plate size, and visual food arrangements has been conducted either online, in laboratory contexts, or in real-life contexts. However, to our knowledge, results from online experiments have not been directly compared to results from real-life experiments. Previous studies have used food pictures to assess appropriate food portion size (Embling et al., 2021; Haynes et al., 2019; Lucassen et al., 2021; Nichelle et al., 2019; Robinson et al., 2016; Salazar Cobo et al., 2023; Salvesen et al., 2021) and found significant differences in the perceived amount of different food items. However, as argued by Rowley and Spence (2018), the angle view of the dish/meal might have influenced these results. When participants evaluate two-dimensional food pictures online, they partly miss the dimension of height of vertically arranged (stacked) dishes, which may result in an inaccurate estimation of the amount of food as compared to real-life when people look down at a plate of food as they typically do when seated at a table. A more valid, interactive online tool that controls for participants' viewing angle and allows consumers to evaluate not only length and width but also height of the food is essential in further research.

The present study builds on prior research by investigating the effect of plate size (small, large), plating (high-stacked, spread) and their mutual interactions on hedonic and appetitive responses (subjective feelings of hunger and satiety) during consumption of a chicken salad. Additionally, we introduced a novel aspect by examining affective responses through the assessment of food-evoked emotions. The study had two main objectives. Firstly, we aimed to evaluate how plate size and plating, along with their interaction, influence liking, hunger, fullness, and food-evoked emotions before and after consuming a chicken salad in a real-life cafeteria setting. Secondly, we aimed to compare the findings from the real-life cafeteria setting with those from an online context. For the online study, we used an improved interactive 360-degree visualization of the chicken salad, allowing participants to better assess the dish's dimensions—length, width, and height—compared to traditional food pictures.

We hypothesized that, for plate size, participants would perceive a fixed amount of chicken salad as less satisfying and less filling when served on a large plate compared to a small plate, both before and after consumption. In addition, we expected that participants would experience less positive food-evoked emotions when the chicken salad is served on a large plate compared to a small plate. Regarding plating, we anticipated that participants would perceive the amount of chicken salad as smaller with a high-stacked arrangement compared to a spread-out plating, due to the reduced coverage of the plate. As a result, we predicted that participants would rate the chicken salad with high-stacked plating lower in fullness. For liking and food-evoked emotions, however, it is less straightforward what to expect. Smaller perceived portion size may result in lower liking ratings and less positive affective responses. Yet, this could be counteracted by the association between vertical or high-stacked plating arrangements and a neat and balanced food presentation as in upscale restaurants. Finally, we expected that the use of a novel interactive 3-D presentation of the chicken salad in different plate size – plating conditions in the online experiment would mimic more closely how consumers view their plate in a real-life eating context. Therefore, we hypothesized similar results for the online and the real-life experiment.

2. Materials and methods

This study consisted of two separate experiments, one conducted online and the other in a real-life setting. Both experiments utilized a 2x2 between-subjects design. Participants either viewed (in the online experiment) or consumed (in the real-life experiment) chicken salads presented on two different plate sizes (small vs. large) and with two distinct plating styles (high-stacked vs. spread). Fig. 1 shows images of the four conditions.

2.1. Online experiment

2.1.1. Participants

A market research agency (Essensor BV, Ede, the Netherlands) recruited 194 participants. Inclusion criteria were: aged 18–55 years; 50 % females and 50 % males; BMI between 18.5 and 24.9 kg/m^2; normal sight; no eating disorders; not vegan or vegetarian, frequency of vegetable salad consumption: at least once per week, consuming chicken and pork at least once a month. Participants who reported moderate dislike

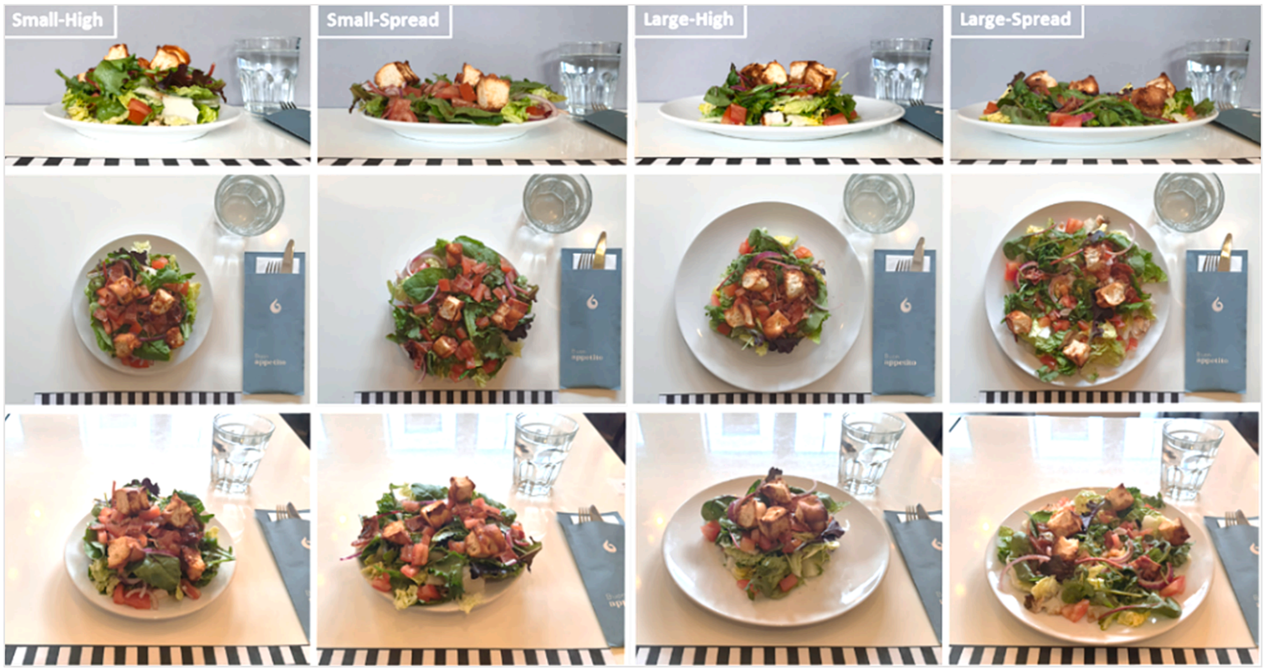

Fig. 1. Depicts chicken salad arranged in four different combinations based on plate size (small or large), and plating (high or spread). From left to right: Small plate-High plating, Small plate-Spread plating, Large plate-High plating, and Large plate-Spread plating.

(≤2 on a 7-point hedonic scale) and/or never consumed chicken, bacon or vegetable salads were excluded. Participants were balanced on gender across conditions. Data from two participants were removed due to missing data in their questionnaires. As a result, we accounted data from 192 participants. Each test condition included 48 participants (50 % females). Our sample size provided over 80 % power at $\alpha = 0.05$ to detect effect sizes of 0.5 or larger (Gacula & Rutenbeck, 2006; Lawless & Heymann, 2010). The experiment was performed according to the ICC/ESOMAR Code on Market and Social Research guidelines (ICC/ESOMAR, 2016). Participants provided written informed consent and had the option to withdraw from the study at any time without providing a reason. Upon completing the experiment, each participant received €5.00.

2.1.2. *Stimuli*

The experiment utilized four interactive 360° videos, each depicting the chicken salads under one of the four experimental conditions. These videos enabled participants to interact with a 3D view of the salads, allowing them to freely rotate the image from left to right to achieve a complete 360° perspective of the dish. Participants were instructed as follows: "*Please click on the ''3D symbol'' to rotate the image with your mouse and look at the salad from different sides*". Fig. 2 shows the 360° spinner photobooth that was used to video record the salads. See "stimuli" section of the real-life experiment for the composition of the salads and the arrangements of the salads on the plate.

To video record the salads for each test condition we used a mobile phone camera with 1080 pixels for a HD video recording at 60 fps mounted on a tripod installed inside the spinner 360° photobooth. A standardized photographing protocol for food images from Charbonnier et al. (2016) was adopted. The camera lens angle was 45° to the horizontal plate, and the height of the camera lens on the tripod was 38 cm from the table to resemble consumer's view of a plate on a table (Fig. 2). Inside the photobooth two daylight lamps (E27/55 W) were used to ensure natural lighting conditions. For each test condition we placed the salad in the centre of the booth and rotated the camera 360° around the salad while video recording. The videos were uploaded to the respective online questionnaire (one questionnaire per condition) generated with Qualtrics Software (Qualtrics, Provo, UT) resulting in four individual questionnaires with four independent links (one link for each test condition).

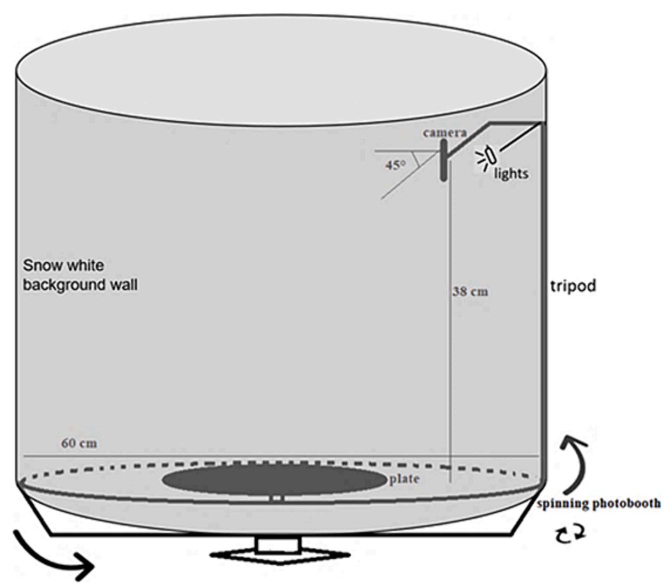

Fig. 2. Illustrates the setup of the 360° photobooth used to record videos for the online experiment.

2.1.3. *Measures*

Participants rated expected fullness, liking, perceived amount of food and eight food-evoked emotions: happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic and pride. The emotions were selected based on a pilot study with 20 participants not included in the final study. They were asked for feedback on which emotions they considered most relevant around eating salads. In recent research on sustainable eating behaviour, the emotion 'pride' showed the most consistent and pronounced differences (Zandstra et al., 2024), so pride was included as well. Based on these inputs and aiming for a balance between emotions classified as positive and negative (Desmet & Schifferstein, 2008; Salazar Cobo et al., 2023), the authors of this paper reached a consensus on the final list of emotions.

Each interactive 360° video was followed by a series of questions: "*How much would you expect to like this salad?*", "*How much do you look forward to eat this salad?*", "*How full would you expect to be after eating this salad*?", "*How small or big do you think this salad is?", and "How happy (other emotions) would you expect to be after eating the salad you are seeing? "*.

Participants used 100-mm visual analogue scales (VAS), anchored from "Not (full/liked) at all" to "Extremely (full/liked)" to rate their feelings of expected fullness and expected liking. Another 100-mm visual analogue scale (VAS), anchored from "Extremely small" to "Extremely big" was used to rate their perceived amount of food. Similarly, participants used 100-mm visual analogue scales (VAS), anchored from "Not (emotion) at all" to "Extremely (emotion)", i.e., "Not happy at all" to "Extremely happy", to rate the expected intensity of the eight food-evoked emotions.

At the end, participants were asked: *"If you could have your "ideal amount" of the salad that you are seeing now, it would be? (Please select an option)"*. To respond to this question, participants used a 9-point Just-About-Right (JAR) Scale that ranged from "100 % smaller" to "100 % bigger", with the option "same as the salad I am seeing now" as middle point. Moreover, participants were asked about how much they would be willing to pay (WTP) for the salad they were seeing. To prevent participants from guessing the main aim of the research, we included distraction questions about participants' lunch habits. In total, the questionnaire contained 24 questions.

2.1.4. Procedure

All participants were instructed to complete the survey individually on their own computers during lunch time between 12:00 h and 14:00 h. The research agency emailed participants the link to the online questionnaire. Each questionnaire presented the respective 360° video corresponding to one of the four test conditions together with the test questions. Participants were instructed to spin the video from left to right for a full view of their salads and respond to the questions. The time to complete the survey was approximately 15 min.

2.2. Real-life experiment

2.2.1. Participants

One hundred eighty (180) participants were recruited through online and offline advertisement, such as flyers, posters, and posts on social media platforms (Facebook, Instagram, and LinkedIn) in the surroundings of Wageningen (The Netherlands).

Eligible to participate were healthy individuals, with a normal BMI ranging from 18.5 to 24.9 kg/m^2, aged 18 to 55 years, who did not suffer from allergies or intolerances to the test meal's ingredients (self-reported), and who were willing to consume meat, i.e., bacon and chicken. Participants who reported moderate dislike ($\leq$2 on a 7-point hedonic scale) and/or never consumed chicken, bacon and/or vegetable salad were excluded from this experiment. Participants were balanced on gender across conditions. A minimum of 44 participants per condition (22 male participants and 22 female participants) was aimed for this experiment based on the sample sizes found in similar studies. Data from 176 participants (50 % females) were included in the analyses. We removed data from four participants due to missing data in their questionnaires. The experiment was performed according to the ICC/ESOMAR Code on Market and Social Research guidelines (ICC/ESOMAR, 2016). Participants were not informed about the main objective of this research, but were told that they would participate in a tasting session on food perception of chicken salads. Participants gave written informed consent, and were able to withdraw from the study at any time without giving reasons. The foods offered were safe for consumption. Participants received a €10 gift card upon completion of the experiment.

2.2.2. Stimuli

2.2.2.1. Test-meal. The test-meal was a chicken and bacon salad, commercially available at the Doppio Espresso cafeteria located at Wageningen Campus (The Netherlands). The salad was chosen because of its nutritional profile, since it contains every macronutrient group, and because it was considered as one of the healthier options from the menu. Another factor was the salad's shape; because salads are amorphous, they can be easily arranged in in a high-stacked or spread out condition. The salad consisted of grilled chicken with pesto (120 g), lettuce (50 g), fresh tomato (45 g), bacon strips (35 g), croutons (35 g), mesclun salad (10 g), red onion (5 g), and balsamic vinegar dressing on top. Each portion weighted 300 g with an estimated energy content of 600 kcal and was kept constant across the four experimental conditions. The salad was prepared by 'Doppio Espresso' staff prior to each test session.

2.2.2.2. Tableware and environment. The salads were served on plain, white, circular ceramic plates with no rim. We used a small (∅ = 20 cm; A = 314 cm^2) and large plate (∅ = 26 cm; A = 531 cm^2). These sizes were selected for comparison with previous research since the same sizes were used in the studies of Pratt et al. (2012) and Rolls et al. (2007). The plates belonged to IKEA's 'FLITIGHET' dinnerware series. For the 'high' plating conditions, a ring mould (∅ = 16 cm, h = 10 cm) was used to shape the salad. The ring was centred on the small or large plate (according to plate size) and the salad was placed into the ring mould. Just before serving, the ring mould was lifted, leaving the salad in a high form resembling the shape of a 'mountain'. For the 'spread' condition, the salad was spread on the plate to cover most of the surface area of the plate.

All tableware, except the plates, were provided by Doppio Espresso. Cold, still water was provided ad libitum, meaning participants could drink as much as they wanted. The quantity consumed was neither controlled nor monitored. Water was served in plain drinking glasses. Plates were placed directly on tables of white, shiny surface, without a tablecloth. Pleasant music was played on low volume in the background as usual in cafes and casual restaurants. The playlist included various popular hit songs from the past two decades.

2.2.3. Measures

Participants rated subjective feelings of hunger upon arrival to the cafeteria. Then, participants received their salads and just before consumption started, they rated hunger, fulness, expected liking, and the emotions they expected to experience, i.e., happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic and pride. In addition, participants rated their perceived amount of food. Participants were instructed to start eating and to rate liking at the third bite before continuing to freely eating their salads. After participants finished their salads they rated again hunger, fullness, liking, happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic and pride. The questionnaires were divided in three sections meant to be completed before receiving the salad, at the beginning and during consumption, and upon finishing the salads.

Subjective feelings of hunger and fullness were rated on 100-mm VAS scales, anchored from "Not hungry/full at all" to "Extremely hungry/full". Similarly, a 100-mm visual analogue scale (VAS) was used for liking, anchored from "Not liked at all" to "Extremely liked".

Participants rated the food-evoked emotions upon receiving their salads without eating them (expected emotions), and upon finishing their salads (actual emotions). For all food-evoked emotions ratings, participants used 100-mm visual analogue scales (VAS), anchored from "Not (emotion) at all" to "Extremely (emotion)", i.e., "Not happy at all" to "Extremely happy". Similarly, participants also used a 100-mm visual analogue scale (VAS), anchored from "extremely small" to "extremely big" to respond to the question: *"How small or big do you think is the salad* *you are seeing now?*".

After participants rated their expected emotions upon finishing their salads, participants responded to the question: *"How much "in EURO" would you pay for the salad you ate?"* Participants were then asked to use a 9-point Just-About-Right (JAR) Scale to answer the question: *"If you could have your 'ideal amount' of the salad you just ate, what would it be? (Please select one of these options)."* The options ranged from 100 % smaller to 100 % bigger with the option "same as the salad I just ate" as middle point.

Questions unrelated to the experiment's objective were also added throughout the lunch, serving as distractors to the subjects. Distractors included questions regarding the service, venue, and participants' experience, and aimed to keep participants unaware of the experiment's main objective. The questionnaires were designed using EyeQuestion® Software, and they included a total of 28 questions, and took approximately 20 min to complete.

2.2.4. Procedure

The experiment was conducted between 12:00 h and 14:00 h in the Doppio Espresso cafeteria at the campus of Wageningen University and Research. Participants consumed a chicken salad while filling out an online questionnaire using their own smartphones. Before and after consumption, explicit responses to hunger, fullness, liking and food-evoked emotions were measured.

Upon arrival, participants were welcomed and shown to their table. Each table seated two to five participants who did not know each other. A similar number of males and females was invited per session, but seating was randomly assigned. During each test session, all participants at a table were served salads presented in the same condition. This consistency was maintained to ensure that everyone was exposed to identical stimuli, minimizing the risk of participants being influenced by observing different salad presentations and potentially guessing the experiment's main objective. Participants were invited to socialise with each other but were asked to refrain from talking about the salad or the questionnaire. Subsequently, we handed participants an individual QR-code to access the online questionnaire from their smartphones. After logging in, participants received their salads, and were asked to follow the instructions on their questionnaires and to answer the questions at specified points: before, during, and after consuming the salad. A printed version of the questionnaire was provided to those participants who were unable to access the questionnaire digitally. Each participant attended one 30-minute test session.

2.3. Statistical analysis

Data are presented as means and standard deviations unless indicated otherwise. SPSS® Software (version 28.0.1.1, IBM Corp, New York, United States) was used to perform the statistical analyses. We considered a difference significant at $p < 0.05$ for all results unless stated otherwise. R Studio (version 4.2.0, RStudio Team (2022), Boston MA, United States) was used for Figs. 3 and 5.

2.3.1. Online experiment

General linear mixed models were used to assess the effect of fixed factors: plate size (small and large), plating (high and spread), and their respective double interactions on expected fullness, liking, and eight food-evoked emotions (happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic, and pride). Age was treated as a covariant and participants were included as random factor. Similarly, linear mixed models were used to evaluate the perceived amount of food and willingness to pay. Finally, post-hoc pairwise comparisons (Bonferroni corrected) were performed on statistically significant effects.

2.3.2. Real-life experiment

We used ANCOVA to control for the effect of subjective feelings of hunger before consumption on the subjective feelings of hunger after consumption. In this model, we used plate size (small and large), plating (high and spread) and the interaction plate size*plating as fixed factors. Post-hoc pairwise comparisons (Bonferroni corrected) were performed on statistically significant effects.

General linear mixed models were used to assess the effect of fixed factors: time (i.e., before and after consumption), plate size (small and large), plating (high and spread), and their respective interactions on hunger, fullness, liking, happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic, and pride. Age was included as covariant and participants as random factor. Similarly, linear mixed models were used to evaluate the perceived amount of food and willingness to pay. Post-hoc pairwise comparisons (Bonferroni corrected) were performed on statistically significant effects.

2.3.3. Comparison online vs. real-life conditions

A linear mixed model with diagonal covariance for random effects was used to examine the effect of context (i.e., online and real-life) on hunger, fullness, liking, happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic, and pride. ANOVA tests were used to analyse differences in liking, fullness and food-evoked emotions between the online and real-life contexts. In addition, Pearson's correlations r were used to assess the relationship between the means of expected fullness, liking, happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic, and pride after eating the salad (online measurements) and the means of actual fullness, liking, happiness, satisfaction, boredom, guilt, relaxed, disappointment, energetic, and pride after eating the salad in the real-life context for the four test conditions (i.e., small plate-high-stacked plating, small plate-spread plating, large plate-high-

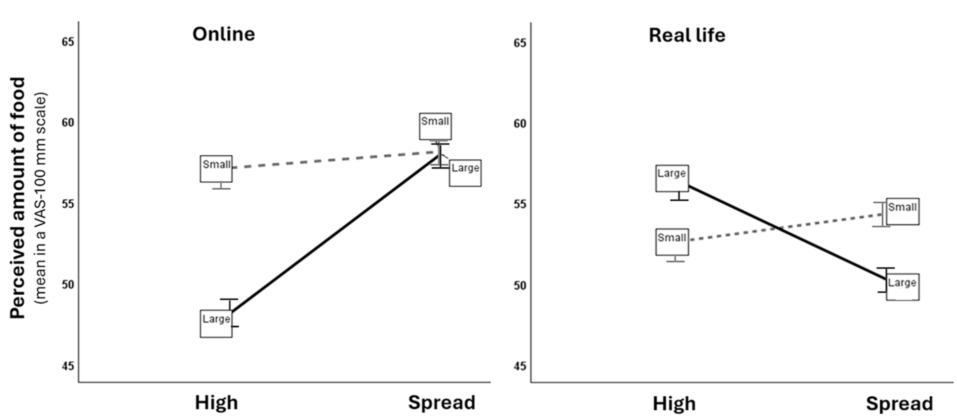

Fig. 3. Average perceived amount of food (±SEM) across different plate sizes (small, large) and plating (high, spread), in both online (left panel) and real-life (right panel) settings. The scale ranges from extremely small (0) to extremely large (1 0 0).

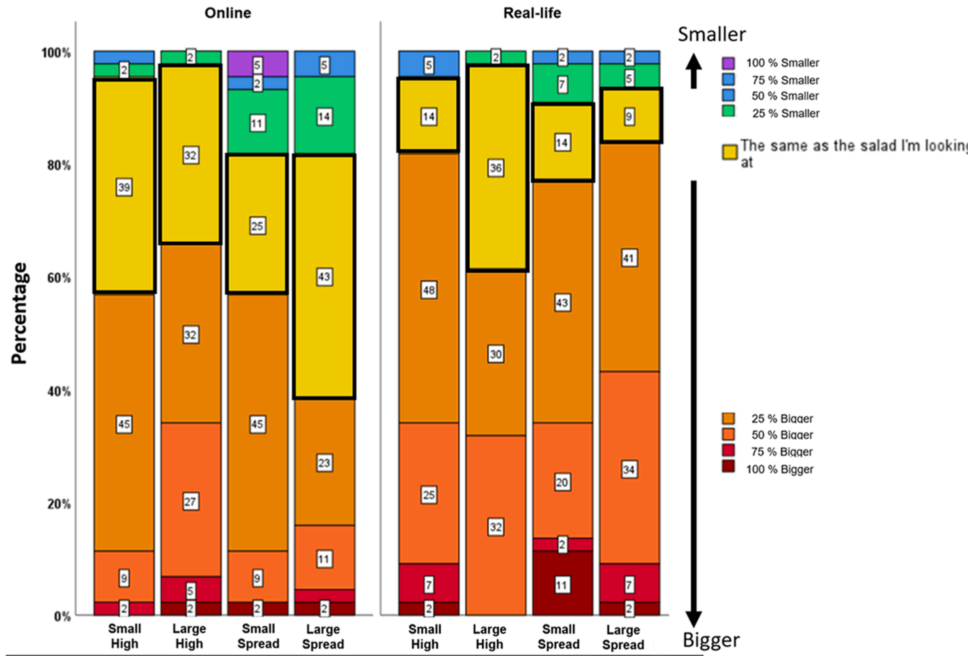

Fig. 4. Percentage of participants who believed that their ideal portion size should be anywhere from 100% smaller to 100% larger than the salad they observed, compared between online (left panel) and real-life (right panel) settings.

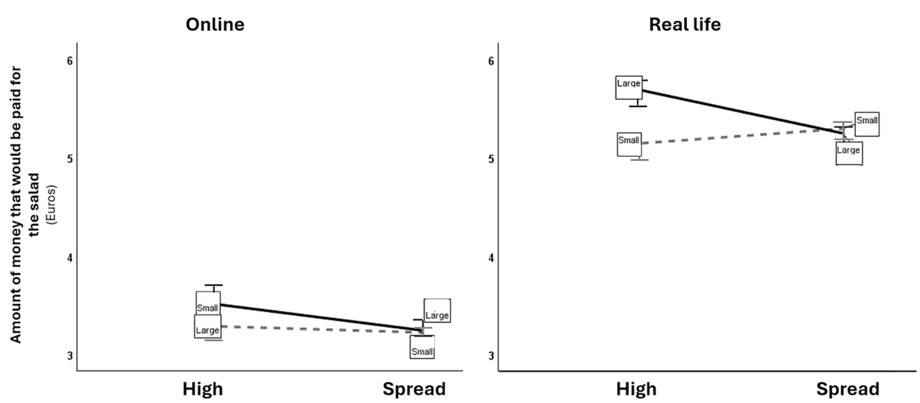

Fig. 5. Average amount of money (in Euros, ± SEM) that participants were willing to pay for the salads, categorized by plate size (small, large) and plating (high, spread), for both the online (left panel) and real-life (right panel) settings.

stacked plating and large plate-spread plating). The correlation coefficients were calculated for the means of each variable across the four conditions, i.e., 4 (online) x 4 (real-life) pairs per coefficient.

3. Results

3.1. Online experiment

Table 1 shows the means *(±SD)* for expected liking, fullness, and food-evoked emotions for the four conditions. For expected liking and fullness, a significant main effect was found of plating (F(1,180) = 5.0, p = 0.02, $\eta^2 = 0.03$ and F(1,180) = 5.0, p = 0.03, $\eta^2 = 0.03$, respectively), with liking and fullness scores being higher for the high than for the spread conditions. Main effects of plate size and interaction effects of plate size*plating on liking and fullness were not significant (all p > 0.10).

For food-evoked emotions, a significant main effect of plate size was found for expected happiness and expected disappointment (F(1,180) = 5.8, p = 0.02, η^2 = 0.03 and F(1,180) = 5.4, p = 0.02, η^2 = 0.03, respectively). Happiness scores were higher for the small than for the large plate size whereas for disappointment it was the other way around. The main effect of plating was non-significant, as well as the interaction effects of size*plating for all emotions, all p > 0.5.

Fig. 3 (left panel) shows the perceived amount of food in the online context. A significant main effect of plating (F(1,180) = 7.4, p = 0.01, η^2 = 0.04) was observed, with the amount of food perceived as larger with spread plating compared to the high plating. Main effects of plate size (F(1,180) = 3.7, p = 0.06, η^2 = 0.02), and the interaction plate size*plating (F(1,180) = 3.7, p = 0.06, η^2 = 0.02), were not significant. Fig. 4 shows that when salads were served in a high-plating manner 61 % thought that their ideal amount of salad should be bigger vs. 47 % in the spread plating conditions.

For willingness to pay, no significant main effects of plate size (F(1,180) = 0.4, p = 0.55, η^2 < 0.001), plating (F(1,180) = 0.7, p = 0.42, η^2 < 0.001), or interaction effects of plate size*plating (F(1,180) = 0.3, p = 0.62, η^2 < 0.001) were found (Fig. 5, left panel).

3.2. Real-life experiment

Fig. 6 depicts the mean (±SEM) liking ratings for the four salad

Table 1
Mean ± *SD* and range *(min, max)* ratings for expected liking, looking-forward-to-eat, fullness, and food-evoked emotions for each plate size*plating condition in the online context. The four plate sizes* plating conditions included Small-high, Small-spread, Large-high, and Large-spread.

Condition	Small-high ($n = 48$) Mean ± *SD* *(min–max)*	Small-spread ($n = 48$) Mean ± *SD* *(min–max)*	Large-high ($n = 48$) Mean ± *SD* *(min–max)*	Large-spread ($n = 48$) Mean ± *SD* *(min–max)*
Liking	61 ± 19 *(11–89)*	58 ± 24 *(0–99)*	56 ± 22 *(8–100)*	49 ± 24 *(3–100)*
Looking-forward-to-eat	56 ± 24 *(5–96)*	52 ± 25 *(1–100)*	53 ± 23 *(8–100)*	49 ± 25 *(5–85)*
Fullness	52 ± 21 *(0–88)*	54 ± 22 *(0–87)*	42 ± 19 *(6–91)*	54 ± 23 *(2–100)*
Positive emotions:				
Satisfaction	62 ± 16 *(21–91)*	58 ± 23 *(0–100)*	55 ± 22 *(9–100)*	54 ± 21 *(9–93)*
Happiness	62 ± 18 *(11–92)*	55 ± 20 *(0–94)*	53 ± 21 *(0–100)*	49 ± 25 *(0–91)*
Relaxed	59 ± 15 *(21–88)*	56 ± 21 *(0–100)*	54 ± 22 *(0–91)*	52 ± 23 *(0–90)*
Energetic	58 ± 19 *(12–99)*	56 ± 22 *(0–91)*	52 ± 19 *(0–96)*	53 ± 23 *(5–89)*
Pride	54 ± 26 *(0–100)*	51 ± 26 *(0–100)*	48 ± 28 *(0–100)*	49 ± 28 *(0–95)*
Negative emotions:				
Boredom	27 ± 24 *(0–81)*	32 ± 29 *(0–92)*	33 ± 28 *(0–100)*	35 ± 28 *(0–91)*
Disappointment	22 ± 22 *(0–89)*	31 ± 27 *(0–100)*	33 ± 26 *(0–76)*	38 ± 28 *(0–94)*
Guilt	14 ± 16 *(0–67)*	13 ± 19 *(0–68)*	10 ± 14 *(0–56)*	12 ± 14 *(0–69)*

conditions at three timepoints during consumption (before, after the third bite, and after consumption). Results from the mixed model showed a significant interaction effect between plate size*plating ($F(1,182) = 8.88$, $p = 0.003$, $\eta^2 = 0.05$) Here, the results from the ANOVA showed that when the salad was presented on a large plate with high plating, liking was significantly higher as compared to the other conditions ($F(1, 182) = 21.3$, $p < 0.001$, $\eta^2 = 0.10$) (see also Table 3). Also, the mixed model revealed a significant main effect of time ($F(2, 354) = 6.7$, $p < 0.001$, $\eta^2 = 0.04$) for liking: on average, participants liked the salad more after consumption compared to before consumption. The main effects of size ($F(1, 182) = 0.5$, $p = 0.49$, $\eta^2 < 0.001$) and plating ($F(1, 182) = 2.3$, $p = 0.14$, $\eta^2 = 0.01$) were not significant.

Table 2 shows the means ± *SD* for fullness, hunger and food-evoked emotions before and after consumption for the four conditions: small-high; small-spread; large-high and large-spread. Table 3 shows a summary of the outcomes of the linear mixed model analysis for liking, fullness, hunger and food-evoked emotions.

For fullness and hunger, significant main effects were found of time, with fullness scores being higher after consumption than before ($F(1, 182) = 121.5$, $p < 0.001$, $\eta^2 = 0.04$), and hunger ratings being lower after consumption than before ($F(1, 172) = 300.5$, $p < 0.001$, $\eta^2 = 0.62$). Furthermore, a significant main effect was found of plating ($F(1, 182) = 32.1$, $p < 0.001$, $\eta^2 = 0.15$), with fullness scores being higher for the high than for the spread plating conditions (Tables 2 and 3). Main effects of plate size ($F(1, 182) = 0.1$, $p = 0.78$, $\eta^2 < 0.001$) and the interaction effects of plate size*plating ($F(1, 182) = 0.2$, $p = 0.63$, $\eta^2 < 0.001$) were not significant. In line with the results on fullness, a significant main effect of plating ($F(1, 172) = 4.7$, $p = 0.03$, $\eta^2 = 0.03$) was observed for hunger, with participants reporting lower ratings of hunger after consuming the salad in high plating conditions compared to spread plating conditions (Tables 2 and 3). However, main effects of size ($F(1, 172) = 1.9$, $p = 0.17$, $\eta^2 < 0.001$) and the interaction effects of plate size*plating were not significant ($F(1, 172) = 0.1$, $p = 0.77$, $\eta^2 < 0.001$).

For food-evoked emotions, a significant main effect of plating ($F(1, 182) = 7.6$, $p = 0.01$, $\eta^2 = 0.04$) and a significant interaction effect of plate size*plating ($F(1, 182) = 7.3$, $p = 0.01$, $\eta^2 = 0.04$), but no significant main effect of plate size ($F(1, 182) = 0.1$, $p = 0.73$, $\eta^2 < 0.001$) was observed for satisfaction (Table 3). Participants reported higher satisfaction ratings for the high plating conditions compared to the spread conditions, as well as higher satisfaction ratings for the large-high condition compared to the large-spread condition (Table 2). In addition, a significant main effect of time ($F(1, 182) = 10.9$, $p < 0.001$, $\eta^2 = 0.06$) was observed for pride (Table 3), with higher ratings after consumption than before (Table 2). Also, a significant interaction effect of plate size*plating was found for happiness ($F(1, 182) = 11.5$, $p < 0.001$,

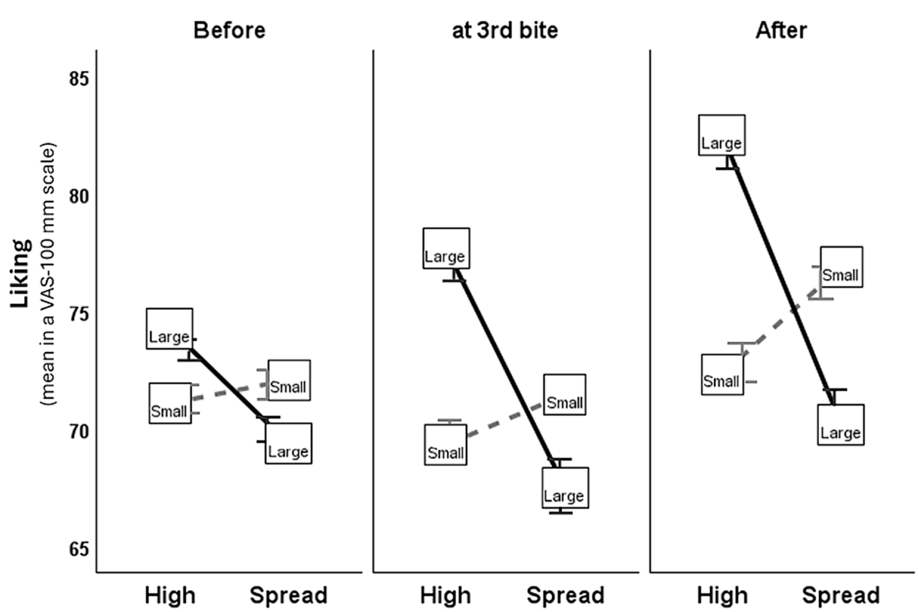

Fig. 6. Mean liking ratings (±SEM) for salads arranged in the different combinations of plate size (small, large), and plating (high, spread) at three stages of consumption (before eating, after the third bite, and after finishing the meal).

Table 2
Mean ± *SD* and range *(min, max)* of ratings for fullness, hunger, and food-evoked emotions for each plate size*plating condition before and after consumption in a real-life context. The four plate sizes* plating conditions included Small-high, Small-spread, Large-high, and Large-spread.

	Before consumption				**After consumption**			
	Small-high (n = 48) Mean ± *SD* *(min–max)*	**Small-spread** (n = 48) Mean ± *SD* *(min–max)*	**Large-high** (n = 48) Mean ± *SD* *(min–max)*	**Large-spread** (n = 48) Mean ± *SD* *(min–max)*	**Small-high** (n = 48) Mean ± *SD* *(min–max)*	**Small-spread** (n = 48) Mean ± *SD* *(min–max)*	**Large-high** (n = 48) Mean ± *SD* *(min–max)*	**Large-spread** (n = 48) Mean ± *SD* *(min–max)*
Fullness	56 ± *19 (21–95)*	50 ± *18 (22–100)*	53 ± *17 (19–87)*	49 ± *16 (8–88)*	75 ± *10 (52–94)*	64 ± *15 (22–86)*	78 ± *8 (60–91)*	62 ± *13 (30–92)*
Hunger	62 ± *23 (19–100)*	64 ± *20 (17–100)*	68 ± *21 (29–100)*	64 ± *21 (19–100)*	32 ± *20 (0–70)*	38 ± *21 (0–94)*	29 ± *19 (0–77)*	35 ± *22 (0–84)*
Positive emotions:								
Satisfaction	66 ± *15 (19–100)*	64 ± *17 (26–100)*	70 ± *16 (32–100)*	60 ± *17 (27–100)*	66 ± *19 (6–100)*	67 ± *18 (29–100)*	73 ± *17 (32–100)*	61 ± *19 (13–100)*
Happiness	66 ± *17 (25–100)*	67 ± *15 (27–100)*	72 ± *14 (36–100)*	62 ± *15 (21–100)*	64 ± *16 (34–100)*	71 ± *12 (31–96)*	73 ± *15 (39–100)*	64 ± *15 (26–100)*
Relaxed	60 ± *19 (0–100)*	63 ± *19 (7–100)*	69 ± *17 (29–100)*	58 ± *13 (25–100)*	58 ± *20 (10–100)*	69 ± *17 (15–100)*	68 ± *17 (24–100)*	62 ± *16 (0–100)*
Energetic	60 ± *19 (23–100)*	59 ± *20 (8–100)*	60 ± *18 (24–100)*	56 ± *16 (15–100)*	62 ± *17 (26–100)*	58 ± *17 (21–100)*	61 ± *21 (19–100)*	57 ± *15 (28–90)*
Pride	47 ± *27 (0–97)*	46 ± *25 (0–100)*	58 ± *24 (7–100)*	43 ± *27 (0–100)*	52 ± *26 (2–100)*	52 ± *26 (0–100)*	60 ± *25 (7–100)*	51 ± *24 (0–100)*
Negative emotions:								
Boredom	29 ± *22 (0–72)*	23 ± *19 (0–65)*	24 ± *15 (0–66)*	30 ± *26 (0–100)*	26 ± *23 (0–100)*	21 ± *20 (0–81)*	22 ± *21 (0–81)*	26 ± *23 (0–78)*
Disappointment	22 ± *21 (0–80)*	19 ± *17 (0–71)*	21 ± *23 (0–100)*	22 ± *19 (0–76)*	22 ± *21 (0–78)*	21 ± *18 (0–59)*	18 ± *22 (0–100)*	23 ± *22 (0–75)*
Guilt	12 ± *15 (0–73)*	14 ± *16 (0–71)*	11 ± *13 (0–60)*	10 ± *13 (0–51)*	13 ± *16 (0–77)*	18 ± *22 (0–86)*	11 ± *18 (0–97)*	14 ± *19 (0–98)*

Table 3
Summary of linear mixed model effects and directions of the significant differences for liking, satisfaction, fullness, hunger, and food-evoked emotions in real-life context.

Variable	**Time**			**Plate size**			**Plating**			**Plate size * Plating**		
	F-value	**p-value**	**Pairs Post-hoc**	**F-value**	**p-value**	**Pairs Post-hoc**	**F-value**	**p-value**	**Pairs Post-hoc**	**F-value**	**p-value**	**Pairs Post-hoc**
Liking	6.7	< 0.001 < 0.001	A > BA > 3rd bite	0.5	0.49		2.3	0.14		21.3	< 0.001	LH > LSp
Fullness	121.5	< 0.001	A > B	0.1	0.78		32.1	< 0.001	H > Sp	0.2	0.63	
Hunger	22.7	< 0.001	A<B	1.93	0.17		4.7	0.03	H<Sp	0.1	0.77	
Positive emotions:												
Satisfaction	1.2	0.27		0.1	0.73		7.6	0.01	H > Sp	7.3	0.01	LH > LSp
Happiness	1.0	0.32		0.1	0.81		1.9	0.17		11.5	< 0.001	LH > LSp
Relaxed	0.8	0.38		0.4	0.55		0.2	0.68		11.7	< 0.001	LH > LSp SSp > SH
Energetic	0.7	0.42		0.1	0.77		2.1	0.15		0.1	0.74	
Pride	10.9	< 0.001	A > B	1.2	0.29		3.3	0.07		2.4	0.12	
Negative emotions:												
Boredom	2.6	0.11		0.0	0.89		0.0	0.98		4.2	0.04	LSp > SSp
Disappointment	0.0	0.97		0.0	0.87		0.1	0.81		0.9	0.34	
Guilt	2.9	0.09		2.0	0.16		1.0	0.32		0.5	0.49	

The abbreviations refer to: Time of consumption **A**: after consumption, **B**: before consumption; Plating condition: **H**: high plating, **Sp**: Spread plating; and Interaction of plate size*plating condition: **SH**: Small-high, **SSp**: Small spread, **LH**: Large-high, **LSp**: Large-spread.

$\eta^2 = 0.06$). Post-hoc pairwise comparisons (Bonferroni corrected) showed that the mean ratings of happiness were significantly higher for the large-high condition compared to the large-spread condition ($F(3, 182) = 4.5$, $p = 0.01$, $\eta^2 = 0.07$). Similarly, the mean ratings of relaxed were significantly higher for the large-high condition compared to the large-spread condition ($F(3, 182) = 4.1$, $p = 0.01$, $\eta^2 = 0.06$). Lastly, the mean intensity of boredom was significantly higher for the small-spread condition compared to the large-spread condition ($F(1, 182) = 4.2$, $p = 0.04$, $\eta^2 = 0.02$) (Tables 2 and 3). All other main effects of plate size and plating were not significant (p-values ranging from 0.07 to 0.98).

For the perceived amount of food, no significant main effect was found for plate size ($F(1, 172) = 0.0$, $p = 0.88$, $\eta^2 < 0.001$), plating ($F(1, 172) = 1.2$, $p = 0.29$, $\eta^2 = 0.01$) and their interaction ($F(1, 172) = 3.66$, $p = 0.06$, $\eta^2 = 0.02$) (see Fig. 3b). Fig. 4 (right panel) shows that the large plate-high plating condition was perceived as the “ideal amount” by 36 % of participants, whereas this percentage was 14 % or less in the other three conditions.

For willingness to pay, the main effects of plate size ($F(1, 172) = 0.9$, $p = 0.33$, $\eta^2 = 0.01$), plating ($F(1, 172) = 0.3$, $p = 0.57$, $\eta^2 < 0.001$) and the interaction effects of plate size*plating ($F(1, 182) = 1.3$, $p = 0.26$, η^2

= 0.01) were not significant (Fig. 5, right panel).

3.3. Comparison of real-life vs. online contexts

A linear mixed model was used to evaluate the effect of context, i.e., online or real-life, on participants' hedonic and appetitive responses, and food-evoked emotions. See Table 4 for means and standard deviations. Overall, the results from the real-life experiment differed significantly from the results of the online experiment ($F(1, 3421) = 6.3$, $p < 0.001$, $\eta^2 = 0.01$). Compared to the online context, participants gave higher scores in the real-life context on liking ($F(350) = 88.2$, $p = < 0.001$, $\eta^2 = 0.20$), fullness ($F(350) = 95.1$, $p = < 0.001$, $\eta^2 = 0.21$), and positive emotions *satisfaction* ($F(350) = 21.2$, $p = < 0.001$, $\eta^2 = 0.06$), *happiness* ($F(350) = 46.7$, $p = < 0.001$, $\eta^2 = 0.12$), *relaxed* ($F(350) = 18.4$, $p = < 0.001$, $\eta^2 = 0.05$), *energetic* ($F(350) = 8.1$, $p = 0.0$, $\eta^2 = 0.02$), whereas for *pride* there was no significant difference ($F(350) = 1.5$, $p = 0.2$, $\eta^2 < 0.001$). In contrast, the ratings of the negative emotions *boredom* ($F(350) = 10.8$, $p < 0.001$, $\eta^2 = 0.03$), and *disappointment* ($F(350) = 16.3$, $p = < 0.001$, $\eta^2 = 0.04$) where higher in the online context compared to those in the real-life context, whereas for *guilt* there was no significant difference ($F(350) = 1.3$, $p = 0.26$, $\eta^2 < 0.001$).

In the real-life experiment, participants displayed significantly higher levels of liking ($F(1, 3776) = 17.57$, $p = < 0.001$, $\eta^2 = 0.05$) and positive emotions ($F(1, 3776) = 20.76$, $p = < 0.001$, $\eta^2 = 0.10$) when the salad was served in the large plate-high plating condition. These effects were not replicated in the online experiment, where instead it showed that the small plate-high plating condition resulted in comparatively higher levels of liking and positive emotions. Moreover, Pearson's correlations between the four conditions in the online experiment and the four conditions in the real-life experiment yielded coefficients of $-0.02 < r < -0.09$ ($p > 0.1$) for liking, fullness, satisfaction, and all food-evoked emotions. This indicates that no linear relationship existed between ratings in the online context compared to the real-life context.

For the perceived amount of salad, the results differed slightly between the online and real-life conditions. In the real-life experiment, a larger percentage of participants (76 %) compared to the online experiment (54 %) thought that their salads should be bigger than the salad they evaluated to be perceived as their ideal portion size ($X^2(4, N = 350) = 15.7$, $p < 0.001$). Moreover, in the online experiment the large plate-spread plating condition was perceived as closest to the "ideal portion size", whereas in the real-life experiment the large plate-high plating was perceived as closest to the "ideal portion size" (Fig. 4).

Table 4
Mean ± *SD* and range *(min–max)* of ratings for overall liking, fullness, food-evoked emotions and willingness to pay for the online and the real-life context.

	Online context	Real-life context
Liking	51 ± *22 (0–100)*	70 ± *14 (22–94)* ***
Fullness	55 ± *22 (0–100)*	76 ± *18 (21–100)* ***
Positive emotions:		
Satisfaction	57 ± *21 (0–100)*	67 ± *19 (6–100)* ***
Happiness	55 ± *21 (0–100)*	68 ± *15 (26–100)* ***
Relaxed	55 ± *22 (0–100)*	76 ± *18 (0–100)* ***
Energetic	54 ± *21 (0–99)*	60 ± *18 (19–100)* *
Pride	50 ± *27 (0–100)*	54 ± *25 (0–100)*
Negative emotions:		
Boredom	32 ± *27 (0–100)* **	24 ± *22 (0–100)*
Disappointment	31 ± *26 (0–100)* ***	21 ± *21 (0–100)*
Guilt	12 ± *15 (0–69)*	14 ± *19 (0–98)*
Willingness to pay *(Euro)*	3 ± *1 (0–100)*	5 ± *2 (0–12)* ***

* $0.01 \le p < 0.05$.
** $0.001 \le p < 0.01$.
*** $p < 0.001$.

Similarly, the willingness to pay also differed between the online and real-life settings ($F(1, 350) = 139.6$, $p < 0.001$, $\eta^2 = 0.29$), where participants in the online setting wanted to pay less compared to those in the real-life setting, 3.3 and 5.4 Euro respectively. However, within the online and real-life contexts no significant difference in willingness to pay was found between the four plate size – plating conditions ($F(1, 172) = 0.4$, $p = 0.74$, $\eta^2 < 0.001$, and ($F(1, 172) = 0.9$, $p = 0.46$, $\eta^2 < 0.001$, respectively).

4. Discussion

This study examined the effect of plate size, plating and their interaction on liking, hunger and fullness, perceived portion size, willingness to pay, and food-evoked emotions. These effects were studied both in an online and in a real-life context. The findings from the two contexts were then compared, with the results from the real-life experiment serving as the "gold standard".

In the real-life context, the salad was liked best when served on a large plate in high-stacked plating compared to the other three conditions, i.e., small plate-high-stacked plating, small plate-spread plating, and large plate-spread plating. Interestingly, the salad on the large plate with high-stacked plating also evoked stronger positive food-evoked emotions (i.e., happiness, satisfaction and relaxed), and was perceived more frequently as the closest to the "ideal portion size". Apart from these interaction effects between plate size and plating, we found that fullness was influenced by plating, with the high plating conditions being more fulfilling than the spread ones. This finding was contrary to our hypothesis. We had anticipated that participants would perceive the high-stacked salad as a smaller portion than the spread-out salad because it covered less of the plate, regardless of whether the plate was small or large. In contrast to some previous findings (Abeywickrema & Peng, 2023; Peng, 2017; Wansink et al., 2006, 2014), the effects of plate size were not significant in this study. It has to be noted, however, that a trend ($p = 0.06$) was observed for plate size and for the plate size*plating interaction in the online context. Future experiments with increased power or less variability in the data could yield significant results for plate size. Overall, the salad was liked more after it was consumed compared to the initial assessment and after the third bite, suggesting that liking increases during the actual eating experience. This dynamic change in liking cannot be captured in studies that use food pictures as stimuli without involving actual consumption.

Our results concur with previous research to the extent that visual food arrangements (how food is presented) influence consumers' liking and appetitive responses (Kokaji & Nakatani, 2021; Rowley & Spence, 2018; Zellner et al., 2011). The large plate-high-stacked plating condition was appreciated most by the participants in the real-life experiment. This is in line with results from earlier studies showing that a vertical or high-stacked plating arrangement is associated with neatness (Zellner et al., 2011) and with upscale restaurants and fine dining (Motoki & Togawa, 2022; Spence et al., 2022; Zellner et al., 2011). High plating arrangement of the food on large plates may suggest that careful attention is paid to the food arrangement on the plate which is appreciated by people and they are willing to pay (more) for this. This effect could be attributed to its frequent use in stylish food and beverage establishments and cooking programs, resulting in a consumer association between neat presentation and restaurant-quality food as has been shown in previous studies (Michel et al., 2014; Zellner et al., 2011).

Previous studies showed that people perceived food portions as larger when using spread or horizontal plating compared to high-plating (vertical) (Rowley & Spence, 2018; Szocs & Lefebvre, 2017). This contrasts the results of our real-life experiment, in which participants perceived the salad in the high-plating condition as a bigger portion than the spread condition, leading to higher ratings of fullness than in the spread condition. A plausible explanation for this difference may lie in ratio between plate- and food surface, i.e., the gap between the plate rim and the food served on it. In the studies of Rowley and Spence (2018) and Szocs and Lefebvre (2017), the gap between the plate rim and the food served on it when arranged high-stacked was visually more evident than in our study. This was explained by Girgus and Coren (1982), who described that when an enclosed circle (i.e., food arranged on a plate) is surrounded by a much larger circle (i.e., a large gap between plate and food as in the studies of Rowley and Spence (2018) and Szocs and Lefebvre (2017), this can lead to an underestimation of the inner circle due to contrast effects. On the other hand, when a circle is surrounded by a slightly larger circle, as in our study, an assimilation effect may be present, resulting in an overestimation of the inner circle's size.

In the present real-life experiment, using fixed portions of food, plate size did not affect reported fullness and hunger. The results of the current study align with previous research by Rolls et al. (2007). Their work involved five amorphous test meals in a controlled laboratory setting, using both ad libitum and fixed portions. They discovered that plate size had no impact on food intake, nor were there differences in hunger and satiety ratings across different plate sizes, either before or after the meal. Research on the effect of plate size on food intake has yielded mixed results (Holden et al., 2016). For instance, Robinson et al. (2014) conducted a systematic review of nine experimental studies that explored the impact of serving food in small versus larger bowls or plates. They found that three studies showed significant effects of plate size on food intake, five found no significant differences, and one had mixed results. Similarly, Shah et al. (2011), in a laboratory study using real food, observed no effect of plate size on meal energy intake. Conversely, Wansink et al. (2006) identified a significant effect of plate size in a real-life context (social occasion). Our results align with those from Rolls et al. (2007) but differ from results of Wansink et al. (2006) despite being conducted in real-life contexts.

Three factors could potentially explain this discrepancy. First, our study tested a fixed portion served to participants, whereas, in the study from Wansink et al. (2006) participants freely served themselves the foods. Second, the used dishware differed between studies. Rolls et al. (2007) used flat dinner dishes (similar to our study), whereas in the study from Wansink et al. (2006) bowls were used. The bowl served as the cue for how much participants consumed, particularly for amorphous foods, and this dishware (bowl) includes a vertical dimension in which participants could have focussed more on the food than in the horizontal dimension of the bowl (Wansink, 2004). Third, the type of food. In our study participants consumed a chicken salad, whereas in the study from Wansink et al. (2006) participants consumed ice cream. The expectation of how satiating the food will be might have influenced portion size choices in the ice cream study. Ice cream generally has a lower expected satiation per kcal (Brogden & Almiron-Roig, 2010). Therefore, consumers may have preferred larger portions of ice cream — a food with low expected satiation — to achieve a sense of fullness. This contrasts with foods that have higher expected satiation, such as meal salads with a protein component, where smaller portions might be chosen because they are perceived to be more filling.

Individual's cognitive and perceptual styles — such as how they process information and allocate attention — are critical in the continuous debate about the effect of plate size in food consumption (Robinson et al., 2014). Sim and Cheon (2022) suggest that individuals who employ a holistic information processing approach, where they consider the relationships between objects and remain mindful of contextual information or distractions during eating, are less influenced by the portion size effect. When individuals' attention was diverted from portion size, they tended to consume more food presented in a vertical orientation rather than a horizontal one, as demonstrated in research by Szocs and Lefebvre (2017). In the current study, which took place in a real-life setting, participants likely did not focus solely on portion size. Participants were exposed to a multitude of stimuli characteristic of a real-life cafeteria setting, namely, lighting conditions, music, background sound, regular customers present, and social interaction with other participants. Hence, it is likely that participants' attention was not focused only on portion size but rather on the concurrence and interaction of other various factors.

Given the inconsistent findings to date, it remains challenging to draw a definitive conclusion to what extent plate size influences food intake in a real-life eating environments. These mixed results suggest that the effects of plate size and plating may be contingent not only on the type of food and the plate itself but also on the broader context in which the eating occurs (e.g., at home, in a cafeteria, or a restaurant), in a particular social setting (e.g., dining alone or with family and friends). We need more systematic experimental studies to reach firm conclusions about how visual presentation of food affects liking, appetitive responses and food-evoked emotions.

The results of our real-life experiment differed from those obtained in the online experiment. Specifically, in the real-life experiment, participants reported significantly higher ratings of liking, fullness, and positive emotions compared to the online context. They were also willing to pay more—over 5 Euros in real-life versus around 3 Euros online. This discrepancy suggests that hedonic, appetitive and emotional ratings, as well as willingness to pay, in a real-life context are influenced by more than just the food's sensory attributes. Factors such as social interaction, the actual experience of taste and smell, and post-ingestive sensations—ranging from alleviating hunger to achieving satiety—also play a crucial role (Bisogni et al., 2007; De Graaf et al., 2005). Real eating is much more satisfying than imagining eating from a salad displayed on a computer screen. In terms of food-evoked emotions, the patterns of responses from the online context did not match those from the real-life context. In the online context participants may have focused their attention more on the portion size without the distraction of other stimuli, resulting in a more analytical processing style where participants were more susceptible to the relationship between food- and surface area (Sim & Cheon, 2022).

Recent studies underscore the importance of context in shaping product perceptions and acceptance (De Wijk et al., 2019; Jiminez et al., 2015; Spence et al., 2019; Van Bergen et al., 2021; Zandstra & Lion, 2019; Zandstra et al., 2020). For instance, viewing an image of a food presented in a contextually appropriate setting has been shown to increase the desire to eat the food and even increased salivation, a physiological indicator of preparing to eat (Papies et al., 2022). Although we used interactive 360° videos to enhance the perceived realism of the salad in our study, these videos did not depict the salad within a congruent contextual background. Future research using 360° videos should consider including the physical (e.g., home, cafeteria, or restaurant) and social context (e.g., dining alone or with others) to better reflect real-life experiences.

To our knowledge, this study is novel in combining hedonic and emotional responses to real food stimuli within a real-life context, adding valuable insights into the relationship between food portion size perception and visual food arrangements beyond the laboratory setting. However, our study has several limitations. The real-life experiment was conducted in a university cafeteria, resulting in a participant pool predominantly composed of Wageningen University and Research students. Furthermore, the study focused on a single product, a chicken salad. Replicating these findings with a broader range of products and a more diverse participant group is recommended. Additionally, some ambient factors in the real-life experiment were beyond our control. Previous research indicates that sound influences food intake and perception (Cui et al., 2021; Spence, 2020; Stroebele & De Castro, 2006; Xu et al., 2019). However, we could not standardize the cafeteria's music playlist, leading to variations in the background music experienced by participants. The cafeteria also provided ad libitum still water, which could not be controlled, possibly affecting the amount of food consumed. Future research should ideally control the background music and monitor water consumption to ensure consistent conditions. Finally, a limitation for the online experiment was the lack of standardization of the devices used by participants to complete their questionnaires at home. The different screen qualities could have influenced how participants perceived the images of the food, potentially affecting their responses.

In conclusion, the present findings show that visual food arrangements affect food portion size perception, liking, satiation and food-evoked emotions. Context played a key role on the perceived amount of food, willingness to pay and on the hedonic and emotional responses to food. These results highlight the importance of considering real-life, multi-modal consumption contexts in consumer testing, implicating that caution should be exercised when extrapolating the results from an online context to the real-life context.

Ethical statement

The work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

The experiments were performed according to the ICC/ESOMAR Code on Market and Social Research guidelines (ICC/ESOMAR, 2016). The studies were explained to consumers in an online questionnaire. They were informed that all data will be de-identified and only reported in the aggregate. All participants gave written informed consent, and were able to withdraw from the study at any time without giving reasons. All foods offered were commercially available and safe to consume. Participants were financially compensated for their participation in the amount of 5 Euro for the online experiment and 10 Euro for the real-life experiment.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT (htpps://chatgpt.com/) in order to improve readability and language. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

CRediT authorship contribution statement

Maria Isabel Salazar Cobo: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gerry Jager:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Orestis Ioannou:** Methodology, Investigation, Formal analysis, Data curation. **Cees de Graaf:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Elizabeth H. Zandstra:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Elizabeth H. Zandstra reports financial support was provided by Unilever Foods Innovation Centre Wageningen, The Netherlands. Maria Isabel Salazar Cobo reports financial support was provided by Secretariat of Higher Education, Science and Technology (SENESCYT-Ecuador). Elizabeth H. Zandstra reports a relationship with Unilever Foods Innovation Centre Wageningen, The Netherlands that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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