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Rotating plates: Online study demonstrates the importance of orientation in the plating of food

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ABSTRACT

We report three online experiments designed to assess how the visual composition of the elements of a commercially-successful dish would be perceived by naïve assessors, in terms of their liking and willingness to pay. Experiment 1 showed that an upward orientation of the dish was preferred as compared to when the elements pointed downward/toward the observer, or else pointed to the side. Experiment 2 demonstrates that optimally orienting the plate translates into an increased willingness to pay for the food. In addition, the results also revealed that both a triangle formed by the three principal elements (onions), and the direction in which these v-shaped elements pointed, affected people's judgments of the ideal orientation of the dish as a whole. Finally, a citizen science experiment (Experiment 3) held at London's Science Museum provided further support for our findings. These results highlight the potential of a digital (Internet-based) testing methodology to determine the optimal visual presentation of food.

1. Introduction

For the majority of chefs, the plating of food is typically approached in an intuitive manner: The visual design of the food on the plate is refined through a natural iterative process until the composition 'feels just right'. Recently, however, a new field of experimental research has started to investigate how differences in the visual arrangement of the food on a plate may modify a diner's expectations, and from there, presumably also their subsequent experience of the food (see Spence, Piqueras-Fiszman, Michel, & Deroy, 2014, for a review).

A number of studies now show that the visual composition of the food on a plate can exert a significant influence over what people think about the dish. The commonly-made assertion that fits with such observations is that people eat first with their eyes (e.g., Apicius, 1936, 1st Century; Delwiche, 2012; Spence, 2015). The latest empirical evidence certainly supports such a claim (e.g., Van der Laan, de Ridder, Viergever, & Smeets, 2011; Zellner, Loss, Zearfoss, & Remolina, 2014). Undoubtedly, what we see on the plate leads to the generation of expectations concerning the taste, flavour, and enjoyment of a given dish (Spence & Piqueras-Fiszman, 2014).

Whenever we set our eyes on a dish in a restaurant, we estimate (consciously or otherwise) its likely value (Michel, Velasco, Fraemohs, & Spence, 2015). Recently, researchers have demonstrated how changes to the visual appearance of a dish can shape people's expectations, resulting in changes in consumption behaviour and enjoyment of the food (Michel, Velasco, Gatti, & Spence, 2014), and even influence our brains' response to a given taste (e.g. Woods et al., 2011). It is our contention that what has up until now primarily been an 'art' (of plating; see Deroy, Piqueras-Fiszman, Michel, & Spence, 2014, for a review; Styler, 2006) could easily be turned into a science, or, at the very least, might benefit from a more rigorous scientific evaluation of the intuitions of the chef. In turn, we believe that the empirical approach outlined here could potentially provide an essential tool for the chef or restaurateur concerned with how his/her dishes appear (either in the restaurant setting or online), in order to increase either the expected or actual satisfaction of their diners.

Food photography now plays an increasingly important role as a medium of diffusion of the aesthetic genres of a chef's/restaurant's cuisine. The interest in the visual appearance of the food on the

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plate really emerged with the 'nouvelle cuisine' movement[1] (Halligan, 1990; Spence & Piqueras-Fiszman, 2014). The recent trend for food images to be shared online (e.g., the Instagram platform www.theartofplating.com) has undoubtedly helped accelerate this emphasis on how the food on the plate looks. Indeed, when it comes to the visual appearance of food, social media platforms are likely to start setting plating trends virally, defining the food aesthetic preferences of the general public.

Given that so much 'hangs' on the visual appearance of the food, and given the explosive growth of interest in food photography in recent years, it would seem sensible to check that the intuitions of the chef or restaurateur concerning how appealing a certain visual presentation is judged to be are shared by the population at large (or at least by the likely customer demographic eating at a given restaurant, or restaurant chain). We hereby illustrate the potential of an Internet-based testing methodology to study the plating of food. We demonstrate that changing the orientation of the elements of a commercially successful dish can give rise to significant differences in terms of people's preferences and their willingness-to-pay (WTP) for the food.

Alberto Landgraf is an up-and-coming chef in the Sao Paulo restaurant scene in Brazil (http://www.theworlds50best.com/latinamerica/en/the-list/41-50/Epice.html). One of the signature dishes at *Restaurant Epice* caught our eye because its main 'visual feel' seemed to point away from the diner (i.e., upwards[2], see Fig. 1). Note how the individual v-shaped elements of the dish (pickled onions) had all been arranged so as to point upward, but also that the Gestalt ('whole', Hartmann, 1935; see Wagemans, in press) forms a triangle whose orientation points upwards. Interestingly, research shows that in triangle-like shapes, orientation appears to matter, with downward pointing triangles being associated with threat (Larson, Aronoff, & Stearns, 2007).

The inspiration for laying out the dish in this way, in the words of the chef (and co-author) A. Landgraf, was as follows: 'I put the onions upwards because I think it's the most natural way for us to look at it, and to identify it as an onion. When you think about Japanese cuisine, it's offensive to point things towards people, towards the guest or towards the chef.'

We wondered whether the chef's 'natural' (intuitive) solution to placing the elements of the dish so as to be oriented away from the diner would also be the one that a random group of people would like the most as well. Alternatively, it could be argued that people might simply be uninterested in the overall orientation of the food on the plate. A picture of the chef's dish was rotated so that the onions pointed to the right, left, up, or down. The participants were then asked to rank the images in order of preference (Experiment 1A). The participants also rotated the dish into their preferred orientation (Experiment 1B). A new group of participants subsequently expressed their WTP for the food when arranged in the various orientations (Experiment 2A). To assess whether the preference judgments were attributable to the whole (or Gestalt) formed by the three elements in the dish, or rather to the orientation of each single onion, the stimuli were modified computationally, now rotating the individual onions to various angles. The participants were asked to rotate the different arrangements of the dish into their preferred orientation (Experiment 2B). We subsequently designed an interactive platform in collaboration with London's 'Science Museum', where the participants had to rotate the image of the same food presentation into their own preferred orientation (Experiment 3).

Fig. 1. 'Red onions, tapioca, sugar cane vinegar, peanut, fermented cream', dish by Alberto Landgraf, restaurant Epice, Sao Paulo, Brazil [photo courtesy of Rafael Facundo and Pedro Santos]. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

2. Experiment 1

2.1. Materials and methods

2.1.1. Participants

Two-hundred-and-four individuals (62 female and 142 male) recruited from Amazon's Mechanical Turk (MTurk) took part in Experiment 1 in return for a payment of 0.30 US dollars. The participants ranged in age from 21 to 70 years (M = 36.0 years). Only those living in the United States of America were able to take part in the study. The experiment was conducted on 22/08/2014, from 18:00 GMT onwards over a 2-h period (see Crump, McDonnel, & Gureckis, 2013; Woods et al., Submitted, for a methodological overview of Internet-based research). A large sample size was chosen, as the study was exploratory in nature. The stopping criterion was 200 participants (small variation is an inherent feature of online testing). The participants took an average of 156 s (SD = 141 s, 95% of respondents finished the study in between 69 s and 354 s) to complete the study. All of the participants provided informed consent prior to taking part in the study. This study has been approved by Oxford's University Medical Sciences Inter-Divisional Research Ethics Committee (approval # MS-IDREC-C1-2015-007).

2.1.2. Stimuli

The image of Alberto Landgraf's 'Red onions, tapioca, sugar cane vinegar, peanut, fermented cream' dish was isolated from its background using graphics software in order to obtain a transparent background. Careful attention was paid to ensuring that any shading around the food was removed. The image was then superimposed onto a photo of a plate proportionally equal to the original. The centre of the circle of the sauce in the food image was aligned with the centre of the plate. In the Ranking task (Experiment 1A), four separate resized 360 × 360-pixel images were created. They showed the food oriented 0°, 90°, 180°, and 270° with respect to the original. For the Rotation task (Experiment 1B), the food (resized to 195 × 195-pixels) could be rotated around this point on the plate (560 × 560-pixels) by moving the cursor around the central position of the display. The degree of food rotation matched the degree of mouse rotation.

[1] "Really, the concern with how the food looked can be traced back to the emergence of nouvelle cuisine. The pictures of these dishes have set themselves in the mind of the public. Nouvelle cuisine was essentially photogenic... Think of the glorious coloured photographs of these dishes, which have become eponymous with the purveying of recipes." (Halligan, 1990, p. 121).

[2] It seems natural to refer to 'away from the diner' using the term 'upwards' in this case, even if one is referring to a horizontal visual arrangement (a plate of food). The implications of testing a visual element meant to be horizontal (a plate on a table), using an image presented on a vertical plane (a computer screen), will be discussed later.

Fig. 2. Ranking task used in Experiment 1A, showing the plates and a different orientation of the food on each plate (plate 1, 2, 3 and the plate with no number were oriented at 90°, 180°, 0°, and 270°). The ordering that three of the four plates have been given by a participant is also shown (for illustration purposes only).

The apparatus varied by participant. The experiment was conducted 'full screen', utilizing the entirety of the participant's monitor, and took place within a 1024 × 768-pixel box in the centre of screen, irrespective of the size of the monitor. The experiment was conducted on the Internet using the Adobe Flash based Xperiment software (http://www.xperiment.mobi).

2.1.3. Design

A mixed design was used with all of the participants undertaking both experimental trials (trial order was the between-participants factor). In Experiment 1A, the dependent variable was the ranked preference assigned to each dish, whilst in Experiment 1B, it was the orientation (in degrees[3]) in which the participants preferred to visualize the food on the plate.

2.1.4. Procedure

In Experiment 1A (see Fig. 2), the participants had to rank the four stimuli presented on the screen in terms of liking. The four food images were placed randomly in a 2 × 2 arrangement on the screen. The participants were instructed to click the images of the plates in order of preference, starting with the most preferred plating. A number appeared in the top-left hand corner of the images as they were clicked indicating preference (with 1 indicating the most, and 4 the least, preferred). Although not stated explicitly, the participants could re-click a ranked image to remove the assignment, and then re-assign it elsewhere if so desired. The participants had to rank all four stimuli before they were allowed to go on to the next screen.

For the rotation task (Experiment 1B, see Fig. 3), the participants were instructed to rotate the food by moving the cursor around the centre of the image so that it looked most appealing. The initial orientation of the food was randomly selected for each participant to avoid any kind of anchoring effect that could have occurred if participants saw the image of the food at the same initial orientation (which might have biased the results; e.g., Stewart, 2009; Kahneman & Tversky, 1973). To indicate that they were satisfied with the orientation of the dish, the participants were instructed to tap the Space bar on the keyboard. The order of presentation of Experiments 1A and 1B was counterbalanced across participants, and after completion of the study, the participants were debriefed as to the nature of the study.

2.2. Results

The results of Experiment 1A (see the ranking task pictured in Fig. 2) revealed that the chef's intuition concerning the orientation of the food that would be preferred was essentially correct in this case. The assignment in terms of preference for each orientation (0°, 90°, 180°, 270°) was coded numerically. A Friedman analysis of variance conducted on the data revealed that the four orientations differed statistically from one another in terms of preference assignment score, $\chi^2(3) = 27.11$, $p < .001$. Posthoc Wilcoxon signed-ranks tests between the different groups revealed that the scores for the dish oriented to 0° ($M = 2.09$, $SD = 1.11$, $Mdn = 2$, $IQR = 2$) were significantly lower (and thus more preferred) than for the dish oriented 90° ($Z = 4.16$, $p < .001$, $r = .15$; $M = 2.64$, $SD = 1.01$, $Mdn = 3$, $IQR = 1$), 180° ($Z = 3.61$, $p < .001$, $r = .13$; $M = 2.57$, $SD = 1.14$, $Mdn = 2$, $IQR = 2$), and 270° ($Z = 4.25$, $p < .001$, $r = .15$; $M = 2.68$, $SD = 1.11$, $Mdn = 3$, $IQR = 1$)[4].

The orientation data from Experiment 1B was analysed in R using the Circular package (Agostinelli & Lund, 2013), a common statistical package for the analysis of circular data (see Pewsey, Neuhäuser, & Ruxton, 2013, for an overview). Kuiper's test of uniformity was significant, $V = 4.29$, $p < .01$, thus suggesting that the data was not uniformly distributed. There was no evidence that the data *did not* have a reflective symmetrical distribution ($p = .81$; via an asymptotic theory-based test as outlined in Pewsey et al., 2013, p. 87). That is, as seen in Fig. 4, a cluster of data around 0° would appear to be mirrored, at least to a certain extent, by a smaller cluster at 180°. Descriptively, the bias-corrected mean orientation at which the dish was orientated by all participants

[3] From this point, noted '°'. All the orientations angles are given with reference to the 0° point, independently from the starting point given, which was randomized.

[4] The data was split according to whether the participant undertook Experiment 1A, $\chi^2(3) = 9.11$, $p = .028$), or Experiment 1B first, $\chi^2(3) = 19.08$, $p < .001$. Both groups were analysed separately, but the overall pattern of significant results remained unchanged.

Fig. 3. Orientation task used in Experiments 1B and 2B.

was 3.92°, with 95% confidence intervals of −9.26° and 17.11°. The concentration of the data, or bias-corrected mean resultant length, was ρ = .34 (CI, .24, .44; this range of values does not include zero, thus suggesting that the data was not uniformly distributed). There was no real change in the pattern of results when the above steps were repeated for data where the rotation task had been performed before, or after, the preference assignment task (before, mean 5.78, CI, −24.42, 35.89; ρ = .21, CI, .063, .36; after, mean 3.03, CI, −10.04, 16.09; ρ = .46, CI, .32, .60).

3. Experiment 2

3.1. Materials and methods

3.1.1. Participants

In Experiment 2A, 301 participants (141 female) were recruited from Amazon's Mechanical Turk and took part in return for a payment of 0.50 US dollars. The participants were aged between 18 and 72 years (*M* = 33.5 years). These participants together with an additional 304 participants took part in Experiment 2B, making a total of 605 individuals (263 female; payment was the same for all participants). A large sample was collected, as this study was exploratory. The combined group's age ranged from 18 to 72 years (*M* = 32.6 years). The experiment was conducted on 23/08/2014, from 18:00 GMT onwards over a 5-h period. The average time taken to complete both studies was 186 s (*SD* = 149 s, 95% of respondents finished the study in between 68 s and 389 s). Only those living in the United States of America were able to take part in the study. All of the participants provided informed consent prior to taking part in the study.

3.1.2. Stimuli

The WTP task (Experiment 2A) consisted of a choice discrimination in which the participants viewed the dish oriented in its original position (0°), together with an image of the same dish randomly oriented at 90°, 180°, or 270°. The two plates were shown side by side, one on either side of the screen (positioning was random across participants). The second Rotation task (Experiment 2B) was identical to Experiment 1B, except for the fact that the participants viewed the food with the orientation of the onions manipulated using graphics software. For these stimuli, the onions (but not the other elements of the dish) were either rotated 45° or 90° to the left or right, or oriented so as to point either Inward or Outward (see Fig. 5). Finally, some of the participants were shown a single onion oriented at 0°. The apparatus was the same as for Experiment 1.

3.1.3. Design

In Experiment 2A, a mixed design was used, with all of the participants ranking two dishes in terms of their preference and specifying how much they would be willing to pay for each dish (the dependent variable). The upward pointing dish (0° orientation) was shown to all of the participants. The orientation of the other dish was varied as a between-participants factor. In Experiment 2B, the participants oriented one of two sets of dishes (set was the between-participant factor; angle, in °, was the dependent variable).

3.1.4. Procedure

In Experiment 2A, the participants were informed that the picture of the dish shown was a version of one served at a fine dining restaurant, and they were asked to imagine that they were eating there. The participants first had to rank which of the two presentations of the dish they would be willing to pay more for. Having done that, they were then asked to enter (in US Dollars), how much they would actually be willing to pay for each presentation. Experiment 2B was identical to the first orientation task (Experiment 1B) except for the stimuli used. Experiment 2A was conducted first followed immediately by Experiment 2B.

3.2. Results

The results of Experiment 2A revealed that the participants were willing to pay significantly more for the dish when it was oriented in the upward orientation than when presented oriented down or left, but, interestingly, not when presented against oriented right (see Table 1)[5]. Each participant specified the amount

[5] The 304 participants who did not take part in Experiment 2A undertook a different version of the study, one in which there was no ordering task preceding the willingness to pay task. There was no difference in the amount that participants were willing to pay for the food at the different orientations ($Z < -1.37$, $p > .017$, $r < -.13$). One pertinent observation here, however, is that in this alternative task 8.87% and 10.52% of the participants said they were willing to pay $0 for the upward orientated dish and other-ways orientated dishes respectively, compared to 1.67% and 1.67% in Experiment 2A.

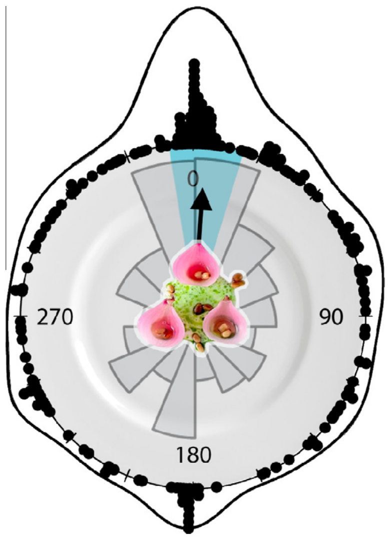

Fig. 4. Circular data plot and rose diagram of the 204 plate orientations selected by participants (see Pewsey et al., 2013). The surrounding line shows a kernel density estimate (bandwidth of 40); this is a non-parametric estimate of the underlying density of the data (each data-point is in effect 'blurred' and so contributes to a range of points that make up the line; the more data-points at a given orientation, the greater the bulge of the line). For clarity and ease of interpretation, the food has been added to the figure and oriented by 3.91° clockwise (i.e., the mean orientation in which the food was placed by participants). An arrow indicates the mean angle that participants placed the food in (beneath which is a blue wedge indicating the lines 95% confidence intervals). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

that they would be willing to pay for the plate of food oriented at 0°, as well as either 90°, 180°, and 270°, hence the comparison between 0° and each other plate-orientation was analysed separately. The data was analysed using non-parametric Wilcoxon signed-ranks tests[6]. The participants were willing to pay significantly more for food at 0°-oriented than for a 180°-oriented dish ($Z = -2.19$, $p = .028$, $r = -.21$), and 270° facing food ($Z = -3.54$, $p < .001$, $r = -.33$), but not for the one facing to 90° ($Z = -.19$, $p > .05$, $r = -.02$; we plan to investigate why this is so in the future as, if replicable, it may infer something special about foods that are oriented toward the right).

The data from Experiment 2B are shown in Table 2 and Fig. 5. Although Kuiper's Test of Uniformity was significant for all food rotations, note that Inward- and Outward-pointing onion rotation-concentration 95% confidence intervals included 0, which indicates a cyclic structure because there is a significant non-uniformity. One observation, though, is that these particular rotations would appear to be symmetrical around 3 orientations, such that they appear similar when oriented 0°, 120°, and 240° (and their reflections). To test whether the participants placed the dishes preferentially at these six orientations as compared to the others, the data was collapsed over reflections (via modulo 60) and split into groups of 7.5° (the groups were 0° < −7.5°, up to 52° < −60°). Frequencies differed from that expected by chance for both the Inward-, $\chi^2 = 205.61$, $p < .001$, and Outward-pointing onions, $\chi^2 = 187.27$, $p < .001$ (frequencies were 118, 28, 27, 22, 20, 20, 24, 42 and 115, 29, 22, 18, 26, 24, 34, 33, respectively). It is worth noting that, contrary to this evidence for preferred Gestalt orientations, the remaining orientations' concentration CIs all overlapped. If the triangular shape (Gestalt) were to have contributed to the preferred upward orientation, we should have observed a stronger concentration of preferred orientations for food oriented at 0°. This particular finding suggests that the Gestalt composition does not affect orientation preference for the dish as much as the orientation of the single-onions.

4. Experiment 3

4.1. Materials & methods

4.1.1. Participants

One thousand six hundred and sixty-seven individuals (1231 female and 434 male; 2 did not report whether they were male or female) took part in a citizen science experiment, conducted at the (Science Museum, 2015) in London in February and March 2015, both online[7], and in an interactive digital platform at the 'Antenna Gallery', as part of an exhibition on the science of eating called 'Cravings'. Online, participants were invited to access this experiment via the information page of the 'Cravings' exhibition, and from the Science Museum's home webpage. At the museum's gallery, the digital platform was one of the attractions of the exhibition.

For the dataset reported here, 660 participants took the test online, and 1007 took the test at the gallery's digital platform which consisted of a touchscreen. The median age was in the 16–34 years range (note that the participants specified if there age was either <16, 16–34, 35–54, 55–74 or 75+; the respective counts in each group were 350, 770, 398, 137, 11; 1 person did not report their age). All of the participants were informed about the nature of the study through a printed information sheet, and provided informed consent prior to taking part in the study. This study has been approved by Oxford University's Medical Sciences Inter-Divisional Research Ethics Committee (approval # MSD-IDREC-C1-2015-004).

4.1.2. Stimuli

The food image used for this experiment was exactly the same that was used for Experiment 1B.

4.1.3. Design

Similarly to Experiment 1B, the dependent variable was the orientation (in °) in which the participants preferred to visualize the food on the plate.

4.1.4. Procedure

The participants who took part in this experiment undertook five or more different tasks, either online, or at London's Science Museum 'Antenna Gallery'. The order of appearance of the tasks and the different conditions was randomised. Note that although it was possible that the same participant would have to respond to the same food orientation task twice, different foods would be seen on the different occasions. At the start of each trial, the plate (whose initial orientation angle was randomised) was automatically rotated by 360° in order for the participant to see the food in all possible orientations. Next, the participant rotated the plate of food into the position they liked best. Similarly to Experiment 1B, the food image was rotated around the central point on the plate, but this time by clicking on a rotation cursor placed either at the left of the plate (to rotate the food clockwise), or at the right (to rotate the food counter clockwise). The participants could either submit their answer by clicking on a 'Submit' button placed

[6] None of the orientation data was found to be distributed normally via Kolmogorov–Smirnov tests $D(82–114) < .17$, $p < .001$. There is an ongoing discussion as to whether preliminary testing for normality can alter the (conditional) type I error rate of the subsequent main analysis. However, this procedure seems to satisfactorily maintain the nominal significance level, and has acceptable power properties (see Rochon, Gondan, & Kieser, 2012).

[7] This experiment is being conducted from the 20th of February 2015, until January 2016, see http://www.bit.ly/1MwGh35 to access the online experiment.

Fig. 5. Circular data plots and rose diagrams of the orientations selected by participants for the different food images (for additional information see the legend of Fig. 4). The large image of the food corresponds to the altered version of the food image, in which the single onions were rotated, respectively −90°, −45°, +45°, +90°, Inward, Single, 0°, and Outward. The small image corresponds to the mean rotation angle at which participants preferred the food image. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 1
Table highlighting the differences in terms of how much the participants were willing to pay for the dish, in US Dollars, after choosing which presentation they were willing to pay more for in a task that presented the 0° oriented plating against 90°, 180°, and 270°.

	Condition						
	0° (n = 301)	0°vs. 270° (n = 114)		0° vs. 90° (n = 82)		0° vs. 180° (n = 105)	
Orientation		0°	270°	0°	90°	0°	180°
Mean	7.65	8.52	7.71	6.55	6.56	7.56	7.11
Stdev	5.46	5.83	5.23	4.12	4.36	5.84	6.17
Median	7	7.50	6.50	5.00	5.00	7.00	6.00
Interquartile range	6.00	8.00	6.75	5.00	6.00	6.00	5.50

right below the food image, leave the experiment by clicking on an 'X' button, or go on to the following question by clicking the 'Skip' button (see Fig. 6).

4.2. Results

A preliminary analysis of the data from the first 1667 individuals who took part in the study revealed that Kuiper's Test of Uniformity was significant, $V = 10.68$, $p < .01$, thus suggesting, once again, that the data was not uniformly distributed. Here, in contrast to Experiment 1B, the data was found not to have a reflective symmetrical distribution, $p = .022$, the difference in experimental results likely a consequence of the relatively large number of participants in this study as compared to Experiment 1. Descriptively, the bias-corrected mean orientation at which the dish was orientated by all participants was 3.20°, with 95% confidence intervals of −2.42° and 8.82° (see Fig. 7). The concentration of the data, or bias-corrected mean resultant length, was $\rho = .29$ (CI, .25, .33).

Table 2
This table shows Kuiper's test of uniformity score (V) for each plating; whether the plating distribution was significantly non uniform ($^{*}p < .05$, $^{**}p < .001$); if the orientation of the plate was *not* symmetrical (via an asymptotic theory-based test as outlined in Pewsey et al., 2013, p. 87); and both the bias-corrected mean orientations of the foods, as well as the concentration (or spread) of placements around this orientation.

	Bias-corrected (95% CIs in brackets)			
	Uniformity	Symmetry	Location	Concentration
−90°	4.70**	.74	93.21 (106.66, 79.76)	0.28 (0.19, 0.37)
−45°	4.99**	.83	39.10 (51.75, 26.45)	0.28 (0.19, 0.37)
45°	3.28**	.35	−31.22 (−11.13, −51.30)	0.21 (0.13, 0.29)
90°	5.51**	.21	−96.88 (−86.23, −108.51)	0.36 (0.28,0.44)
0°	6.76**	.79	2.09 (10.59, −6.41)	0.31 (0.25, 0.37)
Single	7.08**	.04*	6.49 (13.65, 0.67)	0.42 (0.33, 0.51)
Inward	2.40**	.46	−58.00 (−161.55, 45.56)	0.03 (−0.05, 0.10)
Outward	3.14**	.91	−76.91 (−1.55, −152.28)	0.05 (−0.02, 0.12)

5. Discussion

The present study explored the potential of an Internet-based testing methodology for conducting research on plating. We used a commercially-successful dish that consisted of three v-shaped elements (pickled onions) that had all been arranged so as to point away from the diner, in addition, the whole formed a triangle whose orientation pointed away from the diner as well. The results

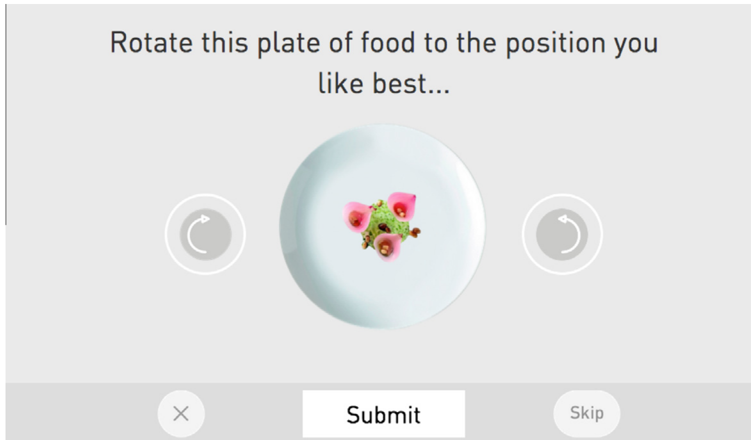

Fig. 6. Screenshot of the orientation-task as performed by participants in Experiment 3, ran in collaboration with London's Science Museum.

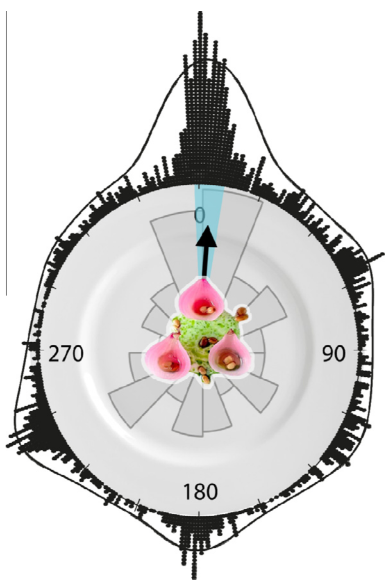

Fig. 7. Circular data plot and rose diagram showing the 1667 plate orientations selected by participants. The surrounding line shows a kernel density estimate (bandwidth of 40); the more data-points at a given orientation, the greater the bulge of the line. The food has been added to the figure and oriented by 3.20° clockwise (the bias-corrected, mean orientation in which the food was placed by participants). An arrow indicates the mean angle that participants placed the food in (beneath which is a blue wedge indicating the lines 95% confidence intervals). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

reported here confirm the intuition that those shapes that point 'up' (or away) appear to be consistently preferred (Experiment 1A, Experiment 3). People were also willing to pay more for the food when optimally oriented (Experiment 2A). When it comes to the preferred orientation of different arrangements of the pointed onions tested using the Rotation task (Experiments 1B and 2B), there would appear to be a consistent preference for when individual elements (each onion) point up (i.e., oriented close to 0°). These findings are discussed in terms of the effect of triangular (or pointed) shapes on visual perception, to then make a link to principles from the field of visual aesthetics.

Research on plating can potentially provide insights that may be relevant to both chefs and psychologists in terms of enhancing the experience of consumers, and understanding the basis of visual preference for food (Spence et al., 2014). Notice how, in previous research, sensory scientists and psychologists have typically looked at the consequences of changing the visual presentation of a dish (Zellner, Lankford, Ambrose, & Locher, 2010; Zellner et al., 2011), while here, in addition to modifying the composition of the food on the plate, we merely altered the orientation in which the dish itself was presented to the viewer. Our results clearly demonstrate that orientation matters, that chef and general viewer alike prefer the appearance of this particular dish when the onions are pointing 'up'. What is more, people were also willing to pay significantly more for the dish when oriented in this manner, as compared to when the onions pointed left or down, but not compared to when they pointed toward the right.

Recently, Shen, Wan, Mu, and Spence (2015) demonstrated that the cognitive processing of food images can be influenced by incidental aspects of their visual appearance. Generally-speaking, people associate angular shapes (such as triangles) with threat (Larson et al., 2007). This is the reason why, or so it has been suggested, downward-pointing triangles capture people's attention more rapidly than other geometric forms. Geometric shapes are also implicitly associated with affective value (Larson, Aronoff, & Steuer, 2012), for example, when added to faces, they affect facial judgments (faces overlaid on downward-pointing background triangles are judged more dominant; see Toet & Tak, 2013). It is easy to imagine how, during a dining experience, the shape of the visual elements (be it on the plate, the shape of the plate itself, or other elements of the dining table) could have a role in modelling certain implicit associations that the diner makes concerning the food, the overall experience, and perhaps even act to influence people's consumption behaviour. The theory outlined here provides a possible explanation as to why it is that v-shaped objects pointed towards the diner are commonly considered as 'aggressive' in the meal setting, and hence tend to be avoided.

Moreover, people seem to prefer images that mimic certain statistical properties of low-level spatial structures found in their environment (e.g., see Palmer, Schloss, & Sammartino, 2013), with viewers generally preferring horizontal and vertical to oblique lines (Latto, Brian, & Kelly, 2000). At this point, a number of interesting questions arise as to whether those principles of aesthetic appreciation derived from studies of the visual arts (see Palmer et al., 2013, for a review) can be directly translated onto the plate (e.g., Deroy & Spence, 2014; Deroy et al., 2014; Zellner et al., 2010, 2011). Knowing whether the basic principles of aesthetics apply when it comes to the visual arrangement of food on a plate could be crucial when it comes to trying to understand optimal plating. Furthermore, most of the studies on visual aesthetic principles have been conducted within rectangular frames: With plating, there would seem to be an interesting field of visual aesthetics to explore, within the typically circular frame of the plate. Ideas such as the apparent 'power of the center' (Arnheim, 1988) and other aesthetic biases on which the viewer constructs his/her appreciation of the visual arts (Palmer, Gardner, & Wickens, 2008) might, then, help to provide some relatively straightforward guidelines for the chef when considering how to plate the elements in his dish. Culinary schools should therefore consider teaching certain basic principles of art and aesthetics, as an integral part of the skills that any chef should have.

The Internet currently offers those with the interest the opportunity to rapidly test their intuitions about the optimal way in which to plate a dish against the views of a random sample of participants. On occasion, as in the experiment reported here, the chef's intuition concerning the optimal presentation of a dish may well turn out to be shared by a random group of participants. On other occasions, they may well differ. It is under such conditions that Internet-based testing will, we believe, really prove its worth.

5.1. Limitations

It is commonly thought that participants recruited through MTurk are likely to be disinterested in the studies they take part in, thus presumably questioning the reliability of the data. In actual fact, almost all classical studies that have been attempted online have been replicated successfully (e.g., see Crump et al., 2013; Germine et al., 2012; Woods et al., Submitted) with only those requiring very fine temporal control of stimuli not entirely replicating (presumably because web browsers cannot access the information as to when their monitors refresh). Indeed, one could even argue that MTurkers are more representative of the general population than the WEIRD (Western, Educated, Industrialised, Rich, and Democratic individuals; see Henrich, Heine, & Norenzayan, 2010) who typically take part in psychological research (e.g., Behrend, Sharek, Meade, & Wiebe, 2011) and who have been argued to be sometimes rather disinterested in the studies that they take part in (Oppenheimer, Meyvis, & Davidenko, 2009). Furthermore, we found the exact same pattern of results in Experiment 3 conducted in collaboration with London's Science Museum (both online people and visitors to the museum's 'Antenna Gallery'), supporting the idea that the data gathered via MTurk is trustworthy. One of the reviewers of this article did raise the possibility that some participants may have used software tools to automatically complete the task in Experiment 1. Reassuringly, none of the participants completed the studies in unrealistically short periods of time (all did so in over 49 s, whereas it would take a tool mere moments); indeed, it is likely that the effort required to build a custom tool to interact with our custom experimental task would exceed many times the total amount of the potential monetary compensation. The above issues form the backbone of a tutorial-review on Internet testing that some of us are preparing (Woods et al., Submitted).

Diners generally assess the visual properties of a food when it is presented in front of them, lying flat on the table. We could assume that the visual evaluation of the food happens on a horizontal three-dimensional plane (if we also consider the height of the food). In this study, participants were asked to assess food images instead of real food, and, in addition, those images were presumably presented on a vertical two-dimensional plane (a computer screen). One might therefore wonder whether the same results would be obtained when, instead of considering 'away vs. toward' orientation (as happens with a dish served in front of us on the table in a restaurant), judgments are based on 'up vs. down' orientation instead (as may have happened for those viewing the images on a standard computer screen).

It would seem reasonable to assume that these studies would be relatively more naturalistic if food images were presented on a tablet placed in front of the participant, or, even better, assessing the impact of plating on ratings of the food during a real eating experience, in a naturalistic setting (see Michel et al., 2015, for a methodological example that could deliver more ecologically-valid results). Obviously, though, this would make this methodology much more difficult to test on large population samples, using online tools such as those advanced here. Perhaps, in the future though, three-dimensional digital models of the plate of food could be used. However, it is possible future research will reveal that this putative difference in orientation may, in fact, have little impact on the patterns of results that are obtained.

6. Conclusions

In this study, we report a novel Internet-based testing methodology designed to assess the impact of different visual orientations of a commercially-successful dish (served in a Michelin-starred restaurant) on people's preferences, and willingness-to-pay. The results suggest that if the food has an explicit point or angle, the dish will be preferred if oriented pointing 'away' from the diner. What is more, people would appear to be willing to pay more for the optimally oriented dish. When asked to rotate the food image, the analysis of people's responses using circular statistics suggested that it is the orientation of the single elements, rather than the orientation of the Gestalt formed by the food's visual composition, that would contribute to establishing these preferences. Data collected at a citizen science experiment ($N = 1667$) using the same food image and experimental design strongly support our hypothesis.

The visual shapes that are presented during a dining experience, and their orientation on a two-dimensional plane, could have an important role in modelling certain implicit associations that the diner would have concerning the food, potentially affecting the pleasure elicited by its consumption. While the visual preferences advanced here still have to be proven effective in a realistic dining setting, it seems that thinking about the optimal visual composition of food on a plate could enhance our everyday food experiences. Furthermore, it seems as if studying visual preferences on a round frame could deliver relevant insights to the study of visual aesthetics.

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