

RUNNING HEAD: JASTROW'S BISTABLE BITE: VISUAL PERCEPTION MEETS
THE CULINARY ARTS

“Jastrow’s Bistable Bite”: What happens when visual

Bistable illusion meets the culinary arts?

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ABSTRACT

We report on the creative process underlying the development of an edible version of Jastrow's (1899) famous bistable duck/rabbit illusion. The culinary research team at Kitchen Theory took this well-known visual illusion as the inspiration for the creation of a new dish using both duck and rabbit as key ingredients. A simplified version of the illusion was stencilled onto the plate and a 'crispy dumpling' of confit duck and rabbit leg placed to one side. We report the results of a large-scale online study designed to assess the visual percept elicited on first viewing the edible version of "Jastrow's Bistable Bite" dish. We assessed whether the orientation in which the dish is presented initially would influence the percept that dominates initially. The results revealed that when served in certain specific orientations the two interpretations – duck and rabbit – were roughly equally dominant. Hence, serving the dish to the diner in one of these specific orientations is likely ideal for generating discussion at the dinner table around the role of vision in multisensory flavour perception. The hope is that the introduction of this dish onto the menu can be used to promote a sustainability message (given that many people believe that we should be eating more rabbit than is currently the case).

KEYWORDS: BISTABLE PERCEPTION; VISUAL ILLUSIONS; CULINARY CREATIVITY; CHEMICAL SENSES; FLAVOUR PERCEPTION; SUSTAINABILITY; GESTALT.

Introduction

One of the classic demonstrations of bistable perception from the psychology literature is shown in **Figure 1**. This visual illusion, which comes in a variety of forms, was first popularized by Jastrow, a North American experimental psychologist, at the end of the 19th Century (see Jastrow, 1899; see also Farand, 2016).¹ Bistability (or multistability) is a phenomenon whereby two (or more) interpretations can be perceived on the basis of a single sensory input. These different perceptual interpretations normally flip back and forth over time. Leopold and Logothetis (1999) established three fundamental properties common to all forms of multistable alternation: Exclusivity, inevitability and randomness. Exclusivity refers to the fact that conflicting representations are not present simultaneously in awareness; Inevitability refers to the fact that the observer will automatically shift from one possible interpretation to the other; And randomness refers to the unpredictability of the duration of each perceptual interpretation (though note that average statistics can, and have, been computed; e.g., see Pöppel, 1988, pp. 55-58).

If ever there was a visual illusion that was ‘kitchen-friendly’ it is the duck/rabbit! From the chef’s perspective, duck and rabbit undoubtedly combine well as ingredients. Indeed, both animals live happily side-by-side in nature as they do in gastronomy: That includes everything from classic French game terrines to pies (e.g., Knowles, 2007; see also Duffin, 2014; Fearnley-Whittingstall, n.d.), and duck & rabbit rillettes. Indeed, given how little fat there is on rabbit (and hence a tendency to get too dry and chewy when cooked) it is common practice to confit the tougher cuts (like the legs) in duck fat. The use of rabbit also appeals in terms of promoting a more sustainable approach to cuisine.

¹ Though, in fact, the first version is an unattributed drawing from an issue of *Fliegende Blätter*, a German humour magazine published in Munich, Germany (October 23, 1892, p. 147; see Kihlstrom, n.d.). Shortly thereafter it reappeared in *Harper's Weekly* (November 19th, 1892, p. 1114).

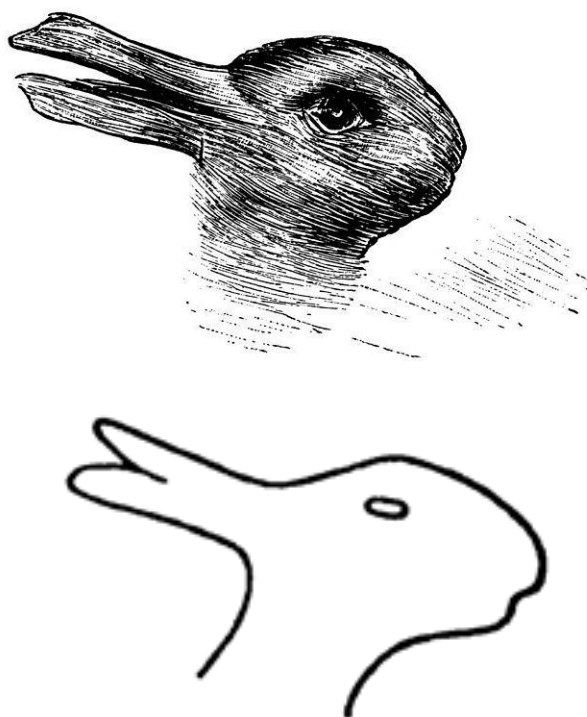


Figure 1: Two versions of the classic duck/rabbit bistable percept. Top: Jastrow's (1899) original image; Below, Wittgenstein's (1953/1958) simplified version of the illusion. On first encountering such visual stimuli, people normally interpret what they see as showing either a duck or a rabbit. Thereafter, once both interpretations have been recognized, most people can flip back-and-forth between the two possible interpretations at will. Note, however, that you can only see one animal at any given time.

In the age of growing concerns about sustainability, rabbit is currently being flagged-up as a more sustainable source of meat than many other, currently more popular, sources of protein (e.g., see Adler, 2014; Theau-Clément, Guardia, Davoust, Galliot, Souchet, Bignon, & Fortun-Lamothe, 2016). Future foods (including those ingredients deemed nutritious and sustainable for future generations) really ought to be a part of the interest of any gastrophysicist (see Spence, 2017). This is especially true when looking to understand how foods which are less commonly available in a local market, or as part of a local cuisine, especially those that may have kind of negative association (e.g., jellyfish, insects; Deroy, Reade, & Spence, 2014; Duggins, 2017) or alternative categorization

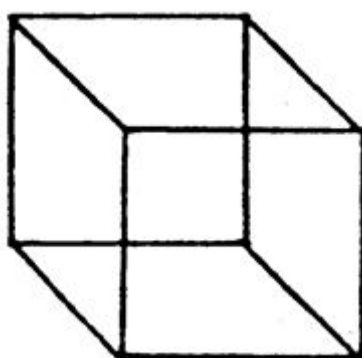
(think only of how rabbits are seen as pets in the UK, whereas in Spain and Egypt they are considered as an everyday culinary ingredient; Hylton, 2012), can be introduced into the diet. Given the above, anything that can be done by means of playful interaction to draw people's attention to this rather more sustainable source of meat can be no bad thing.

Over the years, researchers working in the field of visual perception/illusions have studied the duck/rabbit illusion extensively (e.g., Brugger, 1999; Brugger & Brugger, 1993; Chambers & Reisberg, 1985). Brugger, for instance, assessed the relative ease with which people could flip their interpretation of the various versions of this illusion that have been put forward over the years. Importantly, Wittgenstein's (1953/1958) version of the illusion (shown in **Figure 1**) displayed a satisfactory degree of bistability.² Meanwhile, Chambers and Reisberg investigated whether those who are thought to be more creative (e.g., designers and architects) would be any better at seeing the alternative interpretation on the basis of their mental image of a briefly-flashed version of the stimulus. As it turns out, they were not.

The Necker cube (see **Figure 2**) is another classic bistable visual image. This lattice structure flips back and forth regularly between two possible interpretations (see Necker, 1832). Famous chefs such as Heston Blumenthal have been intrigued by the relation between, or implications of, such ambiguous visual stimuli, permitting as they do of multiple interpretations, for the perception of flavour. Just take the following quote from Blumenthal's classic volume, *The Big Fat Duck Cookbook* to illustrate: *"If you stare at a drawing of The Necker cube two possible perspective interpretations present themselves – a cube with the front, top and right-hand face on view; or one of which the front, base*

² One other intriguing aspect of the duck/rabbit illusion is that people are apparently 15-20% more likely (based on visual inspection of Brugger and Brugger's, 1993, results graph) to see a rabbit first at Easter, while in Autumn (e.g., in October) a duck is more commonly seen first (see also Vaught, Simpson, & Roodin, 1971).

105 *and left-hand face can be seen. The brain flips between the two interpretations...That*
106 *flipping between two perspectives continued to fascinate me, especially once I began*
107 *investigating how the brain makes sense of the sensory data it gets from the food we eat."*
108 (Blumenthal, 2008, p. 237).



109
110 **Figure 2:** Necker's (1832) cube. This is another classic visual image that
111 supports bistable perception. Were there to be an equivalent phenomenon in
112 the chemical senses then this might lead to the development of intriguing new
113 dishes.

114
115 Here, it is worth noting that the very experiencing of a Gestalt, what Muth and Carbon
116 (2013; see also Muth, Pepperell, & Carbon, 2013) memorably refer to as the 'Aesthetic
117 Aha', is likely to exert a positive influence over the diner's liking for the food (not to
118 mention their enjoyment of the dining experience) – i.e., over-and-above their gustatory
119 pleasure. Muth, Carbon and their colleagues have demonstrated this kind of positive
120 carry-over effect in those exposed to challenging examples from the visual arts, including
121 cubist paintings by the likes of Picasso, Braque, and Gris. Indeed, informal observation
122 of the diners as they struggled to interpret 'The Picasso dish' (as described by Spence &
123 Youssef, 2016) suggested that when the latter finally 'saw' Picasso's half portrait
124 stencilled in beetroot on the plate it was a rewarding and enjoyable experience.

That being said, the context in which such dishes are served may well matter. It is easy to imagine how the modernist restaurant may provides a more receptive backdrop for such 'effortful' food experiences than other, more traditional, dining environments (see Spence & Piqueras-Fiszman, 2014; Velasco, Michel, Youssef, Gamez, Cheok, & Spence, 2016). What is more, even if the diner, or museum-goer, doesn't experience the Aha moment, such challenging culinary or visual stimuli can nevertheless still prove rewarding because they trigger what Muth, Carbon, and their colleagues refer to as semantic instability [so called SeIns] (Muth & Carbon, 2016; Muth, Hesslinger, & Carbon, in press).

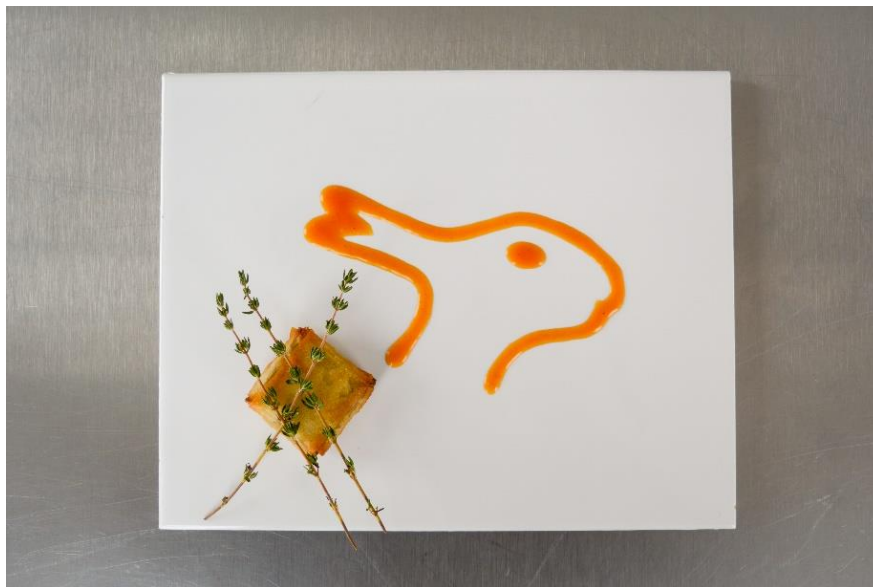
On the development of the "Jastrow's Bistable Bite" dish

For the preparation of the dish, we researched the different textures obtained from rabbit and duck parts, soon coming to the realization that the tougher parts of both meats (the leg), when slow-cooked take on a similar tender yet meaty texture and mouthfeel.³ All texture/colour differences are eliminated by cooking the meats till they have a similar texture and then wrapping the meat in a parcel (see **Appendix** for details).

The idea is that the dish (see **Figure 3**) will be introduced by the host who will start by saying: *"Here is a small bite going by the name 'Jastrow's Bistable Bite'. I would like you to look at the image that you see on your plate and think about which animal you see. Then, I would like you to go ahead and enjoy this little savoury morsel while you think*

³ By opting to pair the rabbit with another slightly more common and appreciated meat such as duck this may also allow the diner to feel more at ease with the notion of eating rabbit (cf. Pliner & Stallberg-White, 2000; Stallberg-White & Pliner, 1999). This is something that needs to be considered carefully for the chef's table, where the menu is set (save only for a few dietary/allergy exceptions). Despite there being a marginal 'trend' among middle class British 'foodies' with eating rabbit (Price, 2014), both rabbit and duck are relatively uncommon here in the UK, especially when looking at home cooking (duck is a little more popular in restaurants).

145 *about what you are eating. Let's see if we can't all agree?"* Unbeknownst to the diner,
 146 the small dish consists of a confit duck and rabbit leg 'crispy parcel' served with a spiced
 147 blood orange sauce stencilled onto the plate in the shape of Wittgenstein's (1953/1958)
 148 simplified duck/rabbit illusion. At first, the diners will not be entirely sure what they are
 149 eating, since the identity of the ingredients will deliberately not be revealed in the
 150 naming/introduction/description of the dish. The diners will be encouraged to focus on
 151 the dish, spending a moment deciphering the image on their plate, before they start to
 152 eat.⁴



153
 154 **Figure 3:** The 'Jastrow's Bistable Bite' dish.
 155

156 The aim of this research project was to investigate whether a popular visual illusion could
 157 be meaningfully used as a basis for developing a dish to be served at the Gastrophysics
 158 chef's table - a 13-course multisensory dining experience for 10 guests hosted at Kitchen

⁴ One can think of this in terms of mindful dining (see Hong, Lishner, Han, & Huss, 2011). Our aim is to make the diner think about what they are eating, and where it came from. That said, it remains an open question as to how good would diners be at identifying confit rabbit vs. confit duck meat in a forced-choice situation (cf. Schiffman, 1977).

Theory's Odyssey Studio (www.gastrophysics.co.uk). Having created a tasty dish that had the requisite visual ambiguity (see **Figure 3**), one question the culinary team at Kitchen Theory had was whether it mattered whether the outline pointed to the left or to the right. Some years ago, Peter Brugger (1999) had conducted some preliminary work on 12 versions of the duck/rabbit illusion (cf. Wade, 1974), however it seemed most sensible to assess the question with this specific plating and image design.



Figure 4: 'Jastrow's Bistable Bite'. Based on the diner's perspective of the dish, and the orientation in which it is placed before the diner, their initial visual impression of there being an image of a duck or rabbit on the plate might differ.

The primary hypotheses concerning the likely pattern of results was that the orientation in which the food in the dish was presented would systematically impact whether participants initially saw a duck or a rabbit. As the plating arrangement moved from a prototypical duck orientation (with the beak horizontal) to a prototypical rabbit orientation (with the ears, i.e., the same element of the image that constitutes the duck's beak, pointing upwards) we should likewise expect the percentage of participants who report seeing a duck to decrease in favor of the rabbit interpretation.

We also decided to test for the impact of inverting the images, with the speculation being that inverted images would disrupt the normal perception of rabbits and ducks, as found with the extensive literature on holistic face perception (e.g., Maurer, Le Grand, &

Mondloch, 2002; Savig & Bentin, 2001) and the Thatcher Illusion (Thompson, 1980) and with a range of non-face objects across humans and monkeys (Parr 2011). Indeed, one can perhaps ponder whether the face aspect of our animals (a duck or rabbit) would make them susceptible to the same phenomena that affect face processing (e.g., as found with dog experts for canine faces, see Diamond & Carey, 1986).

Methods

Participants

982 people from the United Kingdom, the United States, Ireland, or Canada were recruited on Prolific Academic to take part in this study in exchange for £0.30. The participants. The average age was 35.6 years (standard deviation 12.2), 576 individuals were female (406 male) and 118 were vegetarians.

Stimuli, apparatus, design and procedure

Steps were taken to try to ensure this study was conducted on desktop computers (via the 'current-device' JavaScript package <https://github.com/matthewhudson/current-device>). A between-participants experimental design was used (as prior exposure to the stimulus might be expected to influence a participant's subsequent ratings). Each participant saw one randomly-chosen image (see **Figure 5**). The participant's task was to report whether they saw a duck or a rabbit (see **Figure 6**) by clicking on one of two buttons (the buttons occupied either the left or right position as shown in the figure – note that this was set randomly for each participant). In two subsequent randomly-ordered trials, the participants answered the following questions: "Do you like to eat rabbit?" and "Do you like to eat duck?" The participants responded using VAS scales (labelled 'It is disgusting',

‘Undecided’, ‘It is delicious’; the results of which were recorded as percentages). The participants took an average of just under 1 minute to complete the study.

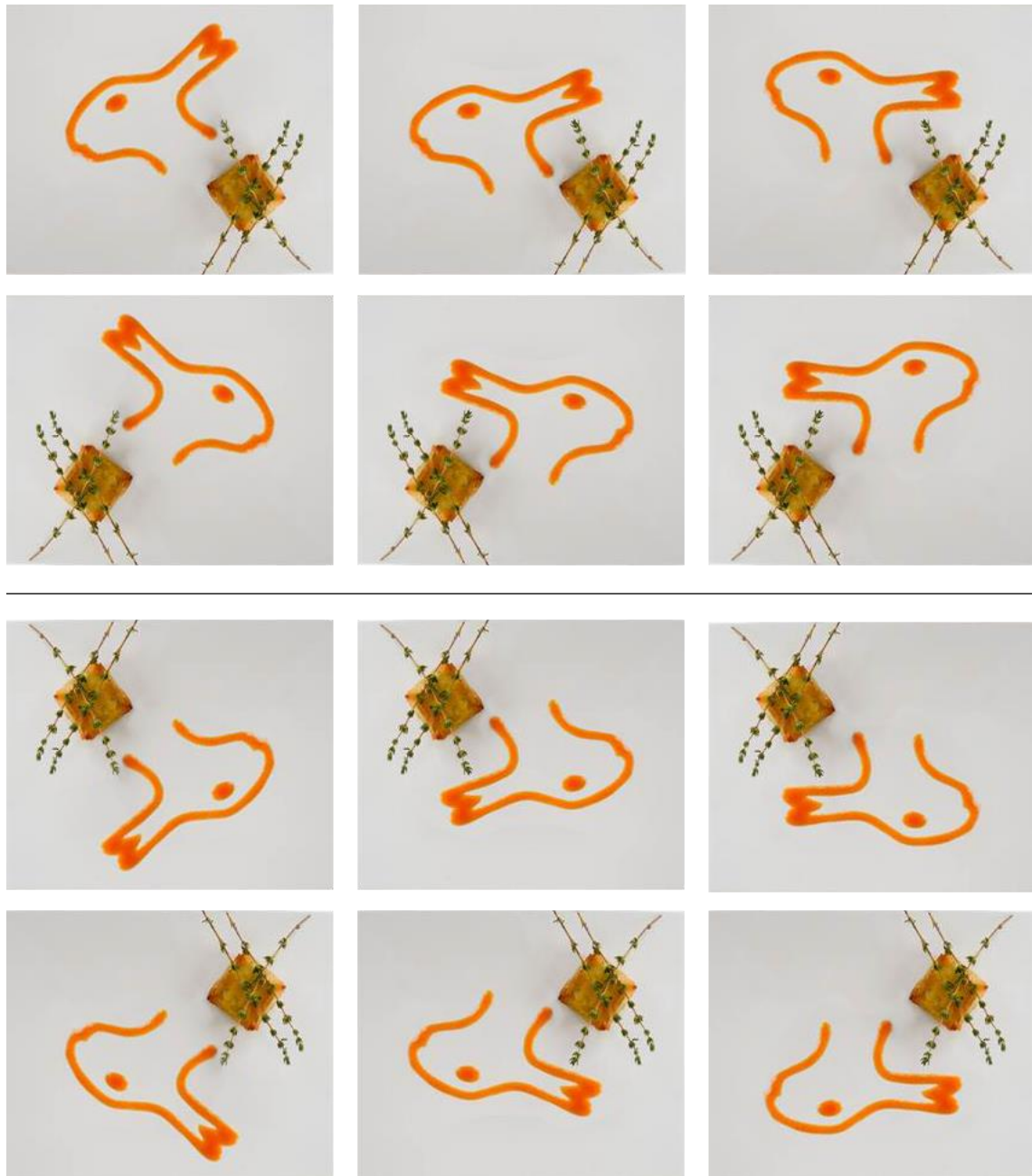


Figure 5: The 12 possible visual images (plating orientations) shown to the participants in the present study. Note that each participant only saw one of the images. The lower 6 images have been inverted. Note also that going from left-to-right the duck/rabbit part of each image is rotated clockwise by 20 degrees.

Please let us know the first animal that came to mind when you saw the image below.



Figure 6: Screenshot from the online experiment.

Results

The results are shown in **Figure 7** and **Table 1**.⁵ 95% continuity-corrected binomial confidence intervals were calculated for each condition. The results revealed that all except two conditions (highlighted with a striped pattern in the figure) differed from that expected by chance (where confidence intervals overlap with 50%), in terms of how often a given image was labelled as looking like either a duck or a rabbit. Visual inspection of **Figure 7** clearly shows that the ‘inverted’ images were significantly more likely to be classified as looking like a duck than the right-way-up images across all conditions. As hypothesized in the Introduction, this is likely because upright interpretations of either

⁵ Subsequent analysis of the data as a function of whether the participant was a vegetarian or not revealed no significant differences, and hence are not discussed in the main text.

animal likely have a slight advantage over the inverted interpretations of the same animals.

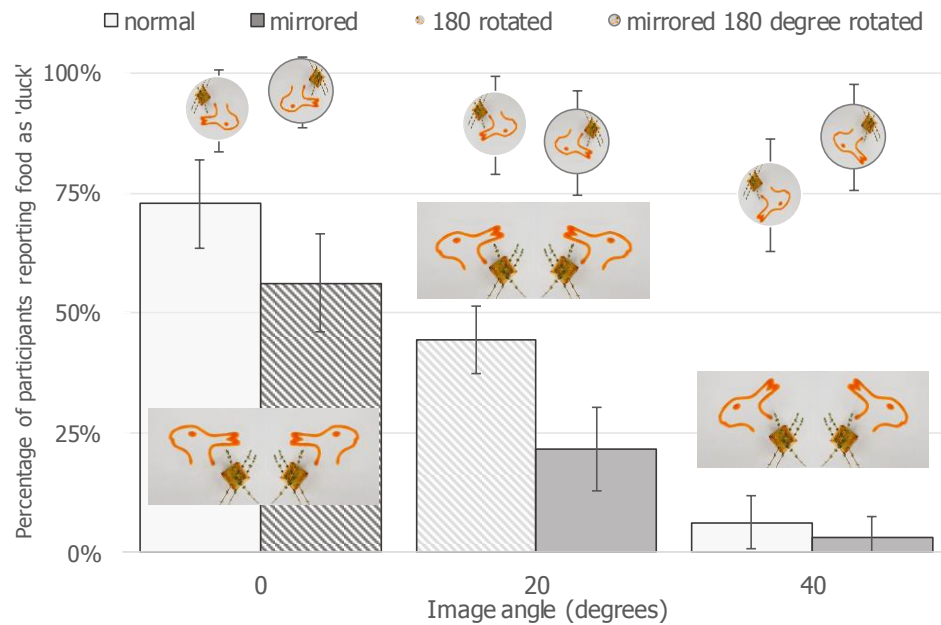


Figure 7: Mean probability of the initial percept being 'duck' as a function of the orientation and reflection of the dish. 95% continuity corrected binomial confidence intervals are shown. A striped pattern indicates those two bars whose confidence intervals overlapped 50%.

Participants' VAS ratings for whether or not they liked to eat duck or rabbit was median split into those who liked or disliked to eat either or both foods. The data for the regular and inverted presentation of the dish was combined, and then separated into 4 groups based on duck and rabbit median split liking. The hypothesis being that people might be more likely to see the animal on the plate that they preferred to eat. However, as can be seen in **Figure 8**, there was no obvious difference in scores for these four groups (that is, those participants who reported liking duck but disliking rabbit were no more likely to report 'duck', on average, than those who reported liking rabbit but disliking duck).

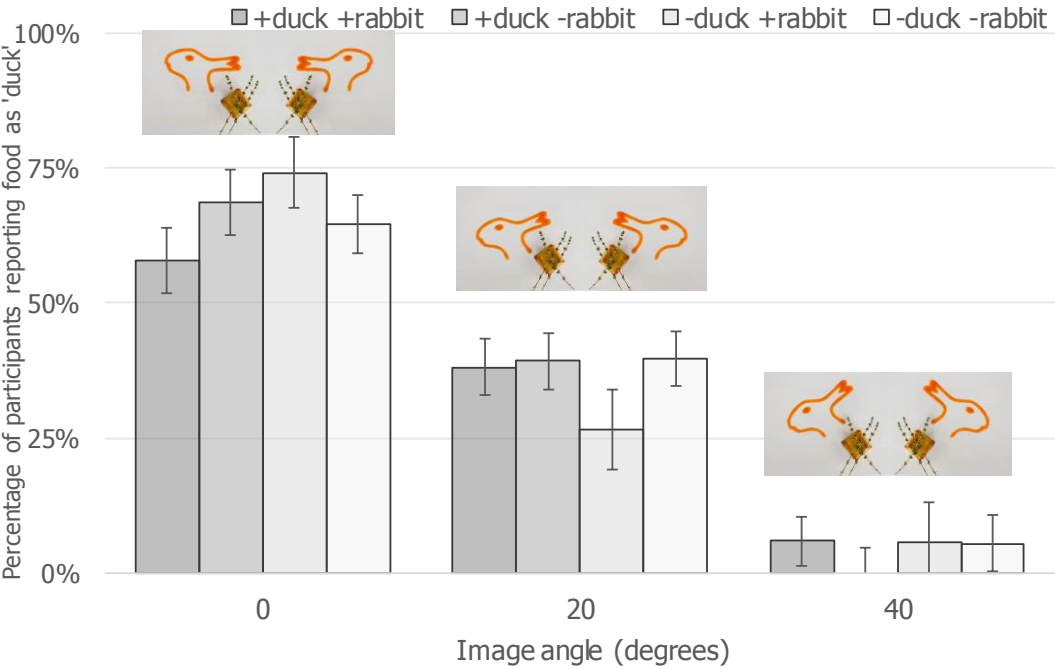














Figure 8: Split by whether participants liked duck and/or rabbit (+ = like, - = dislike), mean probability that the initial perception is a duck as a function of the initial orientation and reflection of the dish. 95% continuity corrected binomial confidence intervals are shown.

Table 1: Summary data from the experiment. [*Experimenter error led to double the number of participants being collected in this condition, respective to other ‘normal side up’ conditions.]

Image	N	Orientation	Mirrored	Inverted	% participants reporting duck (95% CI)
	99	0	FALSE	FALSE	72.7% (62.7%, 81.0%)
	203*	20	FALSE	FALSE	44.3% (37.4%, 51.5%)

	95	40	FALSE	FALSE	6.3% (2.6%, 13.8%)
	96	0	TRUE	FALSE	56.3% (45.8%, 66.2%)
	97	20	TRUE	FALSE	21.6% (14.2%, 31.4%)
	95	40	TRUE	FALSE	3.2% (0.8%, 9.6%)
	51	0	FALSE	TRUE	92.2% (80.3%, 97.5%)
	46	20	FALSE	TRUE	89.1% (75.6%, 95.9%)
	59	40	FALSE	TRUE	74.6% (61.3%, 84.6%)
	48	0	TRUE	TRUE	95.8% (84.6%, 99.3%)
	48	20	TRUE	TRUE	85.4% (71.6%, 93.5%)
	45	40	TRUE	TRUE	86.7% (72.5%, 94.5%)

250

251 **Discussion**

252 The results of the present study demonstrate that the orientation in which “Jastrow’s

253 Bistable Bite” is presented affects the dominant percept on first viewing the dish. Our

results also demonstrate that there are certain orientations in which to present the dish to the diner in order to deliver a visual stimulus maximally ambiguous (these conditions are shown with striped shading in **Figure 3**). It will, in future research, be intriguing to determine whether the initial percept on viewing this dish ends-up influencing the dominant taste/flavour reported on sampling the dish.

In passing, it is also worth noting that the online study reported here was conducted in October. This may turn out to be relevant given Brugger and Brugger's (1993) earlier findings (see also Vaught et al., 1971), suggesting that people viewing the ambiguous visual stimulus are more likely to report the 'rabbit' at Easter, with this bias being reduced in October. However, only time will tell whether a similar bias affects observers/diners when presented with "Jastrow's Bistable Bite" dish at different times of year.

It can be argued that the edible version of the duck/rabbit illusion provides yet one more example of the emerging interaction between psychological and culinary science (see Spence, 2017). We believe that the development of this new dish will potentially enable an engaging dish/dining experience, one around which stories can be told, and a message of sustainability and the popularization of science hopefully be interweaved.⁶ Indeed, one of the goals at Kitchen Theory is to create discussion at the dining table – both between the chefs and the diners they serve, but also amongst the diners themselves. We firmly believe that one innovative way to do this is by creating ambiguous situations, such as by serving an edible version of the duck/rabbit illusion as developed here. And, no matter whether or not the perceived taste/flavour of the dish ultimately turns out to be biased by the initial, or switching, visual interpretation of the outline figure drawn on the plate, the

⁶ Jastrow would, we believe, have appreciated this approach to making his illusion edible, given his interest in popularizing science (<http://onwisconsin.uwalumni.com/features/mind-tricks-for-the-masses/>; Blumenthal, 1991).

challenge experienced by the diner in initially establishing the Gestalt (of seeing the animal on the plate) will likely enhance the diner's pleasure in the dish (see Muth & Carbon, 2016; Muth, Hesslinger, & Carbon, in press). But however the results of this follow-up research turn out, its presentation is, we believe, likely to generate conversation at the dinner table concerning the role of vision (and sensory expectations) in multisensory flavour perception (cf. Velasco et al., 2016). Moreover, we will hopefully also be able to encourage the diner to be a little more mindful about what they are eating, both in terms of the flavours involved, but also with regard to issues such as sustainability.

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Appendix: 'Jastrow's Bistable Bite' Recipe

Confit duck leg

Ingredients	Process
<ul style="list-style-type: none"> - 1 duck leg - 50 g of duck fat - Thyme - 1 sous-vide bag - Steam oven - Salt - Pepper 	<ul style="list-style-type: none"> - Season the duck leg with salt and pepper. - Place the duck leg inside the bag together with the duck fat and thyme. - Vacuum and seal the bag. - Cook at 80 °C for 16 hrs (to get a meat tender and fall-off-the-bone).

Confit rabbit leg

Ingredients	Process
<ul style="list-style-type: none"> - 1 rabbit leg - 50 g duck fat - Thyme - Sous-vide bag - Steam oven - Salt - Pepper 	<ul style="list-style-type: none"> - Season the rabbit leg with salt and pepper - Put the rabbit leg inside the bag together with the duck fat and thyme. - Vacuum and seal the bag. - Cook at 66 °C for 8 hrs.

Blood orange sauce

Ingredients	Process
<ul style="list-style-type: none"> - 500 g of blood orange juice - 50 g of sugar - 15 g of vinegar - 30 g of rum - 2 g of salt - 0.5 g of cloves - 0.5 g of thyme - 0.5 g of cinnamon - 50 g of duck fat - 3 g of garlic - 12 g skin of blood orange - 1 g of xanthan - 0.5 g of ultratex - Pot - Hand blender 	<ul style="list-style-type: none"> - Melt sugar in a pot until one gets a blonde caramel. - Add rum and reduce. - Add vinegar and blood orange juice and let it reduce by half. - Infuse the duck fat with the spices (cloves, thyme, and cinnamon) and garlic. - Once the sauce has reduced by half, strain the duck fat and add it to the sauce in order to texturize and add brightness to it. - Finally, texturize with xanthan and ultratex.

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Ingredients	Process
<ul style="list-style-type: none">- Veal Bones- Duck and rabbit Bones- Kombu- Dry shitake mushroom- Carrots- Onion- Celery- Black Peppercorns- Bay Leaf- Thyme- Red Wine- Water- Mole Negro- Yeast extract- Corn Flour	<ul style="list-style-type: none">- Soak the Kombu and shitake mushroom in water for 4 hrs- Chop the bones and all the vegetables and roast it separatley in trays in the oven at 200 °C till they caramelise nicely.- Discard the excess of fat and add the bones and the veg in the kombu water with the spices and the herbs.- Set the stove at 8 and cook down to 6.5 Kg.- At this point filter the jus from the solids and reduce it down to 4.0 Kg.- Then season it with mole and kokumi and thicken it a little with cornflour.- Reduce it again to 3.2 Kg.

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389 **Process**

390 23 g of the pulled confit duck and rabbit leg meat terrine were coated in a rich duck and
391 rabbit reduction (with veal knuckle for natural added gelatine). It is set in a shallow (1.5
392 cm depth) square 4x4 cm mould, and more of the reduction is poured into the mould,
393 before being frozen. Once set, the duck and rabbit terrine is coated in egg white and
394 semolina before being wrapped carefully in a filo pastry parcel (see **Figure** below), ready
395 to be fried until golden and crispy. This is then presented on the dish along with the blood
396 orange sauce, stencilled on to the plate.

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