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Haptic exploration of plateware alters the perceived texture and taste of food

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ABSTRACT

We report two naturalistic citizen science experiments designed to highlight the influence of the texture of plateware on people's rating of the mouthfeel and taste of food (specifically, biscuits) sampled from that plateware. In the first experiment, participants tasted a biscuit from a pair of plates, one having a rough and the other a smooth finish. In the second experiment, participants tasted biscuits and jelly babies; participants rated the mouthfeel and taste of the two foodstuffs. The results both confirm and extend previous findings suggesting that haptically and visually perceived texture can influence both oral-somatosensory judgments of texture as well as, in this case, the reported taste or flavour of the food itself. The crossmodal effects reported here are explained in terms of the notion of *sensation transference*. These results have potentially important implications for everything from the design of the tactile aspects of packaging through to the design of serviceware in the setting of the restaurant.

1. Introduction

There is now growing evidence that the oral-somatosensory attributes of what we eat and drink can influence our perception of flavour (e.g., Bult, de Wijk, & Hummel, 2007), and even satiety (e.g., Hogenkamp, Stafleu, Mars, Brunstrom, & de Graaf, 2011). However, an equally important topic that has received far less attention, at least thus far, is whether haptically-perceived (i.e., as experienced by the hand) texture, be it the texture of the food (Barnett-Cowan, 2010), or the packaging in which the food or beverage is presented (Krishna & Morrin, 2008; Piqueras-Fiszman & Spence, 2012), or even the feel of the plateware or cutlery used to eat a meal (see Spence, Hobkinson, Gallace, & Piqueras-Fiszman, 2013; Spence & Piqueras-Fiszman, 2014), can also impact our experience of food and drink.

Especially relevant in this regard is a study conducted by Barnett-Cowan (2010). He had blindfolded participants rate the freshness/staleness and the crispness/softness of a series of pretzels while biting into either the fresh or stale end of a pretzel. The congruency between the tactile information provided to the participants' hand and that provided to their mouth was manipulated. In half of the trials, the participants were given a half-fresh/half-stale pretzel, whereas in the remainder of the trials, they were given either a whole fresh or whole stale pretzel. The most interesting results were in the incongruent condition where the stale part of the pretzel was rated as being significantly fresher and crispier in-mouth because the hand held what felt like a fresh pretzel, and vice versa when holding the stale end. Such results therefore clearly suggest that the perceived in-mouth texture of a dry food product can be altered simply by changing the haptic information provided to the consumer's hands. While intriguing, these results are perhaps not so surprising given that the participants were feeling what they presumably took to be the food in their mouth. What is more surprising, therefore, are those studies suggesting that the feel of the non-food items can also influence our perception of food while eating.

Suggestive evidence in this regard comes from a study by Piqueras-Fiszman and Spence (2012b).[1] These researchers demonstrated that people ($N = 58$) rated pieces of stale or fresh digestive biscuit served from a small plastic yoghurt pot as tasting both significantly crunchier and significantly harder when the packaging had been given a rough sandpaper finish, as compared to when exactly

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[1] We have also heard anecdotally that if you were to hold a handful of gravel in one hand then you would end up rating a sample of ice-cream as tasting grittier than if you were to grasp a handful of cotton wool instead (see Spence & Piqueras-Fiszman, 2014, p. 124).

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the same food was served from a container with the usual smooth plastic feel of a yoghurt pot. That said, although the feel of the container influenced people's perception of a dry food product, it had no effect on their ratings of the yoghurt. As such, Piqueras-Fiszman and Spence argued that further research was needed in order to understand the limiting conditions on this particular effect (i.e., the effect of what people hold, specifically the texture, on what they taste or experience).

Elsewhere, Krishna and Morrin (2008) conducted an intriguing between-participants study in which they investigated the impact of the feel of the container (a plastic cup) on people's perception of water mixed with Sprite. Their study was conducted in a university cafeteria where 180 people evaluated the drink after having tasted it using a straw. Half of the participants touched the flimsy cup in which the drink was contained with their hand before evaluating it, whereas the rest did not. Those participants who exhibited less of a need for touch[2] were affected in their evaluation of the drink by the feel (i.e., the firmness vs. flimsiness) of the cup, whereas those participants who scored lower in terms of their need for touch were not. The participants rated the drink as being lower in quality when they felt the cup's flimsiness. These results clearly suggest that changes in the haptic qualities of the receptacle in which a drink is served might have different effects on different people depending on their general liking for haptic input.

Consistent with these findings, the results of a very recent study by Tu, Yang, and Ma (2015, Experiment 1) demonstrated that participants gave a higher rating of the perceived iciness and coldness of a cup of Chinese tea when presented in a glass container than in a plastic or paper container (of approximately the same size). Such results therefore suggest that changes in the haptic qualities of the glass, cup, or any type of container in/on which a food is served, might have important effects on a consumer's appraisal of the quality of the product within, not to mention on their global experience of the food.

Summarizing what we have seen thus far, it would appear that what people hold in their hand, even if it is the non-eating hand, can influence their estimates of the sensory properties of the foods eaten with the other. But how should such robust, yet surprising, crossmodal effects be explained? One suggestion that has been put forward here is in terms of the phenomenon of *sensation transference* (Cheskin, 1957), or what Spence and Gallace (2011) refer to as *affective ventriloquism*, when the transference concerns specifically our hedonic ratings. The basic idea is that a person's thoughts and feelings about a product extrinsic sensory cue can carry over to influence what they say, or think, about other product intrinsic cues that they have been asked to evaluate. In recent years, a number of examples of such sensation transference effects have been reported in the literature (see Gallace & Spence, 2014; Spence & Piqueras-Fiszman, 2014, for reviews). Sensation transference can also occur as a result of the weight of the package, plate, or cutlery we hold in our hand(s), while eating or drinking (Kampfer, Leischnig, Ivens, & Spence, submitted; Michel, Velasco, & Spence, 2015; Piqueras-Fiszman, Harrar, Roura, & Spence, 2011).

In the present study, data was collected from a number of public science events in order to try and both replicate and extend Piqueras-Fiszman and Spence's (2012) findings using a much larger sample of participants (note that they only tested 58 participants). Here, we thus report the results of tests conducted on a far greater number of participants ($N = 695$ in total, across 2 experiments). Acquiring additional evidence concerning the impact of felt texture on the experience of food is clearly of growing relevance, given the increasing number of chefs, artists, and designers interested in utilizing different materials and/or textures in their plateware, cutlery, even the texture of the restaurant seat itself (see Spence & Piqueras-Fiszman, 2014; Stuckey, 2012).

2. First series of citizen science experiments

2.1. Methods

2.1.1. Participants

184 participants took part in this experiment. An additional group of 470 participants was also tested over several science fairs in the UK (including The Big Bang Science Fair, Bestival, The BBC Bakes and Cakes Events, and The BBC Good Food Show). The participants consisted of people of all ages. The data were collected by Flavour SenseNation, UK. Ethical approval to collect citizen science data of this sort had been obtained.

2.1.2. Materials, procedure, and design

Small groups of up to 4 participants were asked to eat a piece of biscuit (Lotus biscuits, Lotus Bakeries) presented on two plates of the same shape. One plate had a rough and grainy surface texture, whereas the other was smooth and shiny, see Fig. 1. The participants were asked to feel the surface of the plate while they consumed a piece of biscuit from each of the plates. A within-participants experimental design was used: That is, each participant sampled a piece of biscuit from both the smooth and rough plates. The participants were requested not to make any comment until they had performed this task with both plates (to avoid influencing anyone else in the group). The participants were instructed to think about the mouthfeel and the taste of the biscuit while they performed the task. Once they had completed the task, the participants answered the following questions for the biscuit sampled from each of the plate: 'When touching the 'rough'/'smooth' plateware, how did the biscuit *feel* in your mouth?' and 'When touching the 'rough'/'smooth' plateware, how did the biscuit *taste*?' The participants were also asked 'Was there a difference in the mouthfeel/taste of the biscuits, when touching the 'rough' and 'smooth' plateware?' Those who answered in the affirmative were then prompted to describe the difference. For each of the plates (rough vs. smooth), we collected estimations of the biscuit mouthfeel and the biscuit taste. For the experimental study, the answers to the questions were open and logged by the experimenter into categories. The participants in the festival session had several predefined choices for their answers (see Fig. 3 for details).

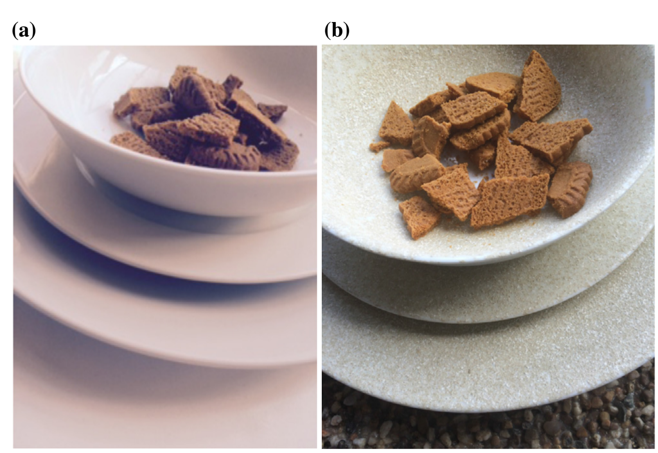

Fig. 1. Examples of the smooth (a) and rough (b) plates used in the first series of experiments.

[2] Peck and Childers (2003a,b) developed 'the need for touch' scale. It consists of a series of questions, and appears to successfully segment populations in terms of how much they like to acquire/use tactile information when making decisions.

2.1.3. Data analysis and results

Each of the mouthfeel and taste estimates were analyzed with Bowker–McNemar tests for symmetry (see Bowker, 1948). Frequencies of the experimental data collected in the lab are presented in Fig. 2, while Fig. 3 depicts data collected from the series of public science events. The results indicate that the texture of the plate influenced people's estimations of the biscuit's mouthfeel, $B(10) = 88$, $p_{two\text{-}tailed} < .001$. Post-hoc tests indicated that the participants perceived the biscuit as being both crunchier, and rougher, when tasted from the rougher plate, as compared to when tasted from the smoother plate; Conversely, the participants described the biscuit as smoother and as melting in the mouth when taken from the smooth plate (all $ps < .001$).

Intriguingly, the participants' taste and flavour judgments were also significantly influenced by the texture of the two plates, $B(6) = 56$, $p_{two\text{-}tailed} < .001$. Post-hoc tests indicated that the sample of biscuit taken from the rougher plate tasted significantly more gingery and salty than the sample taken from the smooth plate. On the other hand, the biscuit eaten from the smoother plate was rated as significantly sweeter than the biscuits taken from the rougher plate (all $ps < .001$).

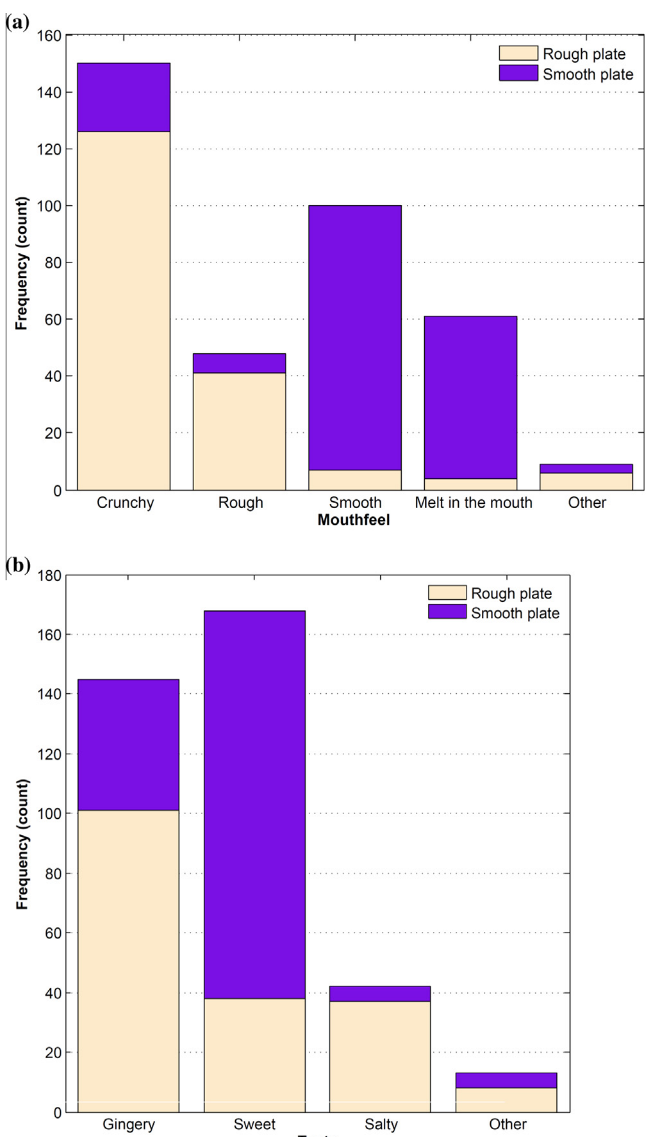

Fig. 2. Frequency of responses relating to the mouthfeel (a) and taste (b) of the biscuit in the first series of experiments collected in the lab ($N = 184$).

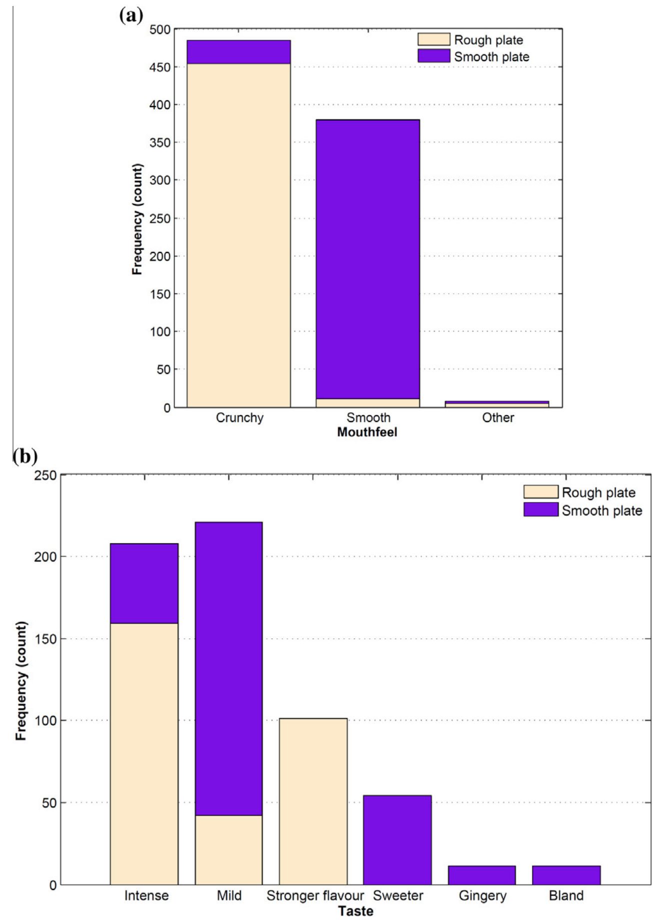

Fig. 3. Frequency of responses relating to the mouthfeel (a) and taste (b) of the biscuit in the data collected from the festivals citizen studies in the first series of experiments ($N = 470$).

The mouthfeel results were replicated on the population of festival-goers (see Fig. 3a). Moreover, the festival goers rated the taste of the biscuit served from the rough plate as being more intense and flavourful, whereas they settled for descriptions such as mild, sweeter, gingery, or even bland in the case of the biscuit eaten from the smooth plate (see Fig. 3b).

2.2. Discussion

In this first series of citizen experiment reported here, we were especially interested in investigating the effect of haptic exploration on mouthfeel and taste of biscuits sampled from plates smooth or rough. The results both confirm and extend previous laboratory findings demonstrating the influence of the feel of the packaging (Krishna & Morrin, 2008; Piqueras-Fiszman & Spence, 2012; Tu et al., 2015), not to mention the feel of the food itself in the hand (Barnett-Cowan, 2010), on the oral-somatosensory perception of food texture. Here, for the first time, we also bring evidence on sensation transference with respect to taste/flavour, as well as texture, judgments (Cheskin, 1957; Kampfer et al., submitted). Importantly, the present results reflect the data from a substantially larger sample size ($N = 654$) than has been tested in any (or for that matter, all) previous research in this area.

When it comes to interpreting the present results we need to assess the contribution of top-down attentional factors. Our participants were explicitly told to rate the biscuit with respect to the texture of the plate, thus we could potentially have witnessed some form of verbal priming (Fischler & Bloom, 1980; Stanovich &

West, 1979). It is an open question whether the same results would surface when participants are simply asked to rate the mouthfeel or taste of the biscuit after each biscuit tasting, without further directing their attentional focus to the texture of the plateware. Therefore, in a second series of citizen experiments, we investigated this question while at the same time controlling for verbal priming. Participants sampled biscuits from either a smooth or a rough plate; they were asked to rate the taste and mouthfeel after each serving. Furthermore, we were interested in investigating whether there could be a somewhat implicit pairing between the biscuit and the rough plate. We therefore decided to use jelly babies in an additional control comparison, as an implicit pairing for the smooth plate (see Piqueras-Fiszman & Spence, 2012, for crossmodal effects evident for biscuit, but not for yogurt-based food stimuli).

3. Experiment 2

3.1. Methods and results

A total of 41 participants took part in this experiment conducted in the UK. A *within-participants* experimental design was used with participants asked to feel both the rough plate and the smooth plate, while sampling the intended foodstuffs (biscuits and jelly babies). Participants felt the plate with their hands while sampling the foodstuffs. They were asked to answer the following two questions, shortly after each of the four tastings: 'How did the biscuit/jelly baby taste?' and 'How did the biscuit/jelly baby feel in your mouth?' For the taste dimension, the response options were smooth/chewy/lumpy/melt-in-the-mouth/rough/crisp/crunchy/other, whereas the response options for the mouthfeel dimension were set to sweet/very sweet/mild/bland/slightly sour/intense/salty/other.

We used Bowker–McNemar tests to analyze the mouthfeel and taste data. Frequencies of the data are presented in Fig. 4. Bearing on the limited power, the results indicate significant modulations with respect to people's appreciation of the mouthfeel manipulation. That is, the results indicate that the texture of the plate significantly influenced people's estimations of the biscuit's mouthfeel, $B(6) = 20.91$, $p_{one\text{-}tailed} = .001$. Post-hoc tests indicated that the participants perceived the biscuit as smoother when tasted from the smooth plate than when tasted from the rough plate. They also estimated the biscuit as significantly rougher when taken from the rough plate (all $ps < .001$). With regard to the jelly babies, a similar effect of the texture of the plate on the appreciation of the mouthfeel was documented, $B(6) = 19$, $p_{one\text{-}tailed} = .021$. This effect is reflected by the jelly babies feeling smoother when sampled from the smooth plate ($p < .001$), and as having a more chewy mouthfeel when tasted from the rough plate ($p = .003$). Lastly, a significant difference in the appreciation of the mouthfeel for the biscuits as opposed to the jelly babies was also detected, when these were sampled from the rough plate, $B(6) = 25.8$, $p_{one\text{-}tailed} < .001$. That is, biscuits were perceived as significantly rougher, whereas jelly babies were rated as significantly chewier (all $ps < .001$). All other comparisons were non-significant.

3.2. Discussion

The results of this second experiment replicate the findings of the first series with a smaller sample of participants, at least in what regards the experimental mouthfeel manipulation. That is, we perceive both the biscuits, as well as the differently-textured jelly babies tested here as rougher when we taste them from a rough plate and smoother when we sample them from a smooth plate. Furthermore, we also find that the rough plateware led to a rougher/chewier mouthfeel, across the two foodstuffs tested here. We touch on the implications of these results below.

4. General discussion

The citizen experiments series presented in this manuscript were designed with the aim of ascertaining a crossmodal association between haptics and the taste as well as mouthfeel of naturalistic foodstuffs that we are likely all familiar with (e.g., biscuits and jelly babies). We demonstrate sensation transference from the type of plate we explore with our hands while we sample the food: That is, biscuits feel rougher when sampled from the rough plate, whereas they feel smoother and as if melting in the mouth when sampled from the smooth plate instead. The same effect is also evident for the taste dimension: Biscuits taste saltier or more gingery when people feel the rough plate, but they are rated as tasting sweeter when sampled from the smooth plate instead. Furthermore, we replicate the mouthfeel results for jelly babies, showing that they are perceived as rougher/smoother when sampled from the rougher/smoother plate. Additionally, we show a sort of 'rough plate effect' characterized by an overall rough/chewy mouthfeel, apparent across the two foodstuffs tested here; Needless to say, this crossmodal effect would likely benefit from further research.

It is interesting to note here that in a recent study examining tactile-taste interactions by using a sucrose/lemon juice mixture only the texture of the food itself was found to alter ratings of its taste, and not the texture of the plateware (Slocombe, Carmichael, & Simner, in press). In this respect, it could be argued that sensation transference from plateware texture to taste is more likely to appear when naturalistic foodstuffs are sampled, such as the biscuits in the present study. On a similar note, the within-participants nature of the experimental design utilized in the present study may have drawn the participants' attention to the (varying) texture of the plateware to a greater extent than would have been the case had we used a between-participants design (cf. Kampfer et al., submitted). It could thus be argued that the replication of this study using a between-participants experimental design would certainly help to strengthen the implications of the sensory transference effect found here.[3]

One other interesting question for future research will be to determine whether any individual differences in the need for touch, as captured by the "need for touch" scale (see Peck & Childers, 2003a,b, 2008) modulate just how much of an influence the felt texture of the plateware has on people's perception of the food served from it. Beyond the practical implications of the results reported here, it is perhaps also worth noting the link back to the Italian Futurists (see Spence et al., 2013): It was Filippo Tommaso Marinetti (1876–1944) and his colleagues who, back in the 1930's organized tactile dinner parties in which the guests were encouraged to wear pyjamas made of (or covered by) differently textured materials such as cork, sponge, sandpaper and/or felt and to eat without the aid of knives and forks to enhance the tactile sensations and maximally stimulate the senses of the diners (see Spence & Piqueras-Fiszman, 2014). Marinetti was, then, perhaps one of the first to think creatively about the importance of touch and tactile stimulation to the act of eating, not to mention its enjoyment by diners. Although dismissed as "*a fart from the kitchen*" by the Italian press at the time (Berghaus 2001, p. 15), contemporary cognitive neuroscience research but also contemporary gastronomic practices are increasingly finding value in a number of the Futurists seemingly-crazy ideas. One might also be reminded here of the many people around the world who eat without the aid of cutlery, and how much tastier some of them claim their food to be (see Spence & Piqueras-Fiszman, 2014, on this theme).

[3] Although note that current tests from our lab ($N = 75$) indicate no significant sensation transference between haptics and mouthfeel/taste in the context of a between-participants design.

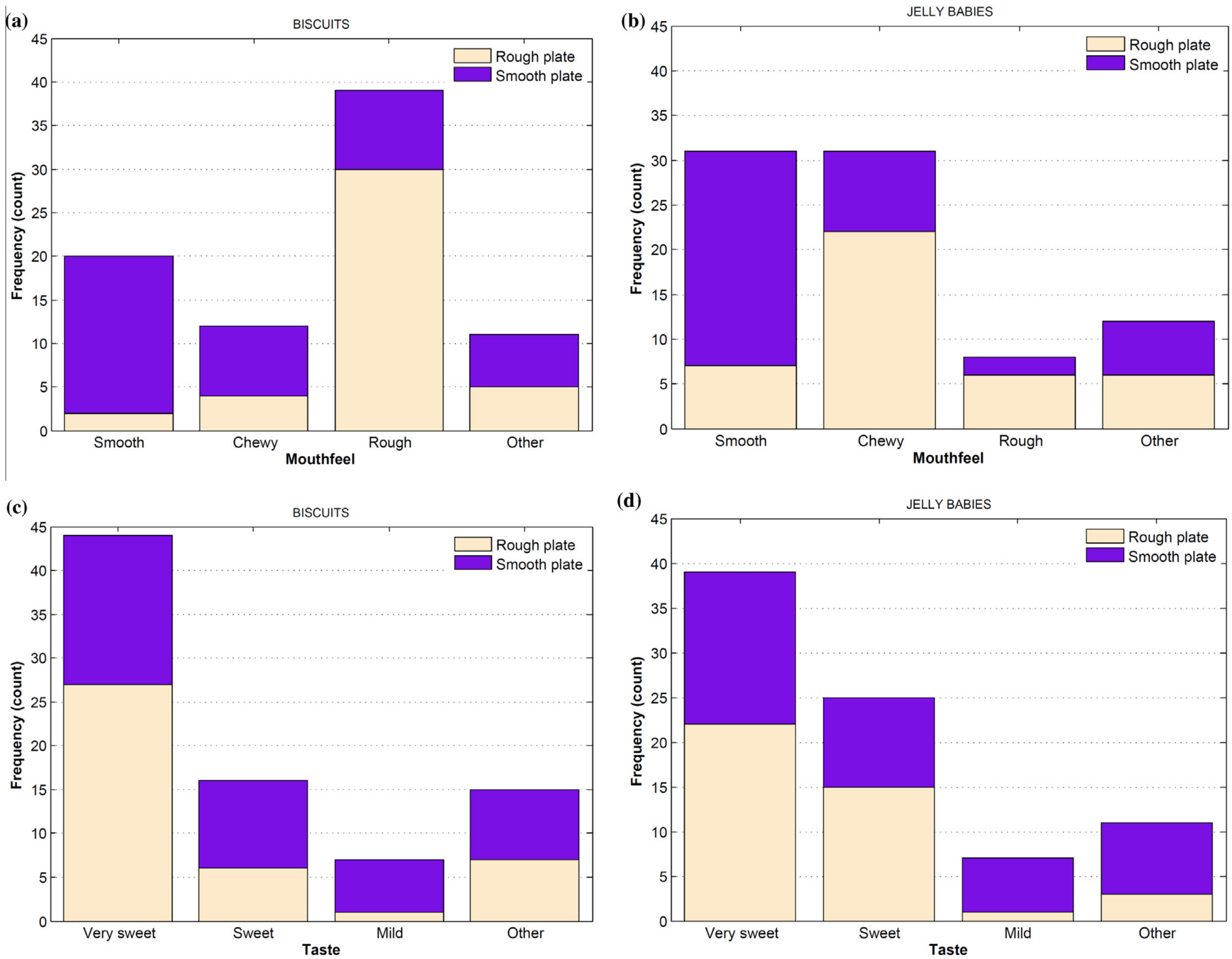

Fig. 4. Frequency of responses relating to the biscuits (a) and jelly babies mouthfeel (b), as well as the biscuits (c) and jelly babies taste (d) in the second experiment ($N = 41$).

On a different note, it is worth bearing in mind that we cannot say whether the results reflect any differences in the *feel* of the texture of the two plates, or in the *seen texture*, of the plates, or perhaps in both attributes. Note that a similar concern also applies to the interpretation of Piqueras-Fiszman and Spence's (2012b) results. From a theoretical perspective it is, of course, interesting to ascertain the relative contribution of each of the senses to the effects reported here. One way to address this point might be to simply show the biscuits on the different plateware (perhaps on a computer monitor; cf. Becker, Van Rompay, Schifferstein, & Galetzka, 2011). Interestingly, Barnett-Cowan (2010) blindfolded his participants to eliminate any direct visual cues. That said, it is worth bearing in mind that people can still generate a visual image of a texture that they are feeling, even when blindfolded (see Spence & Deroy, 2013), so this technique cannot really guarantee eliminating the impact of visual textural cues. Relevant here, even imagined stimuli have been shown to engage in multisensory interactions with other stimuli that are directly perceived (Berger & Ehrsson, 2013).

From an applied perspective, the fact that participants saw the texture of the material they felt isn't a concern given that people (e.g., in a restaurant or home consumption setting) will always see the texture of the plateware or packaging prior to tasting the food.[4] Even more, such a strong haptics to mouthfeel and taste sensation transference as previously demonstrated and furthered in the present study could be of use to the food industry. Relevant here, it has been estimated that we consume a third of all our food and drink direct from the packaging. Interestingly, a number of companies have recently started to give their packaging a distinctive rougher, or textured, feel (see the Heineken tactile can; Anon., 2011; Murray, 2011; see also Spence & Piqueras-Fiszman, 2012; Spence, in press). It is also timely to consider what effect changing the surface texture of a drinking receptacle may have on the consumer's perception of the contents (see Spence & Piqueras-Fiszman, 2012, for a review).

To conclude, the experiments reported here provide additional evidence demonstrating sensation transference from haptics to complex gustatory stimuli. Future research needs to address other multisensory contributions in the context of food perception, particularly to focus on assessing the relative contribution of haptic versus visual texture cues.

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[4] The only exception possibly being those eating dinner in a dark restaurant (see Spence & Piqueras-Fiszman, 2014).

References

Anon (2011). *The Dutch touch*. Downloaded from <http://175proof.com/triedandtested/the-dutch-touch/ on 10/05/2014>.

Barnett-Cowan, M. (2010). An illusion you can sink your teeth into: Haptic cues modulate the perceived freshness and crispness of pretzels. *Perception, 39*, 1684–1686.

Becker, L., Van Rompay, T. J. L., Schifferstein, H. N. J., & Galetzka, M. (2011). Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations. *Food Quality and Preference, 22*, 17–23.

Berger, C. C., & Ehrsson, H. H. (2013). Mental imagery changes multisensory perception. *Current Biology, 23*, 1367–1372.

Berghaus, G. (2001). The futurist banquet: Nouvelle Cuisine or performance art? *New Theatre Quarterly, 17*(1), 3–17.

Bowker, A. H. (1948). A test for symmetry in contingency tables. *Journal of the American Statistical Association, 43*, 572–574.

Bult, J. H. F., de Wijk, R. A., & Hummel, T. (2007). Investigations on multimodal sensory integration: Texture, taste, and ortho- and retronasal olfactory stimuli in concert. *Neuroscience Letters, 411*, 6–10.

Cheskin, L. (1957). *How to predict what people will buy*. New York, NY: Liveright.

Fischler, I., & Bloom, P. A. (1980). Rapid processing of the meaning of sentences. *Memory & Cognition, 8*, 216–225.

Gallace, A., & Spence, C. (2014). *In touch with the future: The sense of touch from cognitive neuroscience to virtual reality*. Oxford, UK: Oxford University Press.

Hogenkamp, P. S., Stafleu, A., Mars, M., Brunstrom, J. M., & de Graaf, C. (2011). Texture, not flavor, determines expected satiation of dairy products. *Appetite, 57*, 635–641.

Kampfer, K., Leischnig, A., Ivens, B. S., & Spence, C. (submitted). Touch-taste-transference: Assessing the effect of the weight of product packaging on flavor perception and taste evaluation. *International Journal of Marketing Research*.

Krishna, A., & Morrin, M. (2008). Does touch affect taste? The perceptual transfer of product container haptic cues. *Journal of Consumer Research, 34*, 807–818.

Michel, C., Velasco, C., & Spence, C. (2015). Cutlery influences the perceived value of the food served in a realistic dining environment. *Flavour, 4*, 27.

Murray, F. (2011). New unified global identity for Heineken. *TheDrinksReport.com*. 1st January. Downloaded from <http://www.thedrinksreport.com/news/2011/13543-new-unified-global-identity-for-heineken.html on 03/07/2014>.

Peck, J., & Childers, T. L. (2003a). Individual differences in haptic information processing: The "Need for Touch" scale. *Journal of Consumer Research, 30*, 430–442.

Peck, J., & Childers, T. L. (2003b). To have and to hold: The influence of haptic information on product judgments. *Journal of Marketing, 67*(April), 35–48.

Peck, J., & Childers, T. L. (2008). Effects of sensory factors on consumer behavior: If It tastes, smells, sounds, and feels like a duck, then it must be a.... In C. P. Haugtvedt, P. M. Herr, & F. R. Kardes (Eds.), *Handbook of consumer psychology* (pp. 193–219). New York, NY: Psychology Press.

Piqueras-Fiszman, B., Harrar, V., Roura, E., & Spence, C. (2011). Does the weight of the dish influence our perception of food? *Food Quality & Preference, 22*, 753–756.

Piqueras-Fiszman, B., & Spence, C. (2012b). The influence of the feel of product packaging on the perception of the oral-somatosensory texture of food. *Food Quality & Preference, 26*, 67–73.

Slocombe, B. G., Carmichael, D. A., & Simner, J. (in press). Cross-modal tactile–taste interactions in food evaluations. *Neuropsychologia*.

Spence, C. (in press). Oral-somatosensory contributions to flavor perception and the appreciation of food and drink. In B. Piqueras-Fiszman & C. Spence (Eds.), *Multisensory flavor perception: From fundamental neuroscience through to the marketplace*. Elsevier.

Spence, C., & Deroy, O. (2013). Crossmodal mental imagery. In S. Lacey & R. Lawson (Eds.), *Multisensory imagery: Theory and applications* (pp. 157–183). New York, NY: Springer.

Spence, C., & Gallace, A. (2011). Multisensory design: Reaching out to touch the consumer. *Psychology & Marketing, 28*, 267–308.

Spence, C., Hobkinson, C., Gallace, A., & Piqueras-Fiszman, B. (2013). A touch of gastronomy. *Flavour, 2*, 14.

Spence, C., & Piqueras-Fiszman, B. (2014). *The perfect meal: The multisensory science of food and dining*. Oxford, UK: Wiley-Blackwell.

Spence, C., & Piqueras-Fiszman, B. (2012). The multisensory packaging of beverages. In M. G. Kontominas (Ed.), *Food packaging: Procedures, management and trends* (pp. 187–233). Hauppauge NY: Nova Publishers.

Stanovich, K. E., & West, R. F. (1979). Mechanisms of sentence context effects in reading: Automatic activation and conscious attention. *Memory & Cognition, 7*, 77–85.

Stuckey, B. (2012). *Taste what you're missing: The passionate eater's guide to why good food tastes good*. London, UK: Free Press.

Tu, Y., Yang, Z., & Ma, C. (2015). Touching tastes: The haptic perception transfer of liquid food packaging materials. *Food Quality and Preference, 39*, 124–130.