RUNNING HEAD: ON THE TASTE OF TYPEFACE

The role of typeface on taste expectations and perception:

A review

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ABSTRACT

In recent years, it has been demonstrated that people associate specific shape properties with basic taste attributes (such as sweet, bitter, and sour). It has been suggested that more preferred visual aesthetic features are matched to sweetness whereas less-preferred features are matched with tastes such as bitter and sour. Given the range of visual aesthetic features that are associated with typeface designs, it would seem reasonable to suggest that typefaces might therefore be associated with specific taste properties as well. Should that be the case, and by analogy with the literature on shape-taste correspondences, one might then wonder whether viewing text presented in say, a rounder typeface would not prime, and hence potentially influence, sweetness perception as compared to viewing the same information when presented in a more angular typeface instead. Here we summarize the latest findings supporting the existence of a crossmodal correspondence between typeface features and taste. Given such evidence, it can be argued that typeface may well be an important, if often neglected, aspect of our everyday experience which can be potentially useful in the design of food and drink product and brand experiences.

KEYWORDS: CROSSMODAL CORRESPONDENCES; TYPEFACE; TASTE; DESIGN; PRODUCT.

> "*…the type faces, by their shape, size, texture and the character of their lines may carry a certain atmosphere about them..*" (Poffenberger & Franker, 1923, p. 328)

1. Introduction

We are frequently exposed to different kinds of typeface in our everyday lives, though rarely do we give it a second thought. In fact, one need only note that whenever we read something that has not been written by hand, which is, nowadays, most of the time, we will have been exposed to a specific typeface (see **Figure 1** for examples). However, the possible influence of different typeface, and their respective connotations, on those who see/read them has garnered surprisingly limited interest from researchers to date. In fact, until very recently, only a handful of studies had attempted to assess the connotations of specific typefaces as well as their impact on people's behaviour (e.g., Burt, Cooper, & Martin, 1955; Davis & Smith, 1933; Kastl & Child, 1968; Morrison, 1986; Poffenberger & Franke, 1923; Tannenbaum, Jacobson, & Norris, 1964, for early research; and Childers & Jass, 2002; Doyle & Bottomley, 2009; Walker, 2008, 2016a, for some more recent developments).

INSERT FIGURE 1 ABOUT HERE

Even in the absence of extensive research, however, it has been acknowledged historically that specific typeface can convey meaning over-and-above the words that they represent (Garfield, 2011). For example, in her famous 1930 essay 'The Crystal Goblet', Beatrice Warde compares typeface readability to the human voice and suggests that if three pages were set in Fournier, Caslon, and Plantin typefaces it would be like: *'three different people delivering the same discourse—each with impeccable pronunciation and clarity, yet each through the medium of a different personality.'* (Warde, 1956, p. 138).

Importantly, however, since the development of the Mac personal computer and the laser printer, which both became increasingly popular amongst the general public from the mid-1980s onwards, almost any kind of printed communication is mediated by typeface. It was the arrival of these technologies, more than anything else that really broadened the range of

possibilities in terms of the typefaces that could be presented on the screen not to mention on the printed page (cf. Garfield, 2011; Hyndman, 2015). Indeed, there is now a wide range of typeface designs (perhaps more than 100,000 according to Garfield, 2011), and many more under development, that are available and used by consumers, designers, artists, and marketers to communicate (even if based on intuition) specific meanings (Henderson, Giese, & Cote, 2004).

Perhaps unsurprisingly, then, a growing number of marketers and designers have become interested in the potential impact of carefully chosen typeface, as, for example, when deciding how to present the brand name, and other relevant information, on different marketing communications (e.g., see Batra, Seifert, & Brei, 2015; Celhay, Boysselle, & Cohen, 2015; see also Anon., 2012; https://www.daltonmaag.com/; www.typetasting.com; Larson, 2015; Setalvad, 2015). Crucially, the evidence published to date suggests that the physical attributes of a given typeface (e.g., whether it is more rounded or angular, light or heavy, etc., see **Figure 2**) can prime certain notions in the mind of whoever happens to be reading, or even just viewing, the text (e.g., Grohmann, Giese, & Parkman, 2013; Gump, 2001; Henderson et al., 2004; Juni & Gross, 2008; Karnal, Machiels, Orth, & Mai, 2016).

INSERT FIGURE 2 ABOUT HERE

Researchers have even started to look at the consistency (or congruency) between elements, and their connotations, such as the curvilinearity of the typeface and a brand's logo, and its consequences for the evaluation of a brand by the customer (e.g., see Klink, 2001, 2003; Van Rompay & Pruy, 2011; see also Poffenberger & Franken, 1923; Walker, Smith, & Livingston, 1986, for the appropriateness of typeface to a given concept). Certainly, typeface can convey meaning, no matter whether in a business-to-business or business-to-consumer interaction (e.g., Salgado-Montejo, Velasco, Olier, Alvarado, & Spence, 2014; see also Doyle & Bottomley, 2004, 2006, 2011).

The psychological effects of typeface on perception and behaviour have been a topic of scientific interest for almost a century now (see e.g., Davis & Smith, 1933; Morrison, 1986; Poffenberger & Franken, 1923, for some early examples). Nevertheless, to the best of our knowledge, the study of whether specific typeface could be used to convey taste information

is something that has only been investigated recently. For that reason, in this review, we focus specifically on the ability of typeface to influence consumers' taste expectations and perception, something that may well be important in the context of food and drink-related marketing communications. In many circumstances, before people taste a food or drink product, they are exposed to the product's associated colours, shapes, pictures, words, and typefaces. These features play a critical role in setting the consumers' expectation about the product's qualities and can have a profound effect on their behaviour (Machiels & Karnal, 2016; Mackey & Metz, 2009; Piqueras-Fiszman & Spence, 2015; Yiannas, 2015).

Here, we argue that there are systematic associations between typeface features and tastes. Moreover, we suggest that given that consumers often buy foods/drinks without tasting them first (at least on the first purchase), typeface can perhaps be one of the elements that helps to disambiguate which taste to expect from a food or drink (cf. Walker, 2016). We also argue that under certain circumstances, typefaces can also guide the experience of a given taste. Think, for example, when a novel product is launch to the market (thus, a new name and/or typeface) or when an existing product changes the typeface of its name. The different features of the typeface may contribute to create an overall sense of what taste to anticipate, therefore, filling the missing information about the taste, which is not available until the product has been sampled (see **Figure 3**). With that in mind, we critically assess the existence of crossmodal correspondences (i.e., or association between features across the senses, see Marks, 1978; Spence, 2011) between both typeface features, such as curvature and bold, and taste attributes (Velasco, Woods, Hyndman, & Spence, 2015b, for an example).

INSERT FIGURE 3 ABOUT HERE

We begin by presenting a short overview of the available literature on taste/shape correspondences (see e.g., Spence & Deroy, 2013; Velasco, Woods, Petit, Cheok, & Spence, 2016c, recent detailed reviews on the topic). We then move on to review the research that has been conducted to assess the association between typeface features and gustatory tastes. Having established the existence of such taste-typeface associations, we then go on to discuss whether viewing specific typeface also influences people's rating of that which they are tasting. Here, we summarize the results of three recent citizen science studies designed to

assess the influence of typeface curvature on taste ratings[1]. Finally, we draw some general conclusions and directions for future research. Here, we refer to other crucial design elements, such as colour and symbolism of brand names, which may interact with typeface when it comes to the communication and influence of taste.

2. The taste of shape curvilinearity and other shape aesthetic features

A growing body of empirical research now demonstrates the widespread crossmodal correspondences that exist between curvilinearity and basic taste properties (e.g., Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014; Velasco, Woods, Deroy, & Spence, 2015a). In particular, a number of recent studies have highlighted the fact that if asked to rate taste words or a range of basic tastes in solution (and sometimes, more complex foods having a specific dominant taste, such as the sweetness of milk chocolate, say, the bitterness of dark chocolate, or the sourness of cranberry juice; e.g., see Becker, van Rompay, Schifferstein, & Galetzka, 2011; Ngo, Misra, & Spence, 2011; Spence, 2014; Spence & Deroy, 2013; Spence & Gallace, 2011) along a line scale anchored by a round cloud-like shape at one end and an angular star-like shape at the other (such as the traditional 'bouba' and 'kiki' shapes, see **Figure 4**), then most people will generally associate sweet with rounder shapes and bitter, sour and, to a lesser extent, salty with a shape that is more angular instead (see Velasco et al., 2016c, for a recent review)[2].

INSERT FIGURE 4 ABOUT HERE

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[1] Notethat while our focus, at least in the first instance, is on taste (meaning the gustatory properties of sweet, sour, and bitter), there is no reason why the same approach cannot be extended to the perception of fragrance, aroma, flavour, or for that matter, any other food or beverage with specific taste attributes. In fact, given that olfaction contributes the majority of what most people categorize as the taste experience (which is more precisely refer to as favour, see Spence, 2015, for a recent review) then there are good reasons for trying to convey and/or modify olfactory experience through typeface. In fact, the reason for starting with taste in our own research has simply been the wider agreement when it comes to the most obvious basic tastes. There is currently no such agreement when it comes to the classification of smells/aromas, say.

[2] One gets similar results if 'round' words, such as "Bouba" are used at one end of the scale and angular words, such as "Kiki", at the other (see Gallace, Boschin, & Spence, 2011; Ngo et al., 2011; Spence & Gallace, 2011).

The intensity of, and the hedonic value associated with, the taste, have both been shown to correlate with this crossmodal mapping, these factors cannot, by themselves, entirely explain the basic crossmodal matching phenomenon (e.g., Velasco et al., 2015a; Velasco, Woods, Liu, & Spence, 2016a). Nevertheless, research has also provided support for the idea that other aesthetic features that influence visual preference, such as symmetry and the number of elements in a shape (Palmer, Schloss, & Sammartino, 2013) can also influence taste/shape matches (e.g., Salgado-Montejo et al., 2015), which suggests that affect can correlate with taste/shape matches.

3. On the taste of typeface

Given that different typeface designs can also be categorized in terms of their curvilinearity, symmetry, orientation, and so on, one might consider the design of typeface specifically to convey taste as a natural progression of this growing body of published research on the topic of taste-shape correspondences. Indeed, while forcing people to pay attention to arbitrary shapes, as has been the case in some of the laboratory research (e.g., see Gal, Wheeler, & Shiv, 2007, for an example), can be seen as a somewhat unnatural situation, it is possible that people pay much closer attention to the typeface when reading text. That said, one might well consider whether, when reading, people are capable of focusing solely on the meaning of the text and somehow ignoring the specifics of the typeface used to communicate a given message (Gauthier, Wong, Hayward, & Cheung, 2006; Walker, 2008).

Whilst research on the crossmodal correspondence between taste and typeface features is not extensive, it has been suggested that certain typefaces may be more appropriate for some products, or product categories, than others (Davis & Smith, 1933; Doyle & Bottomley, 2006; Poffenberger & Franken, 1923). Therefore, one may wonder whether specific products (e.g., chocolate or simply sugar) may be more strongly associated with a specific typeface than another (e.g., coffee or perhaps salt). This is important given that products and product categories (e.g., candies) tend to use specific typeface features or even specific lettering styles (e.g., just think of Coca Cola's signature logo type, which belongs to the script style known as Spencerian).

Crossmodal correspondences are, however, somewhat different in that the correspondence between a visual feature (e.g., symmetry) and a taste (e.g., sweetness) may not necessarily

apply to single object or object category only but rather to many objects and categories (cf. Deroy & Spence, 2016). That is, crossmodal correspondences may represent some more fundamental compatibility between features (Velasco et al., 2016c). With this idea in mind, it is important to mention that the study of the semantic connotations of typeface has provided indirect evidence for the correspondence of typeface features with taste. Given that this research may involve taste scales (e.g., anchored with sweet and bitter), closer inspection of the ratings of typeface reveals a possible tendency for people to associate round typefaces more strongly with dimensions aligned with sweetness (not surprisingly, perhaps, dimensions such as evaluation or emotional valence) as compared to angular typefaces (e.g., Doyle & Bottomley, 2010; Karnal et al., 2016; Kastl & Child, 1968).

Consistent with the aforementioned ideas, some of the first research to extend the idea of shape-taste correspondences from abstract shapes to the design of typeface was reported by Velasco et al. (2014). These researchers observed that a rounder typeface (e.g., Swis721 B1kRnd BT – Black, 44 pt, see **Figure 5A**) was judged as being more consistent with sweet-tasting products than with sour-tasting products and a more angular typeface (e.g., Hollywood Hills—Regular, 53 pt, see **Figure 5B**) as more consistent with sour-tasting products than with sweet-tasting products. From this work, it is possible to conclude that, at least when judging the likely taste of a product, the curvature of a typeface can modify the expected taste. This study only included two typefaces, which also differed in terms of other spatial properties such as the space between letters. However, as we will see below, these results have been replicated with a larger number of typefaces, and in several different languages and countries.

INSERT FIGURE 5 ABOUT HERE

To the best of our knowledge, only a few studies have evaluated the association between typeface curvature and taste. In perhaps the first study of its kind, Velasco et al. (2015b) evaluated the basic taste association that people had with a range of round and angular typefaces, either presented in isolation, or else on the front of what looked like a Styrofoam hot drinks cup (see **Figure 6**, for a summary of the results associated with the typefaces presented on their own, which were largely similar to those including the cups). Again,

rounder typefaces were found to be more strongly associated with sweet tastes than angular typefaces and angular typefaces with the other tastes when compared with round typefaces.

INSERT FIGURE 6 ABOUT HERE

Having demonstrated consistency in a varied sample of participants in terms of the taste associations with typeface (the majority of the participants in Velasco et al.'s, 2015b, study were recruited on Amazon's Mechanical Turk, which typically involves participants from the United States and India, see Woods et al., 2015), we recently went on to assess whether the curvilinearity of the typeface would carry the same taste connotation in different languages and cultures (see Velasco et al., submitted). In this study, we wanted to test whether the association between taste and typeface curvilinearity would be consistent across countries and languages. If this was the case, it would possibly suggest that other properties of the words written (for example, their sound symbolic meaning or identity) would not necessarily be responsible for the crossmodal correspondence between taste and curvilinearity. In addition, Bremner et al. (2013) recently demonstrated that the Himba tribe of rural Namibia were shown to express different carbonation-angularity and bitter taste-angularity associations than the Western participants tested in the majority of other studies (cf. Henrichs et al., 2010). Other research, however, has suggested that round shapes can similarly influence taste detection thresholds in different countries (e.g., Liang et al., in press; Liang, Roy, Chen, & Zhang, 2013).

In Velasco et al.'s (submitted) study, participants from South America (Colombia), China, and the UK were presented with the phrase "Eat me" in angular versus rounded and bold vs. regular typeface in three different languages, namely, Spanish, Chinese, and English (see **Figure 7**). Using an online testing platform (see Woods et al., 2015), the participants were requested to associate a specific taste with the various exemplars of their own typeface that were shown on the screen. The results of Velasco et al.'s study demonstrated that regardless of the first language spoken by the participants, the curvilinearity of the typeface was distinctively associated with specific tastes; that is, round typefaces were more strongly associated with sweet taste and angular typefaces were more strongly associated with the other tastes. Whether a typeface used bold or not only had an effect on the Chinese participants' ratings with bold typefaces being rated as significantly more bitter, salty, and sweet than the regular typefaces.

INSERT FIGURE 7 ABOUT HERE

How should the aforementioned findings be explained? Velasco et al. (2015b) also provided evidence suggesting that rounder typefaces may be, overall, easier to process and liked more than the angular typefaces. Following the same explanation for taste/shape correspondences (Velasco et al., 2016c, for a review) it was suggested that people may associate preferred typefaces (e.g., round) with preferred tastes (e.g., sweet) and less preferred typefaces (e.g., angular) with less preferred tastes (e.g., bitter), something that is correlated with the ease with which typefaces are processed.

Importantly, however, Velasco et al.'s (submitted) also had their participants rate the typefaces in terms of liking, familiarity, and clarity. Whereas the results revealed a similar pattern of results for the participants from Colombia, China, and the UK, when the typefaces were written in Spanish and English, such a pattern was not necessarily consistent for the Chinese language typefaces. That is, the participants liked the round typefaces more, and evaluated them as more familiar and clear than the angular typefaces in English and Spanish, but not in Chinese where such ratings did not differ. Yet, the round typefaces were evaluated as sweeter than the angular typefaces in the three languages and three countries. In other words, when round and angular typefaces are matched in terms of liking, familiarity, and clarity (e.g., when written in Chinese), people still associate them differently with sweetness. This suggests, at least initially, that valence cannot account by itself for taste/typeface associations.

Further research will be needed to test the various possible mechanisms that may explain the association between tastes and features of typeface. For example, it becomes clear after going to the sweets' section in the supermarket that many sweet products use round typefaces (just try searching for the terms "supermarket+sweets+section" in Google Images, and see the typefaces of the products that show up). Is this a result of a more general principle of taste/shape matching, a factor guiding the matching, or perhaps both? One possibility is that a more general mechanism of vision/taste association has been adopted by the marketplace and it expresses itself in the way in which shape features are selected for specific product tastes. For example, it may be the case that we learn to encode the transformation of food products in time, which involves their shape, but also their taste, and as such, we create stronger

associations between foods, their tastes, and the associated shape features (Velasco et al., 2016c; cf. Maga, 1974). Notably, whereas the studies reviewed above provide an interesting initial attempt to study the topic, future research may also manipulate the physical (not only the perceptual) dimensions that determine, for example, the curvature of typeface. What is more, future research on the association between taste and typeface may look to other features of typeface (such as orientation, italics, spacing, and so on). In the end, typeface designs are multi-featured and many of their component features can influence their connotation and preference (Henderson et al., 2004).

4. Does typeface influence taste perception?

Having demonstrated the cross-cultural generalization of shape-taste associations in participants from China, South America, and the UK, we next went on to investigate whether specific typeface designs can actually be used to change people's ratings of the taste of a given standardized food. Below, we present an overview of the results of three citizen science experiments conducted at different events and designed to address the aforementioned question. To the best of our knowledge, not studies have been yet conducted on this specific topic. One can think of this as analogous to the recent line of studies that have demonstrated changes in people's ratings of various foodstuffs (e.g., cheese, basic tastants in solution, and café latte) following their visual inspection of round versus angular shapes that were more, or less, unconnected to what they were tasting (e.g., see Gal et al., 2007; Liang et al., 2013, in press; Spence, 2014; Van Doorn, Colonna-Dashwood, Hudd-Baillie, & Spence, 2015).

4.1. Tasting typefaces I

In an event held at the Victoria & Albert Museum in London for the London Design Festival on 14th September 2014, 80 members of the audience rated a couple of jelly beans (Kingsway jelly beans were sorted into matching pairs according to flavour), a candy in which both sweet and sour are generally present, one while looking at jagged style lettering (Modified London 2012) and the other while viewing round lettering instead (VAG Rounded, see **Figure 8**). This citizen science experiment, as well as the subsequent experiments, were reviewed and approved by the Central University Research Ethics Committee at Oxford University and was carried out in accordance with the World Medical Association Helsinki Declaration.

INSERT FIGURE 8 ABOUT HERE

Each participant was given a plastic bag containing two identical jelly beans, from a selection of flavours/colours. The participants were given a score sheet in which they were asked to rate the sweetness, sourness, and intensity of the jelly bean while viewing the words “eat me” shown as a slide projected on a screen in one of the typefaces and then the other (order was counterbalanced across participants). The ratings were performed on Likert scales ranging from not at all (0) to very much (10). Although 80 participants took part in this study, not all questionnaires were filled in. In total, the ratings for the sweet, sour, and intensity dimensions while looking at the round typeface were responded by 80, 78, and 72, participants. The ratings for these same dimensions but looking at the angular typeface were responded by 79, 79, and 70 participants. These make it difficult to match the data of those participants who responded to more than one typeface condition, hence these analyses should be treated as primarily descriptive.

INSERT FIGURE 9 ABOUT HERE

The results are represented in **Figure 9**. As expected, at the descriptive level, the sweetness ratings were higher for the jelly beans rated while looking at the round typeface (M = 7.04, SD = 2.31) than those rated while looking at the angular typeface (M = 5.38, SD = 2.45). In contrast, the jelly beans were rated as more sour (M = 3.73, SD = 2.68) when the participants looked at the angular typeface than when they looked at the round typeface (M = 2.63, SD = 2.49). The results on the intensity ratings only indicate a subtle difference, with the angular (M = 5.62, SD = 2.72) typeface evoking higher intensity ratings than the round typeface (M = 5.24, SD = 3.04). The results of this experiment, indicate that the sweetness ratings of the jelly beans are somewhat higher when presented together with a round typeface than an angular one and, in contrast, the sourness ratings are somewhat higher for the jelly beans that are presented together with the angular typefaces, than those which are presented with the round typefaces.

4.2. Tasting typefaces II

A citizen science experiment was also conducted at the Science Museum Lates evening event held in London on Wednesday 30th September 2015 (http://www.sciencemuseum.org.uk/visitmuseum/plan_your_visit/lates.aspx). Given the nature of the public event, it was not possible to collect demographic details (e.g., sex, age, nationality), though based on informal observation of those attending, the majority were young adults. Three different pairs of typefaces were presented over the course of the evening (see **Figure 10**), one pair per participant. In all cases, the phrase "Eat me" was printed in black ink on a laminated A4 piece of white paper.

INSERT FIGURE 10 ABOUT HERE

Visitors who were wondering around the Science Lates event were encouraged to stop at the table manned by a number of experimenters. The participants on one side of the table and the experimenters on the other. There were two sets of small paper dispensing cups on the table. Those individuals who agreed to take part in the study were given one paper cup, asked to rate the jelly bean inside in terms of its sweetness and sourness, entering their responses on a tablet computer. Given the dynamics of the social event, it was difficult to guarantee that the same participant would respond to the two pairs of typefaces. Therefore, the analysis of the data is mainly descriptive.

The interface screen is shown in **Figure 11**. Note that separate ratings of sweetness and sourness were required. All of the participants tasted two identical lemon/lime flavoured jelly beans (Jelly Belly jellybeans in lemon/lime flavour). This flavour was chosen since it is both sweet and sour. Our intuition being that it is easier to modulate a pre-existing taste or flavour using crossmodal correspondences than it is to create the impression of a taste or flavour that is not, in fact, present. The experimenters said nothing to the participants about the identity of the jelly beans (i.e., whether they were the same or different).

INSERT FIGURE 11 ABOUT HERE

A summary of the mean sweet and sourness ratings, and their corresponding standard deviations, as a function of typeface pair, curvature, and specific typeface is presented in Table 1.

INSERT TABLE 1 ABOUT HERE

At a descriptive level, it appears that, although certain degree of variability can be found between typefaces, the presentation of the round typefaces from the three pairs resulted in higher sweetness ratings than the presentation of the angular typefaces, in the same pairs, respectively. In contrast, the angular typefaces yielded higher sourness ratings than their round counterparts in each pair of typefaces. Once again, the results of this citizen science experiment provide complementary evidence for the idea that typefaces may be able to influence taste perception.

4.3. Tasting typefaces III

The last citizen science experiment was conducted with 94 participants in a series of two events, one at Bournemouth Arts University (n = 48) and the other at Shillingdon College (n = 46), and include a total of 94 participants (57 females, 26 males, and 11 who failed to respond; 12 participants with ages 10-19 years, 51 aged 20-29, 11 aged 30-39, 6 aged 40-49, and 14 who failed to specify).

The participants were given a sheet with two sides, each containing the instructions in either a round (VAG Rounded) or an angular typeface (Klute) (see **Figure 12**). In order to counterbalance the order of stimulus presentation, half of the participants had the instructions with the round typeface first and on the other side the instructions with the angular typeface, whereas the other half had it reversed. Each group was directed to one of the tables where

they completed the first part of the experiment. Once they had all finished they swapped tables and completed the second part of the study. The experiment itself consisted of reading the corresponding side of the sheet provided, tasting a jelly bean, and evaluating in 10-point Likert scales how sweet and how sour the considered the jelly bean. The participants were instructed to not turn the page until they moved to the next table.

INSERT FIGURE 12 ABOUT HERE

As in the other citizen science events, we were interested in evaluating the effect of typeface curvature on the perception of how sweet or sour the participants rated a jelly bean. The prediction, based on previous research, as reviewed above, was that staring at angular typeface might end-up accentuating the sourness of the jelly beans for the participants, while viewing a rounder script, ought to accentuate the sweetness of the candy instead.

Taking into account the aforesaid predictions, the data was analysed by means of one-tailed Wilcoxon Signed Rank Tests. The analysis revealed that the jelly bean was rated as significantly sweeter when the instructions used the round typeface (M = 6.47, SD = 2.20) than when they used the angular typeface (M = 5.99, SD = 2.30), Z = 2.08, p = .019, r = 0.21. Similarly, the sourness ratings were somewhat higher when the instructions used the angular typeface (M = 4.26, SD = 2.68) than when they used the round typeface (M = 3.75, SD = 2.34), Z = 1.80, p = .0.036, r = 0.19.

4.4. So, can typefaces really influence taste perception? Summary of results from the citizen science experiments

The three different citizen science experiments point to the idea that typeface curvature can influence taste perception. The results presented are consistent with previous studies suggesting that the curvature of typeface differentially corresponds to tastes (Velasco et al., 2015b), and that shape curvature can influence the processing of taste information (Liang et al., 2013, in press; Velasco, Woods, Marks, Cheok, & Spence, 2016b).

However, before jumping to such a conclusion, it is important to highlight a couple of caveats/limitations associated with the results reviewed here. First, it is as yet unclear for how long the effects of (the curvilinearity of) typeface on taste perception last. While the present results demonstrate that they operate the first time that someone looks at typeface, one would probably want to know that such crossmodal effects last into the longer term before changing the typeface of a commercial product in order to convey sweetness/sourness, say.

Second, it is important to highlight the slightly contrived nature of the experimental set-up, where the participants were instructed to taste each of two similar-looking jelly beans while staring at the phrase 'Eat me' written in what were obviously very different typefaces. The worry here is that this kind of experimental design might well inadvertently have drawn the participants' attention to the typeface, and any differences between the one or two exemplars of typeface that they saw (since that was all that obviously differed), in a way that might not necessarily match our everyday experience when reading the label/logo on the front of product packing, say. After all, normally when we read, our attention is on the content of the message, and not on the typeface in which it is conveyed. Future research using between-participants experimental designs will certainly help to address this particular issue.

5. General discussion

5.1. Summary

The research reviewed here shows that typefaces can convey taste attributes (at least when people are thinking about taste), independently of the words that happen to be written in a given typeface. Although research on typeface/taste associations has been rather scarce, the different studies assessing the crossmodal correspondence between shape features have provided some insights that may well extend to typeface/taste associations. This research points to the idea that different visual aesthetic features of shapes, which influence preference, can, at least in part, explain why people match a taste with a shape. For example, people match curved or symmetrical shapes (preferred) with sweetness and angular or asymmetrical shapes with the other tastes (less preferred).

The specific research utilizing typeface demonstrates that, people really can 'taste typeface' in at least two ways. First, people have been shown to associate round typeface with sweet taste, while bitter salty and sour are associated with angular, across cultures. Second, based

on the data presented from different citizen science experiments, we suggest that viewing specific typefaces can influence taste ratings. That is, it appears that round typefaces enhance sweetness perception and angular typefaces enhance the perception sourness. Another way of looking at it though is that round typeface may diminish the perception of tastes such as sourness whereas angular typefaces may diminish the perception of sweetness. As Warde (1930) suggested almost a century ago: *"The type which, through any arbitrarily warping of design or excess of "colour", gets in the way of the mental picture to be conveyed, is a bad type".* That is, typeface may not only facilitate the associations with a given concept but also disrupt them, for good or bad, depending on the aim of the designer.

5.2. On the different connotations of typeface

If one looks in the marketplace, it is clear that distinctive typeface is a key part of the branding of certain products. That is typeface can play a signature role: Take, for example, Cola-Cola. The brand identity of this global giant in the marketplace is undoubtedly closely tied to the traditional red and white colour scheme (not to mention the signature shape of the traditional bottle; see Gallace & Spence, 2014; Prince, 1994). Moreover, given the distinctly sweet taste of the drink, it is noticeable how the company use a very round typeface (i.e., as part of a category of script, namely, Spencerian script). Should the company, for whatever reason, suddenly decide to change to a much more angular typeface instead, one could imagine that it might have a significant impact on people's perception of the brand (e.g., Salgado-Montejo et al., 2015; see also Kastl & Child, 1968; Tannenbaum, Jacobson, & Norris, 1964, for studies on typeface connotations). Based on the evidence reviewed here, it would certainly be easy to imagine how it might perhaps affect the taste of the drink too.

Crucially, a company may have various different objectives in mind, when it comes to choosing a particular typeface for their product or brand: Some might, for instance, want to maximize the processing fluency in the mind of their consumer (e.g., Song & Schwarz, 2010; Westerman, Lanska, & Olds, 2014; Winkielman & Cacioppo, 2001; Winkielman, Schwaatz, Fazendeiro, & Reber, 2003). Increasing the processing fluency is likely advantageous for a brand no matter whether or not there is also a knock-on effect on the product's taste (e.g.,

Novemsky, Dhar, Schwarz, & Simonson, 2007).[3] Other brands, by contrast, might wish to convey notions of authority, or of being trendy/novel (see Batra et al., 2015).[4] Relevant to the present review, typeface may be use to 'season' specific products. For instance, if one is interested in enhancing the sweetness of a product whilst lowering the sugar concentration, a round typeface may contribute to balance the product's perception. From another point of view, one might perhaps mask the bitterness of a healthy salad (think rocket) by using a round typeface.

Whilst one may also consider that disconfirmation of expectations (e.g., expecting that something will be sweet and it is not) can result in product dislike (Piqueras-Fiszman & Spence, 2015), this may be strategically useful in some contexts. For example, from a public policy perspective (and a hypothetical scenario), disconfirmation of expectations may be a useful tool. If a product with a high-concentration of sugar was labelled with a highly angular typeface, not only people would expect it to be less sweet, but its processing would be potentially les fluent, and the resulting experience, not as enjoyable as with a more congruent design. This may be particularly handy given the current discussion of the effects of sugar consumption on people's health (Lustig, Schmidt, & Brindis, 2012).

Nevertheless, conveying notions of sweetness is but one of the objectives when it comes to choosing typeface. In addition, it is also important to highlight that not all consumers look for the same information when buying a product. Indeed, much of the research on taste/shape and taste/typeface correspondences has explicitly asked participants to estimate the likely taste of a product, making it a salient aim for the participant (Velasco et al., 2016c). Furthermore, for companies like Coca-Cola, for whom their distinctive typeface has become part of their brand identity, the potential costs in terms of lost brand recognition associated with changing their typeface might well outweigh any benefits of enhanced sweetness perception that they could obtain. That said, it is presumably not a coincidence that the distinctive typeface is round.

[3] Some companies might actually wish to make the text harder to read, that is, to reduce processing fluency – to perhaps convey notions of a more complex tasting product (e.g., Gmuer, Siegrist, & Dohle, 2015; Song & Schwarz, 2008; though see also Gump, 2001).

[4] And yet others might rather less prosaically simply want on save on their ink costs (see http://www.fastcodesign.com/3028436/why-garamond-wont-save-the-government-467-million-a-year; see also http://www.creativereview.co.uk/cr-blog/2014/april/ryman-eco-grey-london-and-ryman-launch-sustainable-free-font/). The Garamond study has been questioned because Garamond has very small x-height so in reality it would generally be used a point size larger to be readable, thus using the same amount of ink.

5.3. Future research: The role of colour and sound symbolism

It is currently an open question as to whether it is only possible to design rounder typeface that are generally associated with sweetness, and angular typeface that are associated with the other tastes (e.g., sour, bitter, salty, and who knows, umami), or whether it is really possible to design typeface that are associated with each one of the basic tastes, and are sufficient to discriminate between sour, bitter, and salty say, remains an important question for future research. One of the ways in which to enhance the signalling potential of a specific typeface (Lee & Pai, 2012) might be to combine it with, say text (and possibly also background) colours that are uniquely associated with each one of the four basic tastes. Indeed, in the context of food and drink products several other multisensory elements, in addition to typeface, are also part of the overall experience designed for the consumer. For example, Spence et al. (2015) recently reviewed three decades of research on crossmodal correspondences between colour (hue) and basic tastes, as well as presenting their own research showing that red and pink are the two colours that would appear to be most strongly associated with sweetness, white and blue with salty, green and yellow with sour taste, and browny-black and purple with bitterness.[5]

Moreover, those wishing to optimize the taste connotation of their text designs may also want to consider which speech sounds to use in e.g., in a brand name in order again to prime certain taste expectations (e.g., see Abel & Glinert, 2008; Fenko, Lotterman, & Galetzka, 2016; see also Van Doorn & Spence, in press). Indeed, the research demonstrates that speech sounds convey meaning in and of themselves, a phenomenon that is known as 'sound symbolism' (Köhler, 1929; Lockwood & Dingemanse, 2015). For instance, long ago Fónagy (1963) suggested that there might be a crossmodal correspondence between bitter-sweet tastes and front/back vowel sounds (e.g., an example of a frontal vowel sound is the 'i' sound in 'hit' whereas a back vowel sound would be the 'o' in 'home'). However, as far as we are aware, no empirical research has been conducted to follow-up on these intuitions. It is known though, 'round' brand names such as 'Blum' are a much better match for a sweet-tasting product than others such as 'Clax', which are better matches for sour-tasting product instead (e.g., Velasco et al., 2014).

[5] Here one can think of the analogous work combining colour-taste correspondences with shape-taste correspondences that led to a range of 'tasty' plateware designs from designer Jialing Deng of London (see Spence et al., 2015).

The appropriateness of a typeface (e.g., the extent to which it is a good match) shape features and other sensory design elements which are distinctively use in relation with food and drink products can add or subtract value to the communication of specific meanings. Currently, most of the research on crossmodal correspondences associated with tastes have focused on a pair of sensory features, such as a shape curvature and taste (e.g., Velasco et al., 2016c, for a review), colour hue and taste (e.g., Spence et al., 2015), or pitch and taste (e.g., Crisinel & Spence, 2010). Nevertheless, in our everyday lives, we experience several cues at a time. Think again, for example, of the case of Coca Cola. The typeface is curvy and the words are sometimes presented in white or in red, with red or white backgrounds, respectively. Moreover, the sound associated with the words 'Coca Cola' may convey a specific meaning, independently of the colour or the typefaces which they use. The combination of multiple sensory features, as captured in typefaces, undoubtedly represents an interesting opportunity for future research.

5.4. Final remarks

Typeface is a ubiquitous design element that, as demonstrated throughout this review, can influence people's taste expectations and experience. One of the hope for the future is that, by giving the typeface in which the text and/or brand name of a commercial food or beverage product is written, a 'sweeter' association (or connotation; Doyle & Bottomley, 2009; Walker, 2008), it might just be possible to modify the actual sweetness of the product ever so slightly, while keeping the impression in the mind of the consumer the same (i.e., constant). Further research will be undoubtedly needed to clarify under which circumstances the studies reviewed here replicate in more ecologically-valid settings (e.g., mass consumption products). Nevertheless, we believe that designers, food and drink companies, but also for those who regulate what is shown and what is shown in different marketing communication associated with food and drink products, should think twice before selecting the typefaces associated with such products. In the end, changing a small detail such as the font of any message included in a package of, for example, a mass consumption product can impact the behaviour of a large group of people.

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FIGURE LEGENDS

Figure 1. Which of these typefaces would you associate with a sweet-tasting product? Examples of typeface having different connotations: (A) Dampfplatz, (B) Helvetica ultra-light, (C) Bodoni Poster Italic, (D) Lazybones, (E) VAG Rounded, (F) Klute. While the same word is presented in each case, the connotations differ (see Hyndman, 2015).

Figure 2. Examples of different typeface demonstrating some of the characteristics that are taken into consideration by the designer during the process of typeface design. The yellow shaded areas highlight different widths of typeface, differing x-heights, and the contrast between thick and thin strokes.

Figure 3. If these jams differed in terms of their level of sweetness, which do you think would be sweeter? Panels A and B present the same jam packaging with a round and an angular typeface, respectively.

Figure 4. Example of scale used in taste/shape and flavour/shape association studies. People are asked question such as: "To what extend do you associate the taste with the shapes? Mark an X anywhere on the line, where you think best represents your association."

Figure 5. Round (A) and angular (B) typefaces used in Velasco et al.'s (2014) experiment.

Figure 6. The rounded and angular typeface used in Velasco et al.'s (2015b) recent study of the taste associations that people hold with typeface. In summary, sweet taste was associated with the rounder typefaces, whereas the other tastes (bitter, sour, and salty) were all associated with the more angular typeface [Figure adapted and reprinted from *i-Perception, 41*, Carlos Velasco, Andy T. Woods, Sarah Hyndman, & Charles Spence, Copyright (2015].

Figure 7. The various typefaces used in Velasco et al.'s (submitted) recent cross-cultural study of the taste associations with angular and rounded typeface. The expression "eat me" is written in Spanish, English, and Chinese, respectively, in round and angular typefaces and their regular and bold versions. The typefaces used for the Spanish and English words include the following (from left to right): Eras Light ITC, Jasmine UPC, Segoe script, Bell MT, Nueva Std, and メイリオ. The typefaces used for the Chinese words comprise (also from left to right): Round sans, SimYou, SimLi, Simsun, SlimSimsun, Imitated Simsun. A general

finding from this study was that rounder typefaces were more strongly associated with sweet, whereas angular typefaces were more strongly associated with the other tastes.

Figure 8. Typefaces used at the Victoria & Albert Museum for the London Design Festival on 14th September 2014: A) Modified London 2012 and B) VAG Rounded.

Figure 9. Boxplots representing the results of Experiment 2. Boxplots for the different ratings as a function of group. Boxplots visualize the distribution of the data based on the minimum value, first quartile, median, third quartile, and maximum value. The points that are shown individually are those which fall in the lower or upper percentiles. These kinds of figures can provide the reader a better representation of the distribution of the data (see Weissgerber, Milic, Winham, & Garovic, 2015).

Figure 10. The three pairs of rounded vs. angular typeface that were used in the present study. A) VAG Rounded and Onyx slanted, upper case; B) Flemish Script and Klute; C) Candice and Engraver's MT slanted, upper case. Each of the typefaces was typeset to sit within a central area on an A4 page so that they appeared visually balanced (based on the suggestions of the designer). For example, the more condensed typefaces are shown a larger point size so that they appear equally prominent and it is therefore the typeface and not the scale being compared.

Figure 11. The response screen on the tablets used by participants to enter their responses.

Figure 12. Questionnaire used in the experiment. Note that one group of participants started with A and then B, and the other with B and then A.