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The taste of typefaces in different countries and languages

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Abstract

People associate tastes and taste words (e.g., “bitter”, “sweet”, etc.) with shape features in predictable ways. In the present study, we evaluate how the curvature and boldness of typeface influences the gustatory taste (i.e., bitter, salty, sour, and sweet) associated with the typefaces of words written in three languages (Spanish, English, and Chinese). The study also included participants from three countries: Colombia, the United Kingdom, and China. Consistent with previous research, rounder typefaces were reliably associated with the word sweet, whereas more angular typefaces were associated with the other tastes in all three languages and countries. These results provide robust support for the notion that shape curvature is differentially matched to tastes, in a manner that is similar, across countries. Moreover, the results also indicate that all of the participants evaluated the angular typefaces in Spanish and English as more bitter, salty, and sour than the round typefaces in Spanish and English, but this angular/rounded effect was not found with Chinese typefaces. Additionally, the rounder typefaces were evaluated as sweeter than the angular typefaces in all languages and countries. Given that the Chinese round and angular characters differed only in terms of the perceived curvature (not liking, familiarity, and clarity), it is not possible to conclude that liking accounts for all the correspondences that we report. Possible mechanisms and directions for future research are discussed.

Keywords: typeface, curvature, boldness, taste, crossmodal correspondences.

The taste of typeface in different countries and languages

Introduction

Visual cues typically provide important information about foods and drinks before they are tasted and consumed (e.g., Spence, 2015; Spence, Okajima, Cheok, Petit, & Michel, in press). Therefore, what we see before we eat and drink, such as the appearance of a fruit or product, can exert a significant influence over what we expect and hence subsequently what we perceive (Delwiche, 2012; Michel, Velasco, Gatti, & Spence, 2014; Piqueras-Fiszman & Spence, 2015). Here, we focus on typeface as it is a ubiquitous element of design that people are often exposed to before they eat (e.g., just think about reading a menu, or a product label/packaging, etc.) but which has received relatively little research interest to date. In particular, we explore how typeface features, namely their curvature and boldness, are associated with tastes, in the gustatory meaning of the term.

Typeface conveys meaning over-and-above the actual content of the words written (Doyle & Bottomley, 2009; Juni & Gross, 2008; Karnal, Machiels, Orth, & Mai, 2016; Kastl & Child, 1968; Poffenberger & Franker, 1923; Tannenbaum, Jacobson, & Norris, 1964). Just think of the typefaces that can be found in everything from book fonts through to the title of a movie and advertising messages (e.g., Garfield, 2011; Hyndman, 2015). There is evidence to suggest that the spatial structure and aesthetic properties of fonts can influence visual preference and prime specific concepts (e.g., Doyle & Bottomley, 2004, 2006, 2009; Grohmann, 2014; Grohamn, Giese, & Parkman, 2013; Henderson, Giese, & Cote, 2004; van Leeuwen, 2005, 2006).

Typeface may very well influence people’s expectations concerning food and drink and may prime specific associations (even without conscious awareness) prior to consumption. Nowadays, most products are contained within packaging whose (often branded) labelling (e.g., think of the distinctive typeface of *Coca Cola*) can influence people’s expectations, perception, and behaviour towards the product (e.g., Celhay, Boysselle, & Cohen, 2015; Silayoi & Speece, 2007; Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014). That said, the expectations we may have about the taste of a product can be influenced by the curvature of the typeface of, for example, the brand of the product. Indeed, Velasco et al. (2014) demonstrated that people categorize a product as sweet or sour depending on whether its name is written in a round (sweet; Swis721 B1kRnd BT—Black, 44 pt) or angular font (sour; Hollywood Hills—Regular, 53 pt). This effect is consistent with the literature suggesting that round shapes tend to be associated with sweetness whereas more angular shapes tend to be associated with the other basic tastes (see Velasco, Woods, Petit, Cheok, & Spence, 2016b, for a review).

The idea that round versus angular typefaces can lead to different taste associations has recently been further explored by Velasco, Woods, Hyndman, and Spence (2015b). In two experiments, these researchers demonstrated that rounder typefaces are evaluated as sweeter than more angular typefaces (the latter being rated as more salty, bitter, and sour). In addition, rounder typefaces were judged as easier to read and were liked more than their more angular counterparts. These results would appear to be consistent with the notion that people generally tend to prefer round as compared to angular shapes (see Gómez-Puerto, Munar, & Nadal, 2016, for a review). In turn, and given the fact that people tend to prefer sweet tastes over the other basic tastes (Birch, 1999), Velasco et al.’s (2015b) results would appear to suggest a possible hedonic mechanism when it comes to the matching of shape curvature and taste (Velasco, Woods, Deroy, & Spence, 2015a; Velasco, Woods, Marks, Cheok, & Spence, 2016b).

At least some associations between features and dimensions across the senses, such as those between tastes and shapes, may be in part based on a common feeling evoked by the stimuli that people associate[1] (e.g., Collier, 1996; Marks, 1996; Palmer, Schloss, Xu, & Prado-León, 2013). Therefore, people's liking for one typeface or another may, theoretically at least, influence the extent to which they match them to a taste. Here, however, it is worth mentioning that previous research has also suggested that the preference for curvature can be influenced by contextual variables (Carbon, 2010; Gómez-Puerto, Munar, & Nadal, 2016; Silvia & Barona, 2009). In that sense, both the language that one speaks and the typefaces in which different languages are written may provide different contexts that may modulate curvature preference and thus influence matches between tastes and typeface features.

The present study builds on the results reported recently by Velasco et al. (2014, 2015b). First, we wanted to replicate previous studies assessing whether shape curvature, in this case, the shapes of typeface, are similarly matched to taste words in different countries (Wan et al., 2014). Our prediction was that, at least those typefaces that are liked more, will be rated as significantly sweeter, and less bitter, salty, and sour, than those that are liked less. Second, we wanted to test whether the difference between typefaces that are distinctively perceived as either round or angular would vary as a function of both the language of the participants (Colombian, British, and Chinese participants) and the language of the words presented in specific typefaces (Spanish, English, and Chinese). Given that typefaces can be used to adorn written language (Doyle & Bottomley, 2006), conducting this study across languages can potentially provide information as to whether it is a typeface feature and not specific speech sound themselves, that drives the correspondence between taste words and typeface features. Moreover, we wanted to evaluate the strength of our results by conducting the same experiment across countries (in part, motivated by the recent discussion on

[1] Crossmodal correspondences are thought to provide complementary information about sensory events in the environment, in that, people can potentially infer something about a stimulus in one sensory modality (e.g., a taste) from a seemingly unrelated stimulus in another sensory modality (e.g., shape; Walker, 2016). Thus, when the only available information is a shape, people may potentially be able to infer something about a taste that matches the emotional connotation of the shape.

replicability issues in psychology, see Open Science Collaboration, 2015) and in participants with different backgrounds (not only from Western, educated, and from industrialized, rich, and democratic countries, see Henrich, Heine, & Norenzayan, 2010).

Lastly, we include an additional factor in our study, namely, the boldness of the typeface. We tested whether ‘bold’ as opposed to regular, typefaces impact taste-typeface associations – note that initial evidence from Velasco et al. (2015b) suggested that boldness did not influence which taste people associated to a typeface. Nevertheless, it is another critical visual feature of typefaces which can denote ‘potency’ (Henderson, Giese, & Cote, 2004). This is a dimension that relates to how strong or powerful people perceive a typeface as being (Morrison, 1986). Given that taste-shape associations may be influenced by the ‘potency’ of visual attributes (Velasco et al., 2016b), we further tested such prediction in this study, by including a larger and more varied set stimuli than used previously by Velasco and colleagues (2015b).

Methods and materials

Participants

In total, 322 participants took part in the study in Colombia, China, and the UK. However, the data from some of the participants had to be excluded from the analyses either because they failed to complete the task and/or because they indicated that they were not fluent in Spanish, English, or Chinese, respectively (n = 57). In total, the data from 82 participants from Colombia, 97 from the UK, and 86 from China, were analyzed (see Table 1, for a summary of the demographic data of these participants). All of the participants took part in the experiment through the Adobe Flash based Xperiment software (http://www.xperiment.mobi; for considerations regarding research online see Woods, Velasco, Levitan, Wan, & Spence, 2015). The Colombian participants were recruited via a database of participants from Universidad de la Sabana (Bogotá, Colombia), the UK participants were recruited via Prolific Academic (http://prolificacademic.co.uk/) and were compensated with £1.50 for their time, and the Chinese participants were recruited through the subject pool of a Laboratory in Tsinghua University in Beijing, China.

INSERT TABLE 1 ABOUT HERE

Apparatus and materials

The images of the words “eat me” in 12 different typefaces in Spanish, English, and Chinese, respectively, were selected to have a distinct perceived curvature (3 round and 3 angular) and boldness (in their regular and bold formats, see Figure 1, all stimuli can be access here osf.io/hp5yp). The typefaces were carefully chosen based on the recommendations of a designer based in Colombia and another based in China and we will refer to them from now as round and angular typefaces. The English and Spanish rounded typefaces comprised Eras Light ITC, Jasmine UPC, and Segoe Script. The angular English and Spanish typefaces, on the other hand, included the following fonts: Bell MT, Nueva Std, メイリオ. For the rounded Chinese

characters, the following typefaces were used: Round sans, SimYou, and SimLi. The angular Chinese characters included: Simsun, Slim Simsun, Imitated Simsun. Note that the Chinese characters used in the present study are Simplified Chinese Characters currently used in mainland China; and that 5 of the 6 Chinese typefaces (except for the Simyou) were selected from Hanyi Fonts Library (Beijing Hanyi Keyin Information Technology Co. Ltd., www.hanyi.com.cn). Several typefaces, that were intuitively thought of as angular or round and which were in their bold and not bold versions, were included in order to guarantee some variability in the stimuli that would likely boost the generalizability of the results. That said, as it will be described later, perceived curvature ratings were included in order to confirm that the typefaces were distinctively perceived as either round or angular by the participants. The participants in Colombia, China, and the UK were presented with the words in the different typefaces of the three respective languages. The experiment was reviewed and approved by the Central University Research Ethics panel.

INSERT FIGURE 1 ABOUT HERE

Procedure

At the beginning of the study, the participants were presented with a general overview of the experiment and a standard consent form, to which they agreed before taking part. The experiment started after the participant had answered some demographic questions (age, gender, country of origin, proficiency level of Spanish, English, and Chinese). The experiment consisted of three blocks (one per language) of eight trials. Both block and trial order were randomized. Throughout the eight trials, the participants were asked to arrange, into various box-type visual analogue scales, the different typefaces in terms of the extent to which they thought they associated them with sweet, sour, salty, and bitter tastes (e.g., “not at all sweet” to “sweet”, see Figure 2 for a sample trial). The participants also organized the font stimuli as a function of their perceived familiarity, curvature, liking, and clarity, in scales anchored with “not familiar” and “familiar”, “round” and “angular”, “like” and “dislike”, and “not at all clear” and “clear”, respectively. We included curvature in order to confirm that our experimental manipulation of this variable was perceived by the participants. The other variables were included as they may influence (and possibly mediate) the way in which people associate a taste with a shape feature (Velasco et al., 2015b, c). At the end of the experiment, one additional trial was included in which the participants arranged the different taste words (sweet, sour, bitter, and salty) in order to indicate how much they liked them[2]. All of the variables were scored from 0 to 100 to two decimal places (each score reflected the horizontal position of the midpoint of each text relative to the length of the box they were placed within).

INSERT FIGURE 2 ABOUT HERE

Analysis

The results are presented for each country separately. Based on our hypothesis, the different typefaces were collapsed across curvature and boldness for each language block for the analyses. We evaluated whether language, typeface curvature, and the boldness of the typeface influenced the participants' ratings for each of the variables. For that purpose, we used a Gaussian Generalized Estimating Equations (GEE) method (with an exchangeable correlation matrix, see Liang & Zeger, 1986), as implemented in the R statistics package {geepack} (Halekoh, Højsgaard, & Yan, 2006). The advantage of using a GEE over, for example, a standard regression is that it is more robust when controlling for multiple responses and particularly when the data is not independent (as is the case with many repeated measures designs). With the latter in mind, for the type of data we have there is a lower chance of incurring in a type-II error with a GEE (see Hanley et al., 2003; Salgado-Montejo, Alvarado et al., 2015). The significant main effects and interactions were

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[2] These data were analysed by means of a 4 x 3 mixed design analysis of variance with taste (bitter, salty, sour, and sweet) as the within-participant factor and country (Colombia, UK, and China) as the between-participant factor. The results revealed a significant effect of taste, $F(2.91, 761.48) = 218.66$, $p < .001$, $\eta_p^2 = .455$ (note that the Greenhouse-Geisser correction was applied) and the interaction between taste and country, $F(6, 786) = 8.09$, $p < .001$, $\eta_p^2 = .058$. No significant effect of country was observed, $F(2, 262) = .20$, $p = .820$, $\eta_p^2 = .002$. Bonferroni-corrected pairwise comparisons revealed that the participants liked "sweet" ($M_{sweet} = 85.20$, $SD_{sweet} = 21.32$) more than the other tastes ($p < .001$, for all comparisons, $M_{bitter} = 22.60$, $SD_{bitter} = 25.84$; $M_{salty} = 52.11$, $SD_{salty} = 32.36$; $M_{sour} = 49.35$, $SD_{sour} = 32.06$) and liked bitter less than the other tastes ($p < .001$, for all comparisons). As for the interaction term, the participants in Colombia and China reported liking "sour" more than the participants in the UK ($p < .001$, for both comparisons).

subsequently analysed using Bonferroni-corrected pairwise paired Wilcoxon Rank Sum Tests, as implemented in R statistics.

Results

Colombia

Curvature, familiarity, liking, and clarity ratings in Colombia. The GEE analysis of curvature, familiarity, liking, and clarity, is presented in Table 2 (see also Figure 3, for a visualization). In Colombia, the round typefaces were considered rounder, clearer, more familiar, and were liked more, than the angular typefaces. The participants rated the bold typefaces as significantly rounder and less clear, than those without bold. Notably, the participants rated the typefaces in English (p = .014) and Spanish (p = .020) as significantly clearer and more familiar (p < .001, for both comparisons) than those typefaces in Chinese.

INSERT TABLE 2 ABOUT HERE

An interaction between language and curvature was found for all ratings. The participants liked the round typefaces more and rated them as more familiar and as clearer than the angular typefaces when they were presented in Spanish and English (*ps* < .001), but not in Chinese (*ps* > .999). In contrast, the angular typefaces were considered as more angular than the round typefaces, in all three languages (*ps* < .001). Pairwise comparisons performed after the interaction between language and bold revealed that, overall, the participants rated the typefaces in Chinese without bold as more angular and clearer than the typefaces in Chinese with bold (*ps* < .001). In terms of the three-way interaction, whilst the difference between the curvature ratings of the Chinese typefaces with and without bold was significant (p = .001) for the angular typefaces, such difference was not significant for the round typefaces (p = .477).

INSERT FIGURE 3 ABOUT HERE

Taste ratings in Colombia. GEE analysis revealed a significant effect of typeface curvature and a significant interaction of language and typeface curvature for all taste ratings (see Table 3, for a summary of the statistics, and Figure 4 for a visualization of the mean taste ratings obtained in Colombia). The participants considered the rounder typefaces as sweeter than the angular typefaces, and the angular typefaces as more bitter, sour, and salty, than the round typefaces. As for the interaction term, the participants considered the angular typefaces in Spanish and English to be more bitter, salty, and sour than the round typefaces ($ps < .001$). Note that this was not the case for those typefaces presented in Chinese ($ps \geq .058$), though the Chinese angular typefaces were rated as more salty than their round counterparts ($p < .001$). The round typefaces were considered as significantly sweeter than the angular typefaces in all three languages ($ps \leq .027$).

INSERT TABLE 3 ABOUT HERE

The interaction between language and bold for the sour ratings was not significant in terms of the pairwise comparisons ($ps \geq .097$). Finally, a three-way interaction between language, curvature, and bold, for the salty ratings was obtained. After correcting for multiple comparisons only a borderline trend suggests that the angular Chinese typefaces without bold are rated as more salty than the round ones ($p = .051$), a difference for which there was no evidence when it comes to the Chinese typefaces with bold ($p = 491$).

INSERT FIGURE 4 ABOUT HERE

UK

Curvature, familiarity, liking, and clarity ratings in the UK. The summary of the GEE analyses on the curvature, familiarity, liking, and clarity ratings are presented in Table 4 (see also Figure 5 for a visualization of the mean ratings). The participants from the UK rated the Chinese typefaces as significantly more angular than the Spanish and English typefaces (*ps* $< .001$). The participants from the UK also rated the English typefaces as being significantly more familiar than the Chinese ($p < .001$) and Spanish typefaces ($p = .003$), and the Spanish typefaces as more familiar than the Chinese typefaces ($p < .001$). In addition, the participants liked the round typefaces more, and rated them as significantly rounder, more familiar, and clearer, than the angular typefaces. The participants rated the bold typefaces as significantly rounder, and clearer, than the typefaces without bold.

INSERT TABLE 4 ABOUT HERE

An interaction between language and curvature was found for all variables. As with the Colombian participants, participants from the UK also liked the round typefaces more and rated them as more familiar and clear than the angular typefaces when they were in Spanish and English ($p < .001$), but not when they were in Chinese ($p > .999$). The angular typefaces, on the other hand, were considered as more angular than the round typefaces, in the three languages (*ps* $< .001$). The two-way interaction between language and bold, and the three-way interaction between language, curvature, and bold, also exerted a significant effect on the curvature ratings. The participants rated the Chinese typefaces without bold as more angular than those with bold ($p < .001$). This did not happen for the English and Spanish typefaces (*ps* $\geq .990$). As for the three-way interaction, visual inspection of Figure 5 indicates that the participants rated both the Chinese round ($p < .001$) and angular typefaces ($p < .001$) without bold as significantly more angular than their counterparts with bold, something for which no evidence was found for the typefaces in Spanish and English ($p > .999$).

INSERT FIGURE 5 ABOUT HERE

Taste ratings in the UK. A visualization of the mean taste ratings as a function of language, curvature, and bold, in the UK, is presented in Figure 6 (see also Table 5 for the GEE results). Here, a significant effect of typeface curvature and an interaction between language and typeface curvature were also found for all taste ratings (see Table 3, for a summary of the results). The participants from the UK also considered the rounder typefaces to be sweeter than the angular typefaces, and the angular typefaces to be more bitter, sour, and salty, than the round typefaces. The results from the interaction term between language and curvature were also similar to those obtained in Colombia. The participants rated the angular typefaces in Spanish and English as more bitter, salty, sour, and less sweet than the round typefaces (*ps* < .001). Note that this was not the case for those typefaces in Chinese (*ps* ≥ .18).

INSERT TABLE 5 ABOUT HERE

Pairwise comparisons conducted in order to assess the interaction between language and bold for the sour ratings revealed that the participants rated the Chinese typefaces without bold as more sour than the ones with bold ($p = .047$), a difference for which we did not find evidence in the words in Spanish and English ($p > .999$). For bitter, there was also a three-way interaction between language, curvature, and bold. The participants rated as more bitter the angular than the round typefaces with and without bold in English and Spanish (*ps* < .001) but not in Chinese (*p* >.878). Visual inspection of Figure 6 shows that it may be the case that a difference between typefaces with and without bold in the angular Chinese typefaces but not in Spanish and English.

INSERT FIGURE 6 ABOUT HERE

China

Curvature, familiarity, liking, and clarity ratings in China. The GEE analyses of curvature, familiarity, liking, and clarity ratings are also presented in Table 6 (see also Figure 7, for a visualization of the mean ratings). The main effect of language on the clarity ratings did not reach statistical significance after correcting for multiple comparisons (*ps* > .071). The round typefaces were considered rounder, clearer, more familiar, and were liked more, than the angular typefaces. What is more, the participants liked the bold typefaces more, and considered them as rounder and clearer than the angular typefaces. The interaction between language and curvature was significant for all variables but curvature. Consistent with the results from both Colombia and the UK, the participants also liked the round typefaces more and rated them as more familiar and clear than the angular typefaces when they were in Spanish and English (*ps* < .001), but not in Chinese (*p* > .999).

INSERT TABLE 6 ABOUT HERE

An interaction between language and bold was found for all variables but liking. The participants rated the typefaces with bold as less angular than those without bold in Spanish (*p* < .001), English (*p* = .005), and Chinese (*p* = .050). Participants also considered the

Spanish typefaces with bold, but not those in other languages (*p* > .999), as more familiar than those without bold in the same language (*p* = .017). The bold typefaces were considered as clearer than those without bold in English (*p* = .003) and Spanish (*p* < .001), but not in Chinese (*p* = .47). In addition, a significant interaction between curvature and bold was found for familiarity. After comparing bold vs. no bold within the angular and round typefaces, the comparisons were not significant (*ps* > .058). Three-way interactions between language, curvature, and bold, were found for curvature and liking ratings. As it appears in Figure 7, the Chinese angular and round typefaces without bold were rated as more angular than their non-bold counterparts (*p* < .001 and *p* = .006, respectively), however, there was no evidence for such a difference in the other languages and typeface curvatures (*p* > 07). Moreover, the participants seemed to like the Spanish round typefaces with bold more than those without bold (*p* = .001). However, such differences do not appear to be as salient in the other languages (*p* ≥ .124).

INSERT FIGURE 7 ABOUT HERE

Taste ratings in China. The analyses of the taste ratings were also similar to those obtained in Colombia and the UK (see Figure 8, and Table 7 for the GEE results). A significant main effect of curvature was found for all taste ratings. The participants considered the angular typefaces as significantly more bitter, sour, and salty, whilst considering them to be less sweet, than the round typefaces. In addition, a significant main effect of bold was found for bitter, salty, and sweet. The bold typefaces were considered more bitter, salty, and sweet than the typefaces without bold.

INSERT TABLE 7 ABOUT HERE

The results of the Chinese participants were similar to those from the participants of both Colombia and the UK in terms of the interaction between language and curvature. Here, the angular typefaces in Spanish and English were considered as more bitter, salty, and sour than the round typefaces (*ps* < .001) but there was no such difference between Chinese typefaces (*ps* > .45). Round typefaces though were considered as significantly sweeter than the angular typefaces in all three languages (*ps* < .001). Finally, the interaction between curvature and bold, found for the bitter ratings, revealed that the angular typefaces without bold were rated as less bitter than the angular typefaces with bold (*p* = .002), however, there was no evidence of such a difference for the round typefaces (*p* = .930).

INSERT FIGURE 8 ABOUT HERE

Discussion

We conducted an experiment in Colombia, the UK, and China, where the participants were asked to match the words "eat me", in different typefaces varying in terms of their perceived curvature and boldness, and whether this was written in Spanish, English, and Chinese, to four basic taste words, namely, sweet, sour, bitter, and salty. Moreover, the participants also had to rate the same typefaces in terms of how much they liked them and also how round/angular, familiar, and clear, they considered them to be.

Typeface curvature, familiarity, clarity, and liking evaluation

Each group of participants rated the typefaces somewhat differently as a function of language. In particular, the Colombian participants rated the Spanish and English words as clearer and as more familiar than the Chinese words. The British participants rated the

English words as more familiar than the Spanish and Chinese, and the Spanish as more familiar than the Chinese. Moreover, they also rated the Chinese words as more angular than the Spanish and English words. In contrast, no effect of language was found for the Chinese participants. Whilst the participants were asked to rate the typeface and not the words it is possible that the participants' responses were somewhat influenced by whether or not the typefaces were presented in the participants' language (cf. Walker, 2008; Warren & Lasher, 1974).

As expected, the participants rated the round typefaces as rounder than the angular typefaces in all languages, in the three countries tested in the present study. In addition, the round typefaces were liked more and thought of as clearer than their angular counterparts. This is largely consistent with the idea that people generally prefer round over angular visual contours (Gómez-Puerto, Munar, & Nadal, 2015, for a review); it is also possible that round objects may be easier to process than angular objects (LoBue, 2014, Song & Schwartz, 2008), resulting in increased preference (Velasco et al., 2015b). On a similar note, it has been suggested that the level of horizontal autocorrelation of the image of words in a given font can influence reading speed (Jainta, Jaschinski, & Wilkins, 2012; Wilkins et al., 2007). Given that that round fonts have lower horizontal autocorrelation than angular fonts, people may process them faster (A. J. Wilkins, personal communication, October 6, 2016), regardless of their subjective experience (as captured in the present research) of how 'clear' they appear to be.

Overall, the rounder typefaces in Spanish and English, though not the Chinese, were considered to be more familiar than their angular counterparts. Whereas feelings of familiarity may be linked with memory, such feelings may also arise from the fluency with which a stimulus is processed (Whittlesea, 1993). That said, one possibility is that the perceived ease with which the round typefaces are processed led to increased feelings of familiarity (see also Westerman, Lanska, & Olds, 2015; though see Bernard, Chaparro, Mills, & Halcomb, 2003). Alternatively, however, the participants may have found round typefaces to be more familiar as they are more prototypical of commonly used typefaces compared to angular typefaces (Velasco et al., 2016b, potentially, the preference for curved vs. Agular may well be captured in the way in which typefaces are used in different communication contexts).

In terms of the effect of boldness, bold typefaces were considered as rounder in Colombia (where they were also considered to be less clear) and the UK. In China and the UK, bold typefaces were not only considered rounder, but were also rated as clearer, and in china they were also liked more. The idea that bold typefaces were considered as rounder than regular typefaces suggests that boldness may have strengthened ratings on a dimension that can also denote intensity, namely, curvature (Lyman, 1979; Morrison, 1986; Poffenberger & Barrows, 1924). Note, however, that the increased 'roundness' ratings of the bold typefaces did not necessarily mean that the participants always liked the bold typefaces more, at least, that was not the case for Colombia and the UK.

Here, it is worth mentioning that the many reported interaction effects of, for example, curvature and language or boldness and language on the curvature, liking, familiarity, and clarity ratings in all three countries indicate that the different written languages used are, in some cases differently evaluated. For example, no difference was found in terms of liking, familiarity, or clarity between the round and angular Chinese characters in any country, though a difference in terms of curvature was found in all three. Context, in this case provided by specific languages, can shape people's evaluations of the typefaces (cf. Carbon, 2010).

The association between typeface features and taste

Overall, the participants in all three countries evaluated the round typefaces as sweeter than the angular typefaces, and the angular typefaces as more salty, sour, and bitter, than the round typefaces. These results are largely consistent with the literature in suggesting that shape curvature is differentially associated with both tastes and taste words, with sweetness being associated with round shapes and the other tastes with angular shapes instead (see Spence & Deroy, 2013; Velasco et al., 2016b, for reviews). Bold in itself only exerted an effect on the taste ratings provided by the Chinese participants. The latter rated the bold typefaces as significantly more bitter, salty, and sweet. Our initial hypothesis was that bold typefaces would signal ‘potency’ (Henderson, Giese, & Cote, 2004) and thus influence people’s associations with tastes. If that had been the case one may have expected an increase of taste ratings, as well. However, we did not find evidence in this direction in our data. Here, it is interesting to highlight that even if bold typefaces were perceived as rounder in all countries, only the Chinese participants considered them as sweeter (but also more bitter and salty, perhaps suggesting a differential effect in this group, when it comes to the potency that bold may represent).

The interaction between language and curvature was also present for the taste ratings in the three languages and countries. The participants evaluated the angular typefaces in Spanish and English as more bitter, salty, and sour than the round typefaces in these languages, but not in Chinese. However, the round typefaces were evaluated as sweeter than the angular typefaces in the three languages and three countries, with the exception of the Chinese typefaces in the UK sample. The latter parallels with the results of the curvature, familiarity, liking, and clarity ratings. That is, the liking, familiarity, and clarity ratings of the Chinese characters did not differ as a function of round vs. angular typefaces in any country, though the curvature ratings did. In other words, when the characters were similar in terms of liking, familiarity, and clarity, and not curvature, the Chinese participants still rated the round typefaces as sweeter than the angular ones. This did not extend to the other tastes. The aforesaid results are consistent with the idea that curvature influences the taste that people match with a given typeface (Spence & Deroy, 2013). Nevertheless, based on the aforesaid ideas, we cannot conclude, based in our data, that liking, familiarity, or clarity (an alternative word of easiness to process) can fully account for taste/shape matches, at least, as measured in the present study (see Velasco et al., 2016a).

Alternative accounts, limitations, and future research

One of the key limitations of the present study relates to the idea that the round and angular, and bold and regular typefaces used in the present study, varied in more ways than just curvature (e.g., concavities and convexities). This consequently makes it more difficult to pinpoint the key physical characteristics of typefaces that explains why it is that certain typefaces go better with some tastes. Despite this though, our results provide strong support for the idea that perceived roundness/angularity of fonts, at least for extreme exemplars, leads to different taste matches. Follow-up studies are thus called for, to keep as constant as possible different physical features of typeface (e.g., spacing, height, width). Yet, our results open up an interesting idea for the understanding of taste/shape associations, that is, even when there is no evidence for the alignment between liking and curvature (as in our data), people still match typefaces which are perceived as rounder to sweet tastes. This adds weight to the claim that these correspondences cannot entirely be thought of as affective correspondences, as suggested previously (Velasco et al., 2016b).

Evidence from aesthetic science and evolutionary biology suggests that, throughout evolution, different organisms (including humans) became especially sensitive to specific visual features. The sensitivity to specific features may be the result of a systematic and ancient association between these features and a survival advantage (Enquist & Arak, 1994; Gómez-Puerto, Munar, & Nadal, 2015, Makin, Pecchinenda, & Bertamini, 2012; Palumbo, Ruta, & Bertamini, 2015, Reber, Schwarz, & Winkielman, 2004, see also Collingwood, 1958; Hobbs & Salome, 1991). If we specifically consider roundness and angularity, we find that these features are present in multiple objects ranging from fruits (e.g., apples and berries) to weapons (e.g., knives). What is more, there is also evidence that some bodily movements and facial expressions can appear more or less angular or rounded (Aronoff, Woike, & Hyman, 1992, Larson, Aronoff, Sarinopoulos, & Zhu, 2009) and that these same expressions are associated with different gustatory tastes (Bredie, Tan, & Wendin, 2014, Steiner, Glaser, Hawilo, & Berridge, 2001). One possibility is that the effects reported showing that typefaces that are more angular are associated sourness and rounder typefaces are sweeter could be due to how the brain recognizes and associates these two basic features and associates them with the corresponding facial expressions when trying different sweet and sour foods. Alternatively, it may be the case that tastes and shapes are mapped onto common semantic dimensions, which will then provide the basis for the matches, something which would highlight the role of language and metaphor in crossmodal correspondences (Velasco et al., 2016a).

Furthermore, it is worth mentioning here that many previous studies in the context of taste/shape correspondences have similarly utilized taste words instead of actual tastants. As suggested by Velasco et al. (2016a), this can certainly be problematic given that the sound symbolic meaning of taste words may already convey specific notions that could lead to particular shape matchings (though e.g., Velasco et al., 2015a reported that people matched taste words and tastants in a similar way). With that in mind, in this study we utilized taste words in different languages with different phonetic properties (“dulce” in English phonetics sounds as in /DOOL:seh/, “sweet” as in /swiːt/, and “甜” as in /tiːən/ or /Tiːan/). If the results obtained in different countries were to follow the same pattern, this may provide initial evidence that it is the meaning of the words “sweet”, and not its sound symbolic meaning, which is what drives the association between taste words and shape features.

It is also important to consider that for many Spanish and English speakers, the Chinese characters may have not been understandable, whereas for Chinese participants, the Latin characters used in both Spanish and English (though perhaps more strongly with English words) would likely have been somewhat more comprehensible (see Table 1). Therefore, any semantic content of the words may have confounded our study. Yet, the findings presented here are still largely consistent across countries and languages, implying that any such an effect of semantics is not overly impactful in our study.

Given that our main focused was perceived typeface curvature and typeface boldness, it should be mentioned that, as one of the oldest written languages worldwide, Chinese is figuratively referred to as “Square Characters”. That is, each Chinese character, as the written symbol of the Chinese language, represents only one spoken syllable and carries one basic meaning. Most importantly, each Chinese character occupies a more or less square area in which the components of every character, regardless of whether this character has a very simple or complex structure, are written in, so to maintain a uniform size, shape, and spacing. We propose that the Chinese characters might generally be in a more “angular” global shape, whereas different typefaces might be considered angular or round only based on subtler, local features such as the start and/or the end of the strokes, and the angularity of the joints. In this sense, the roundness/angularity of the Chinese characters that the Chinese participants perceive might be very subtle and depend on their life experience. For example, those Chinese participants who have studied Chinese Calligraphy, the artistic form developed from the writing of Chinese characters, might be more sensitive to these subtle local features than others. Perhaps, the Chinese character might be less influenced by the roundness/angularity of the typefaces, partially because they are not that different from one another. No matter how round/angular local features are, the characters themselves are still “square”. That being said, bold might be a more important feature for the Chinese typefaces.

One last element to consider relates to the types of scales used in the present study. As discussed by Velasco et al. (2015b), in the box scales used in the present study, all typefaces are presented together and therefore their subtle differences may become more salient. For instance, it may be the case that for each language, the participants perceived certain differences between the typefaces as more or less salient. Furthermore, it is also possible that there are learned differences in how different features that are part of the typeface design are perceived and judged in each culture. Take for example the differences in visual exploration to recognize faces in Western and Eastern countries (e.g., Blais, Jack, Scheepers, Fiset, Caldara, 2008). In the context of our study, it is possible that differences in the characters that make of Chinese and Western alphabets, as well as the direction of writing, could all have an influence on what features of a typeface are more relevant to participants in each country.

Conclusions

The results of the present research further corroborate the idea that round typefaces are more strongly associated with sweet tastes than angular typefaces, which are more strongly associated with the other tastes than round typefaces. This effect is robust across languages and countries. What is more, our results indicate that valence cannot be thought of as the sole mediator of the associations between taste words and shape features; as found here, typefaces, just as is true of many other design elements, can also be used to convey taste-related information in the context of food and beverages. Taking into account both common associations (taste and curvature) and some more context-specific (boldness and taste), our results show it is possible to influence the taste that people associate with a given typeface.

"All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

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FIGURE LEGENDS

Figure 1. Stimuli utilized in the present study. 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, and Imitated Simsun.

Figure 2. In this sample trial, the participants responded to the words written in Spanish (thus in they were in the “Spanish” block). Note that the position of the different words/fonts above the box varied randomly across participants within a 1000-pixel x 154-pixel rectangular area. The participant’s task was to drag each word down into the 1000-pixel x 346-pixel box beneath this area, positioning each word according to the instructions. By allowing participants to place words within a box, participants could place several words at the same horizontal position but different heights, allowing those words to remain visible for future reference.

Figure 3. Mean ratings for the curvature, familiarity, liking, and clarity ratings in Colombia (n = 82) as a function of language, and typeface curvature and boldness. Each variable was rated on a VAS from 0 (not at all) to 100 (very much). Larger (smaller) values in the variable ‘round/angular’ in this and other figures indicate that the participants associated the typefaces more with angularity (roundness). The error bars in this and the other figures included in the present study represent the standard error of the means.

Figure 4. Mean taste ratings in Colombia (n = 82) as a function of language, typeface curvature and boldness.

Figure 5. Mean ratings for curvature, familiarity, liking, and clarity in the UK (n = 97) as a function of language, typeface curvature and boldness.

Figure 6. Mean taste ratings in the UK (n = 97) as a function of language, typeface curvature and boldness.

Figure 7. Mean ratings for the curvature, familiarity, liking, and clarity ratings in China (n = 86) as a function of language, typeface curvature and boldness.

Figure 8. Mean taste ratings in China (n = 86) as a function of language, typeface curvature and boldness.

Figure 1.

	Round			Angular		
Spanish	cómeme cómeme	cómeme cómeme	cómeme cómeme	cómeme cómeme	cómeme cómeme	cómeme cómeme
English	eat me eat me	eat me eat me	eat me eat me	eat me eat me	eat me eat me	eat me eat me
Chinese	吃我 吃我	吃我 吃我	吃我 吃我	吃我 吃我	吃我 吃我	吃我 吃我

Figure 2.

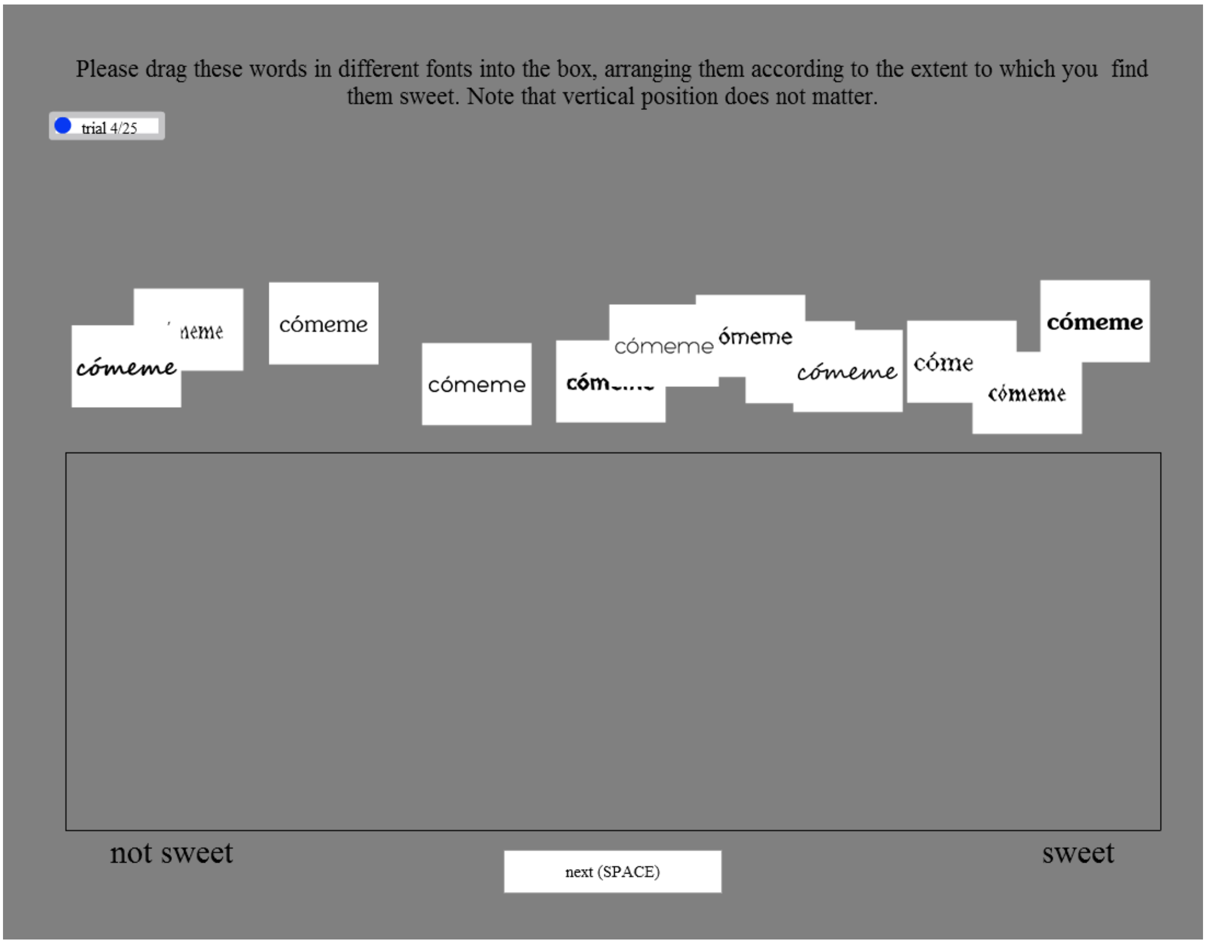
Please drag these words in different fonts into the box, arranging them according to the extent to which you find them sweet. Note that vertical position does not matter.
trial 4/25
cómeme
cómeme
cómeme
cómeme
cómeme
not sweet
next (SPACE)
sweet

Figure 3.

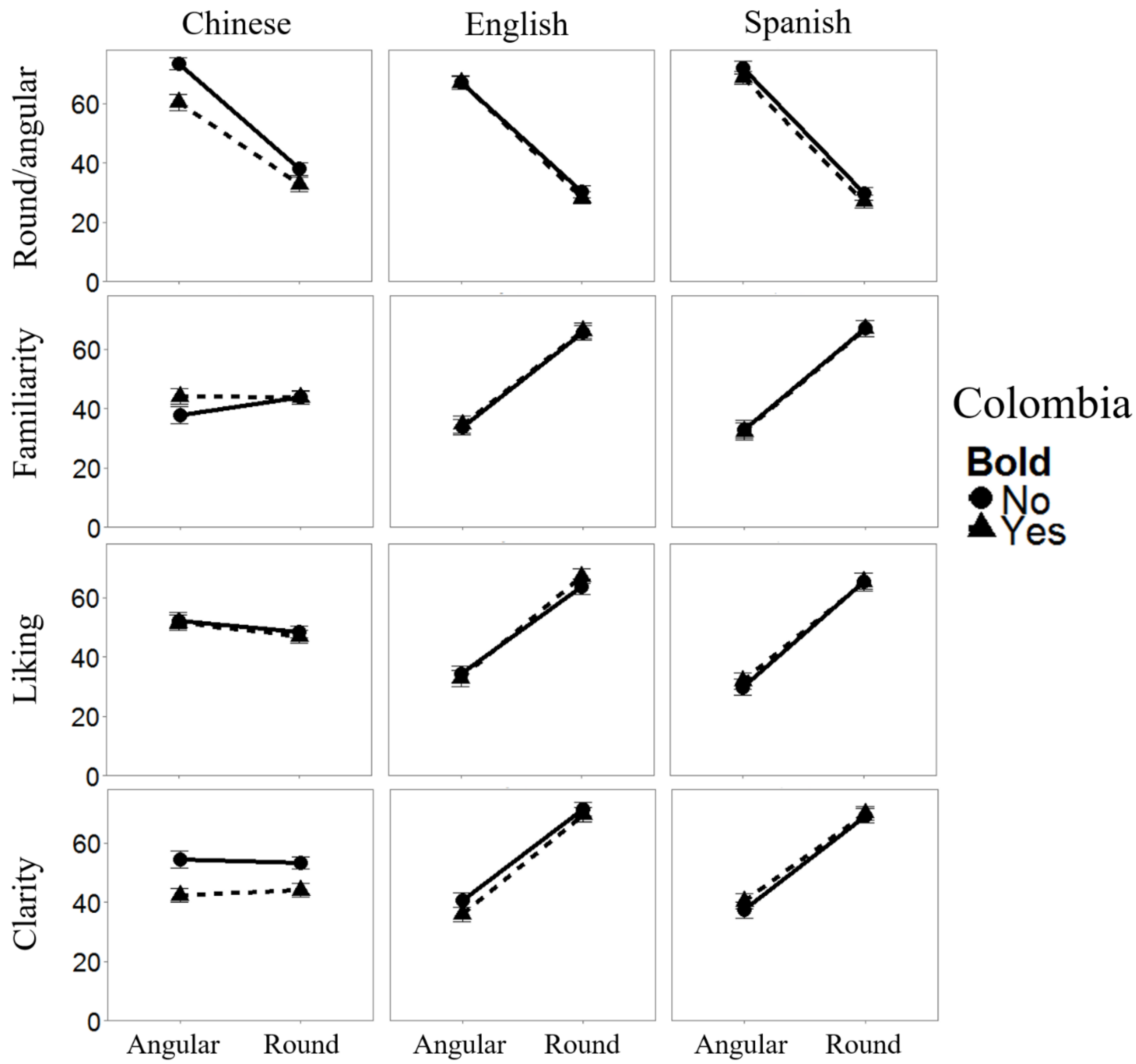
Chinese
English
Spanish
Round/angular
Familiarity
Liking
Clarity
0
20
40
60
Angular
Round
Colombia
Bold
No
Yes

Figure 4.

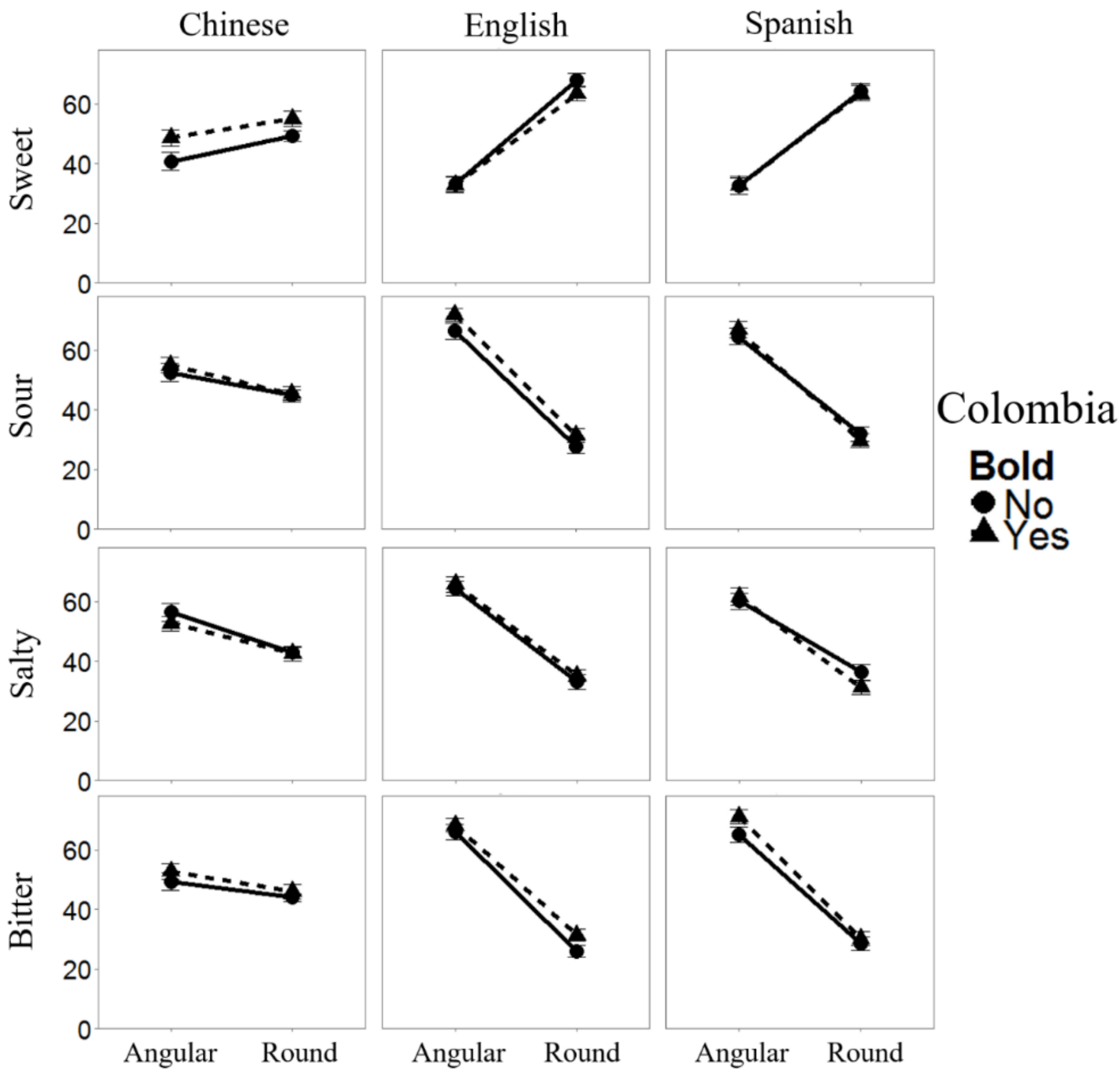
Chinese
English
Spanish
Sweet
Sour
Salty
Bitter
0
20
40
60
Angular
Round
Colombia
Bold
No
Yes

Figure 5.

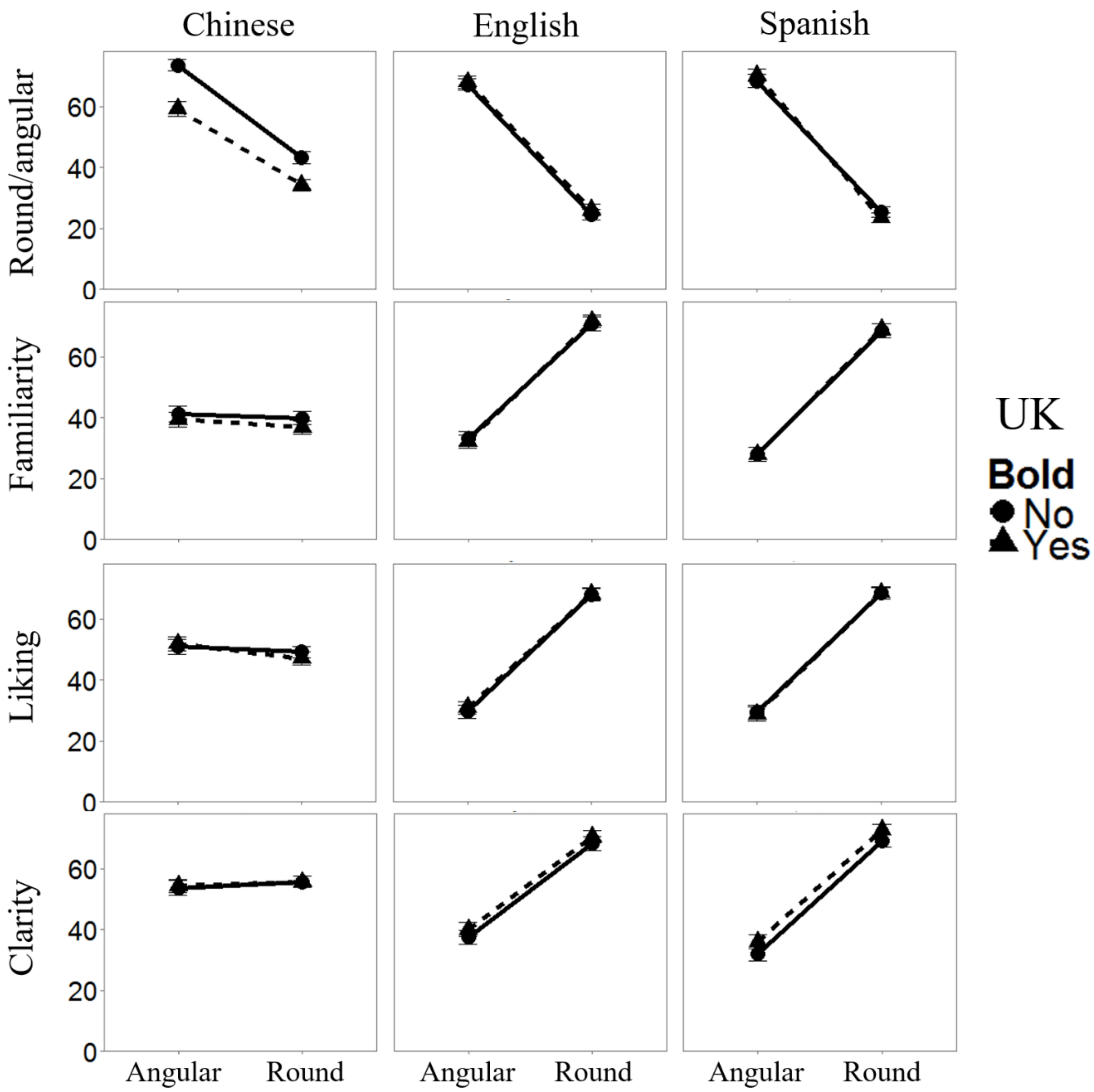
Chinese
English
Spanish
Round/angular
Familiarity
Liking
Clarity
0
20
40
60
Angular
Round
UK
Bold
No
Yes

Figure 6.

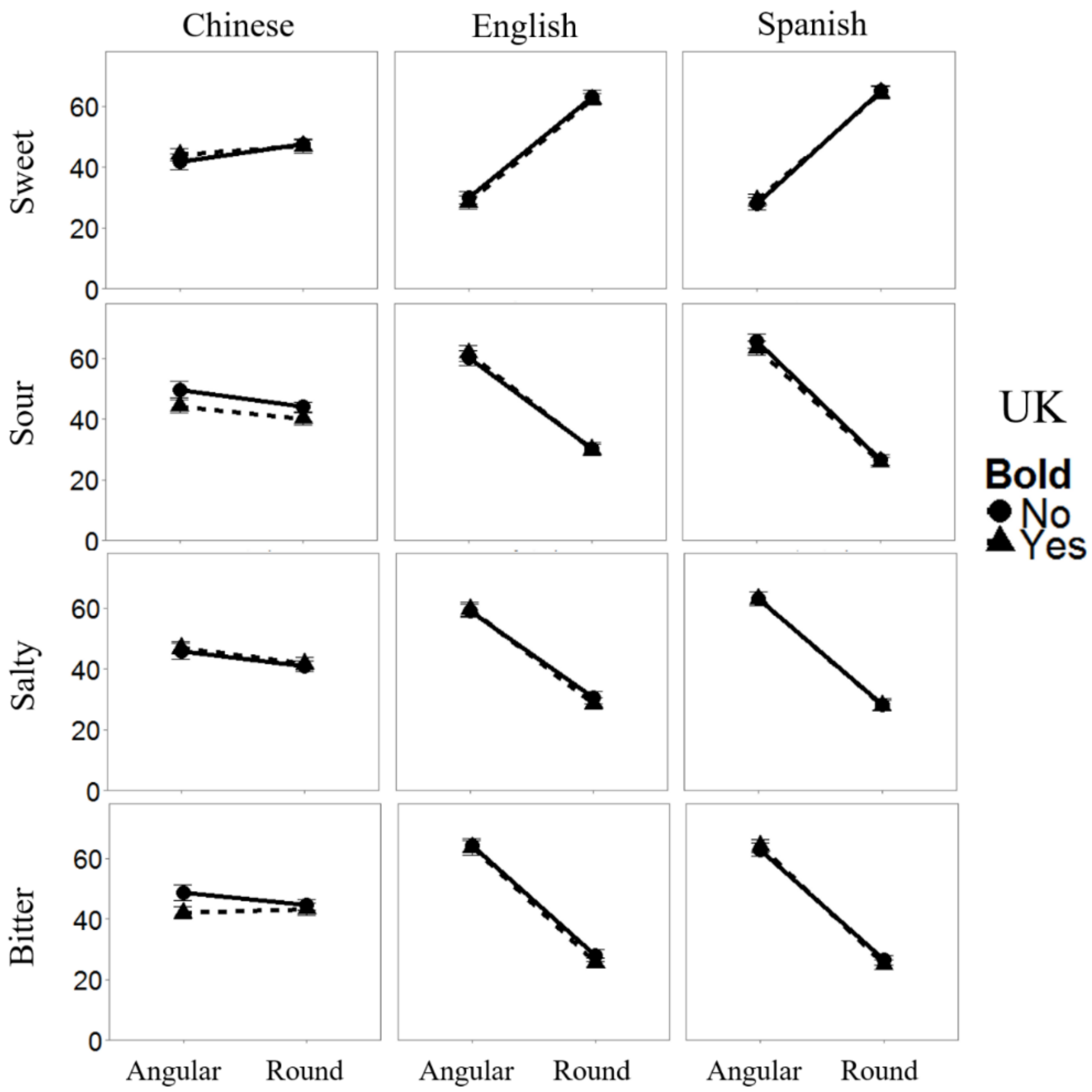
Chinese
English
Spanish
Sweet
Sour
Salty
Bitter
0
20
40
60
Angular
Round
UK
Bold
No
Yes

Figure 7.

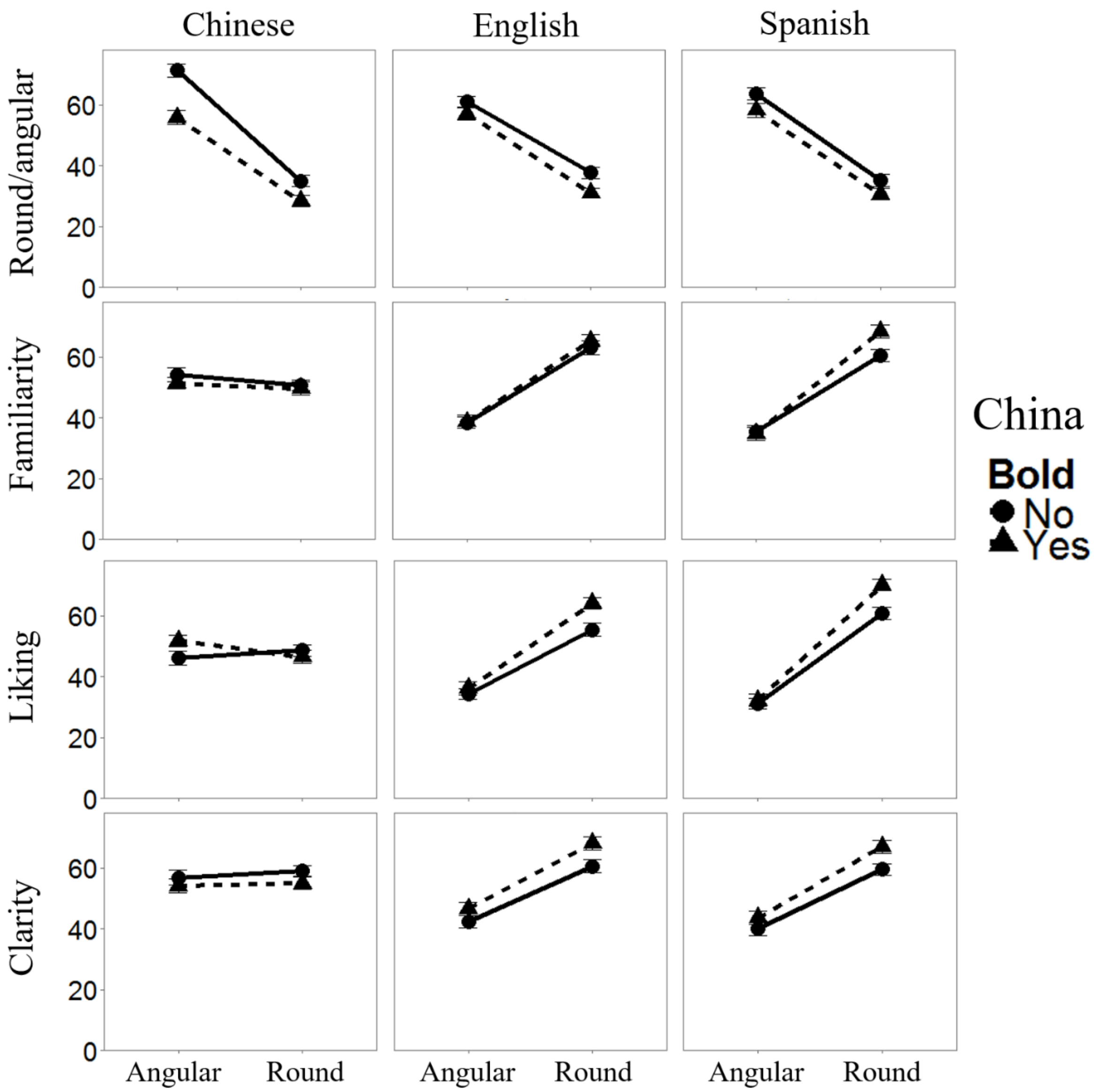
Chinese
English
Spanish
Round/angular
Familiarity
Liking
Clarity
0
20
40
60
Angular
Round
China
Bold
No
Yes

Figure 8.

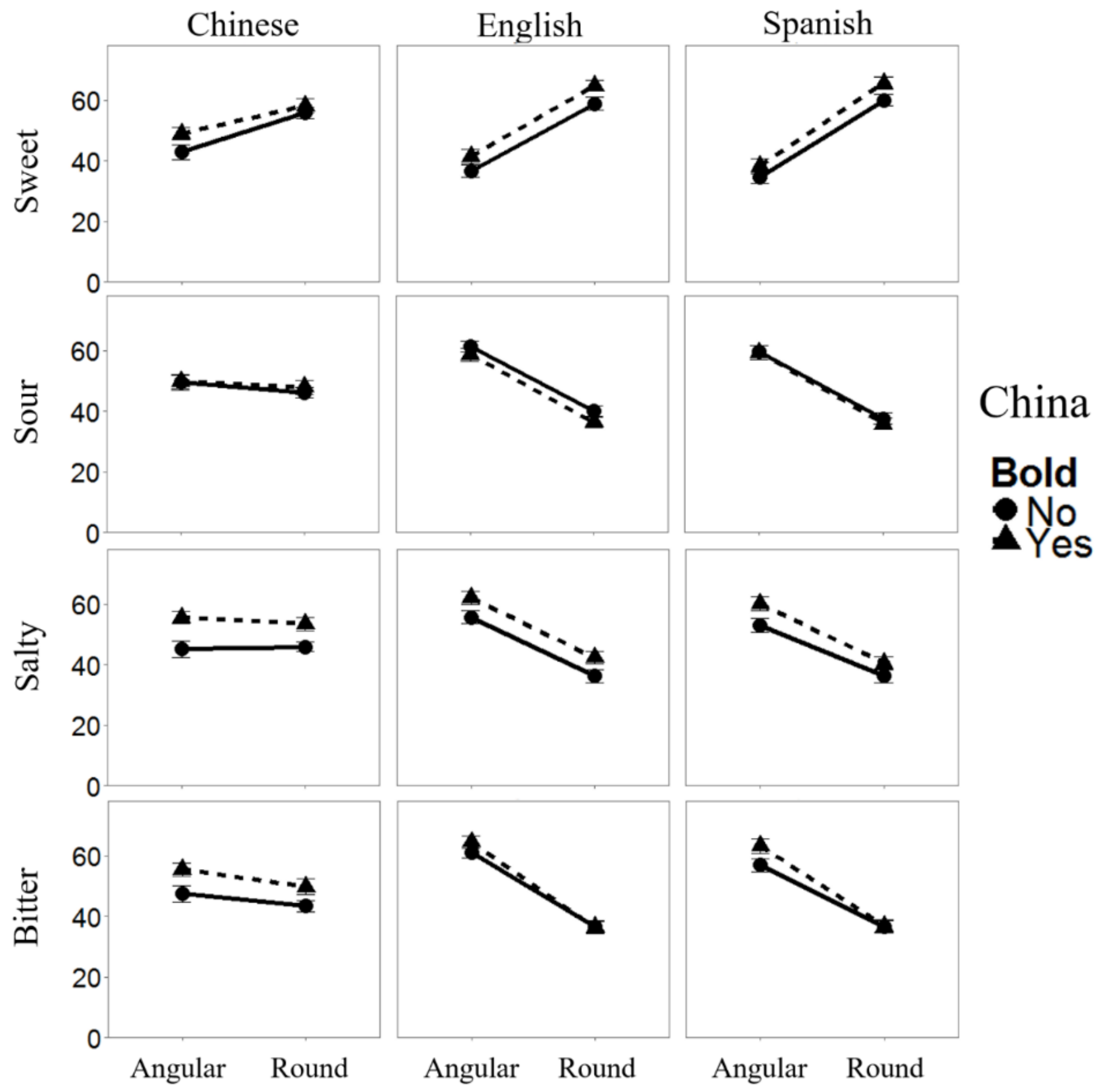
Chinese
English
Spanish
Sweet
Sour
Salty
Bitter
0
20
40
60
Angular
Round
China
Bold
No
Yes

Table 1. Summary of the demographic data of the participants from Colombia, the UK, and China whose data was included in the analyses.

Country	Age (Mean and SD)	Gender			Language fluency			
		Female	Male	NS	Level	Chinese	English	Spanish
Colombia	26.04 (9.21)	47	34	1	No	80	5	0
					Basic	1	18	0
					Conversational	0	38	0
					Fluent	1	21	82
UK	32.24 (10.39)	58	39	-	No	94	0	71
					Basic	2	0	25
					Conversational	0	0	1
					Fluent	1	97	0
China	20.85 (2.51)	41	43	2	No	0	2	86
					Basic	0	50	0
					Conversational	0	27	0
					Fluent	86	7	0

Table 2. Summary of the generalized estimating equation (GEE) analyses for the curvature, familiarity, liking, and clarity ratings in Colombia.

GEE - Colombia	Curvature		Familiarity		Liking		Clear	
(n = 82)	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	5.19	.075	**19.83**	**<.001**	2.47	.291	**10.89**	**.004**
Curvature	**219.99**	**<.001**	**70.12**	**<.001**	**62.37**	**<.001**	**84.41**	**<.001**
Bold	**27.37**	**<001**	1.07	.301	0.06	.805	**9.81**	**.002**
Language × curvature	**6.62**	**.037**	**51.06**	**<.001**	**75.52**	**<.001**	**56.08**	**<.001**
Language × bold	**13.69**	**.001**	2.51	.285	0.59	.744	**21.75**	**<.001**
Curvature × bold	1.62	.203	1.23	.267	0.19	.665	0.59	.443
Language × curvature × bold	**6.01**	**.050**	2.86	.239	5.28	.071	2.12	.346

Table 3. Summary of the generalized estimating equation (GEE) analyses for each of the taste ratings in Colombia.

GEE - Colombia (n = 82)	Bitter		Sour		Salty		Sweet	
	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	1.03	.598	1.88	.392	**5.97**	**.050**	1.07	.586
Curvature	**127.41**	**<.001**	**122.99**	**<.001**	**72.13**	**<.001**	**83.07**	**<.001**
Bold	3.37	.066	1.68	.194	0.19	.667	1.08	.300
Language × curvature	**85.45**	**<.001**	**55.10**	**<.001**	**18.68**	**<.001**	**37.68**	**<.001**
Language × bold	0.14	.934	**6.16**	**.046**	3.22	.200	5.54	.063
Curvature × bold	0.26	.611	3.38	.066	0.20	.655	1.87	.171
Language × curvature × bold	4.15	.126	0.73	.694	**10.57**	**.005**	0.84	.656

Table 4. Summary of the generalized estimating equation (GEE) analyses for the curvature, familiarity, liking, and clarity ratings in the UK.

GEE - UK (n = 97)	Curvature		Familiarity		Liking		Clear	
	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	**19.07**	**<.001**	**41.26**	**<.001**	0.62	.734	4.86	.088
Curvature	**310.55**	**<.001**	**153.89**	**<.001**	**129.63**	**<.001**	**127.85**	**<.001**
Bold	**24.23**	**<.001**	0.66	.415	0.00	.975	**4.60**	**.032**
Language × curvature	**29.91**	**<.001**	**124.58**	**<.001**	**130.82**	**<.001**	**106.03**	**<.001**
Language × bold	**53.19**	**<.001**	2.77	.251	0.60	.74	2.79	.248
Curvature × bold	0.43	.513	0.10	.747	0.87	.351	0.13	.715
Language × curvature × bold	**12.10**	**.002**	1.00	.605	1.43	.489	0.02	.993

Table 5. Summary of the generalized estimating equation (GEE) analyses for each of the taste ratings in the UK.

GEE - UK (n = 97)	Bitter		Sour		Salty		Sweet	
	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	0.60	.74	0.84	.656	1.91	.385	1.63	.443
Curvature	**153.85**	**<.001**	**120.06**	**<.001**	**118.59**	**<.001**	**155.98**	**<.001**
Bold	2.77	.096	2.60	.107	<0.01	.985	<0.01	.997
Language × curvature	**124.66**	**<.001**	**66.14**	**<.001**	**82.99**	**<.001**	**69.12**	**<.001**
Language × bold	3.48	.176	**6.04**	**.049**	0.48	.787	1.21	.547
Curvature × bold	0.08	.778	0.13	.721	0.64	.422	1.13	.288
Language × curvature × bold	**8.79**	**.012**	2.08	.354	0.70	.704	1.41	.495

Table 6. Summary of the generalized estimating equation (GEE) analyses for the curvature, familiarity, liking, and clarity ratings in China.

GEE - China (n = 86)	Curvature		Familiarity		Liking		Clear	
	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	0.81	.667	2.69	.26	1.03	.596	**8.47**	**.015**
Curvature	**153.42**	**<.001**	**78.65**	**<.001**	**87.58**	**<.001**	**66.39**	**<.001**
Bold	**42.78**	**<.001**	0.97	.326	**14.38**	**<.001**	**5.26**	**.022**
Language × curvature	3.06	.217	**61.80**	**<.001**	**93.57**	**<.001**	**30.31**	**<.001**
Language × bold	**9.75**	**.008**	**7.68**	**.021**	2.81	.245	**16.19**	**<.001**
Curvature × bold	3.68	.055	**7.35**	**.007**	1.80	.18	2.20	.138
Language × curvature × bold	**10.47**	**.005**	4.78	.092	**25.07**	**<.001**	1.92	.382

Table 7. Summary of the generalized estimating equation (GEE) analyses for each of the taste ratings in China.

GEE - China (n = 86)	Bitter		Sour		Salty		Sweet	
	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*	Wald X^2	*p*
Language	1.58	.454	0.58	.748	2.64	.267	2.80	.247
Curvature	**89.87**	**<.001**	**79.10**	**<.001**	**52.87**	**<.001**	**89.53**	**<.001**
Bold	**5.01**	**.025**	0.41	.521	**15.23**	**<.001**	**11.08**	**<.001**
Language × curvature	**35.81**	**<.001**	**31.18**	**<.001**	**30.10**	**<.001**	**14.32**	**<.001**
Language × bold	5.50	.064	3.31	.191	1.80	.408	0.31	.855
Curvature × bold	**8.03**	**.005**	0.01	.916	1.72	.190	0.06	.812
Language × curvature × bold	1.52	.469	0.62	.734	0.55	.758	2.38	.305