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Bittersweet Findings: Round Cups Fail to Induce Sweeter Taste

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Abstract: An increasing body of literature demonstrates that consumers associate visual information with specific gustatory elements. This phenomenon is better known as cross-modal correspondence. A specific correspondence that has received attention of late is the one between round forms and sweet taste. Research indicates that roundness (as opposed to angularity) is consistently associated with an increased sweetness perception. Focusing on two different cup forms (round versus angular), two studies tested this association for a butter milk drink and a mate-based soft drink. Results, however, were not able to corroborate the frequently suggested correspondence effect, but a correspondence was found between the angular cup and a more bitter taste for the soft drink. These results are discussed in light of previous findings matching sweetness with roundness and bitterness with angularity, hopefully aiding researchers in this field in conducting future experiments.

Keywords: cross-modal correspondence; shape; taste; beverage

1. Introduction

Recent research in sensory marketing highlights the fact that forms and visuals can influence perception of foods, a phenomenon known as cross-modal correspondence [1]. Specifically, perception through one or more senses, such as vision and touch, can influence perception in other modalities, such as taste [2] (see [3] for a recent review specifically related to beverages). Across a range of food products, round forms are believed to be associated with a sweeter taste [1], which is corroborated through a number of experiments [4]. Although such effects are readily discerned in exploratory research and shape-taste matching studies [4,5], it also seems to hold for empirical research involving actual food products. For instance, sweeter beers, as well as sweeter chocolate, are more strongly associated with round shapes [6,7]. These studies, however, rely mostly on controlled laboratory conditions and within-participants designs, where consumers can carefully deliberate associations between sweetness and roundness across shapes. Recent research, however, extends these laboratory results to actual retail settings by showing that consumers, in fact, perceive hot drinks (coffee and chocolate) consumed from cups with round surface patterns to be sweeter than when consumed from cups with angular surface patterns [8].

Empirical evidence thus indicates the non-randomness of associations between round shapes and sweet tastes. Here, I report two studies concerning container shape effects, designed to corroborate the "round equals increased sweetness" heuristic using two different beverages; a butter milk drink and a mate-based soft drink. Contrasting previous work, both studies failed to find differences in terms of sweetness perception. The taste of the mate-based soft drink, however, was found to be bitterer when consumed from an angular cup. In reporting these results, I aim to aid cross-modal correspondence researchers in making better choices in designing future experiments, and as such advance science's cumulative nature in this important field.

2. Study 1

2.1. Materials and Methods

2.1.1. Design, Participants, Stimuli, and Procedure

The study used a one-factor (drinking cup: angular versus round) between-subjects design. A total of 86 consumers (58.1% female, mean age = 46.89, SD = 19.47, range = 18–79) were intercepted randomly (i.e., every fifth visitor) upon entering a large, local supermarket, and were invited to participate in the tasting of a strawberry-flavored butter milk drink. Strawberry-flavored butter milk was chosen for its general non-conspicuousness, its fruit-flavored sweetness, and with the intent to extend the evidence base of cross-modal correspondences to other product categories. No specific ex- or inclusion criteria were applied, but, before participating, all participants were informed about the product and the voluntariness of their participation, and were fully debriefed afterwards. The drinking cups were hard transparent polystyrene cups, chosen based on their similarity in measurements and volume (see Figure 1 for the two cups). To ensure that participants were unaware of the manipulation, they were randomly assigned to either the round or the angular cup in batches of ten (i.e., first to tenth participant drank from the round, eleventh to twentieth from the angular cup, etcetera). Participants completed the questionnaire one after another using the same bar table situated near the entrance of the supermarket. In both conditions they sampled an identical premium brand of strawberry-flavored butter milk, and care was taken for all samples to include exactly the same amount of drink (40 mL). Temperature of the drink was kept at a constant 7 degrees Celsius.

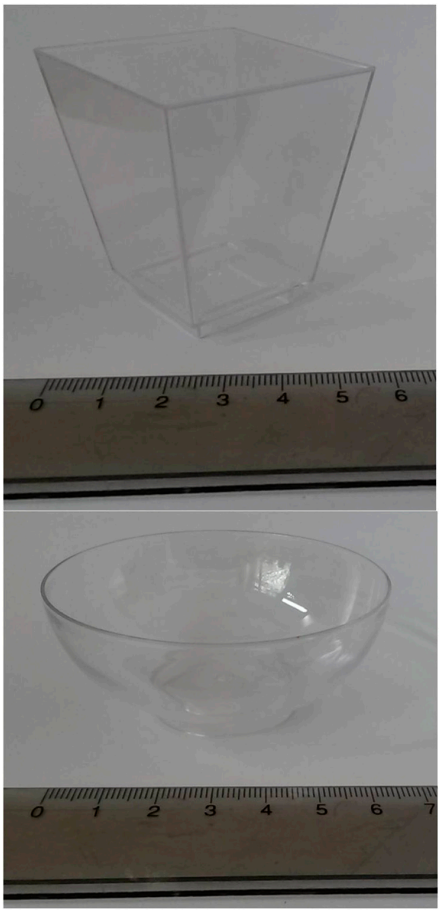

Figure 1. The angular (**above**) and round (**below**) cups used in the Study. Note: ruler measurement is metric (cm).

2.1.2. Measures and Analyses

To ascertain that participants held the cups long enough to get a feeling of the cup's form, they were first asked to answer questions regarding the smell of the product, assessed through the items *strong*, *powerful*, and *intense* (α = 0.83 [8,9]). More importantly, perceived sweetness was assessed through a single item (i.e., *this drink has a sweet taste*). Since sweetened butter milk has both sweet as well as sour taste components, and because angularity can be associated with sourness [10], a related question assessed how sour the drink was perceived (i.e., *this drink has a sour taste*). Complementing basic taste perception, participants additionally assessed the strawberry flavor of the drink with the items *this drink . . . . . tastes fruity*, *. . . has a dominant strawberry flavor*, and *. . . has a distinct strawberry flavor* (α = 0.87). Given that product form angularity is also related to intensity [9], taste intensity was assessed through the items *strong*, *powerful*, and *intense* (α = 0.82 [8,9]). Accounting for subjective differences, general product liking was measured through the item *this product tastes very good*. To control for possible differences in taste experience based on the premise that angular cups are commonly not used as drinking vessels, participants were asked to what extent they thought the drinking experience was *comical* (reverse scored) and *pleasant* (α = 0.76). General preference for butter milk was measured through the items *I generally like butter milk* and *I often drink butter milk* (α = 0.85). The questionnaire ended with questions regarding age and gender. All measures were 7-point Likert scales, ranging from 1 (completely disagree) to 7 (completely agree). Descriptives, frequencies, and between-group differences were calculated, where applicable, through analyses of variance, using IBM SPSS Statistics 22.

2.2. Results

Four consumers did not understand the questionnaire, or submitted non-usable answers (e.g., highlighting whole blocks of question items); their data sets were eliminated, reducing the analysis sample to 82 (57.3% female, mean age in years = 45.91, SD = 19.37, range = 18–79, two participants did not report their age). Preliminary analyses of variance showed that there were no differences between the two groups regarding age and gender (both F's < 1), nor in general liking of butter milk and drinking experience (both F's < 1).

Table 1 lists respondent age and gender distribution, together with means and standard deviations for all dependent variables, per group. Although slightly redundant (given these figures), a multiple analysis of variance, testing differences in the dependent variables depending on the independent variable (cup form: angular versus round) showed no differences between groups for any of the dependent variables (all F's < 1). *P*- and F-values have been omitted from Table 1 due to the obviousness of non-differences between the group means. Additional—explorative—analyses investigating between-group differences showed no contingence on moderator variables (i.e., gender, butter milk liking, and drinking experience).

Table 1. Age and gender distributions across groups, and means (standard deviations) for all dependent variables (Study 1).

Group Characteristics			Outcomes							
Manipulation	***N* (Female)**	**Age**	**Sweetness**	**Sourness**	**Smell Intensity**	**Taste Intensity**	**Liking**	**Strawberry Flavor**	**Butter Milk Preference**	**Drink Experience**
Round cup	39 (23)	46.18 (21.58) [1]	4.34 (1.84) [1]	2.72 (1.49)	4.16 (1.48)	4.14 (1.29) [3]	4.05 (1.84)	4.19 (1.60)	3.14 (1.78)	5.24 (1.61) [3]
Angular cup	43 (24)	45.67 (17.40) [1]	4.12 (1.79)	2.72 (1.55)	4.31 (1.54)	4.15 (1.20)	4.33 (1.67)	4.38 (1.39)	3.37 (1.77)	5.03 (1.58)
Overall	82 (47)	45.91 (19.37) [2]	4.22 (1.80) [1]	2.72 (1.51)	4.24 (1.50)	4.14 (1.24) [3]	4.20 (1.75)	4.29 (1.48)	3.26 (1.77)	5.13 (1.58) [3]

Note: superscripts denote number of missing values; Statistical values are based on univariate analyses to account for missing values.

2.3. Discussion

Eighty-two supermarket visitors sampled a strawberry-flavored butter milk drink from either a round or an angular cup. Against expectations, consumer responses showed little sign of the cross-modal correspondence effect between round shapes and sweet taste. One reason for this unexpected finding could lie with the product. Although the mean values for sweetness perception show no indication of this, the approximately 11% sugar content may have been too sweet, limiting variance for effects to occur. Another possibility could trace back to the specific mouth feel associated with butter milk, for instance its creamy consistency. There is evidence that creaminess correlates with sweetness [11,12], which may have influenced participants' sweetness perception. At this point, however, both explanations are speculative only.

Another reason could be that for round shapes to actually change taste perception, more is needed than just the association between round shapes and sweet taste. This means that Study 1's findings are not meaningful with regard to whether consumers actually relied on this specific correspondence. It can only be concluded that no downstream influences on taste perception took place. Wang, Reinoso Carvalho, Persoone, and Spence [11] report on a study where pre-tasting evaluations of round versus angular pieces of chocolate indeed showed a round equals increased sweetness bias, but effects vanished when participants actually tasted the food [11]. As Wang's study manipulated the shape of the actual food, possible priming effects were lost when the food was eaten, indicating the possible necessity of multisensory feedback during consumption (i.e., haptic and visual; [8]). Their findings, together with the basic cross-modal correspondence claim as discussed in the Introduction here, might, then, indicate that this specific correspondence possibly exists on multiple levels. A 'weak' claim, associating round shapes with sweetness, and a 'strong' claim, that sweetness ratings are changed due to exposure to roundness (cf. the different classes of correspondences in [1]). If this assumption were correct, consumers might have associated the round cups with sweetness, but the strength of this association was insufficient to change sweetness perception.

These limitations motivated Study 2, which investigates a different product category, and additionally measures pre-consumption taste expectations in order to incorporate both the weak and strong claim detailed above.

3. Study 2

3.1. Materials and Methods

Similar to Study 1, Study 2 used a one-factor (drinking cup: angular versus round) between-subjects design. This time a convenience student sample was used (n = 89), consisting of students of two Introductory Marketing courses (73% female, mean age in years = 23.31, SD = 2.88, range = 18–32). As in Study 1, students were informed beforehand about the product and the voluntariness of their participation, and were fully debriefed afterwards. All students completed the questionnaire simultaneously, while seated in the same auditorium. They tasted a caffeinated soft drink based on mate extract from either a round or an angular cup. The cups were identical to the ones used in Study 1 (see Figure 1). Choice of beverage was based on the premise that the soft drink constitutes another beverage category, is non-creamy, would fit well with the student sample, and is less sweet (appr. 5.7% sugar) than the buttermilk drink sampled in Study 1. Additionally, paralleling sweetness, the drink also incorporates bitter taste notes. The drink is common in Germany, and is comparable to the brands Materva and Club Mate available in the US. Samples were again standardized in volume (40 mL) and temperature (room temperature).

3.2. Measures and Analyses

One limitation of Study 1 was that it did not measure whether participants associated roundness with sweetness, in addition to possible downstream effects on taste perception. In an attempt to overcome this limitation, Study 2 required participants to rate their expectation of the taste of the drink

before tasting it [11]. Taste expectation was assessed through the items *I expect this drink to taste . . . . . sweet*, . . . *sour*, and . . . *bitter.* Measures regarding the product's smell (*strong*, *powerful*, and *intense* [8,9], $\alpha = 0.81$), liking (*this product tastes very good*), taste intensity (*strong*, *powerful*, and *intense* [8,9], $\alpha = 0.89$), mate-based soft drink preference (*I generally like mate drinks* and *I often drink mate drinks*, $\alpha = 0.83$), and drinking experience (*comical* (reverse scored) and *pleasant*, $\alpha = 0.87$) mirrored those of Study 1. It could be argued that the round cups might additionally be associated with smoothness. Therefore, two additional items assessed taste smoothness (i.e., *smooth* and *rough* (reverse scored), $\alpha = 0.70$, note that the German words used in the questionnaire were *mild* and *herb.* The adjective *rough* is used here in the absence of a better alternative.) The taste items (*sweet* and *sour*) were complemented with *bitter*. As in Study 1, all measures were Likert scales, ranging from 1 (completely disagree) to 7 (completely agree), and statistical analyses (i.e., analyses of variance) were calculated using IBM SPSS Statistics 22. As such, Study 2 differed from Study 1 in its sample (students, versus supermarket visitors in Study 1) and beverage (soft drink, versus a buttermilk drink in Study 1).

3.3. Results

Preliminary analyses of variance indicated no differences between the two experimental groups in terms of age ($F(1,83) = 2.18$, ns), gender, general liking of mate-based drinks, and drink experience (all F's < 1).

Table 2 lists group characteristics, along with mean scores and standard deviations for all dependent variables, separately for each group. No differences emerge between the two groups regarding expected and actual sweet taste, or the intensity measures (all F's < 1). However, two findings are noteworthy; the taste of the drink consumed from the round (rather than the angular) cup is perceived as being more smooth (difference of 0.40) and less bitter (difference of 0.76). Analysis of variance shows the difference for *bitter* to be significant at $\alpha = 0.05$ ($F(1,87) = 4.45$, $p = 0.038$, $\eta_p^2 = 0.05$; results for *smooth*: $F(1,87) = 1.33$, $p = 0.252$, $\eta_p^2 = 0.02$).

Table 2. Age and gender distributions across groups, and means (standard deviations) for all dependent variables (Study 2).

Group Characteristics			Outcomes											
Manipulation	***N*** **(Female)**	**Age**	**Expectations**			**Actual taste**			**Smell Intensity**	**Taste Intensity**	**Taste Smoothness**	**Liking**	**Mate Preference**	**Drink Experience**
			Sweetness	**Sourness**	**Bitterness**	**Sweetness**	**Sourness**	**Bitterness**						
Round cup	48 (36) [3]	22.85 (3.20) [2]	5.29 (1.38)	2.92 (1.62)	3.08 (1.82)	4.38 (1.54)	2.54 (1.62)	2.83 (1.67)	4.11 (1.25)	3.75 (1.34)	4.02 (1.67)	4.17 (1.51)	3.14 (1.66) [1]	4.57 (1.81)
Angular cup	41 (29)	23.83 (2.42)	5.07 (1.57)	2.80 (1.32) [1]	3.13 (1.51)	4.46 (1.60)	2.49 (1.72)	3.59 (1.69)	4.06 (1.32)	4.02 (1.32)	3.62 (1.58)	3.93 (1.83)	3.16 (1.99)	4.59 (1.84)
Overall	89 (65) [3]	23.31 (2.88) [2]	5.19 (1.47)	2.86 (1.49) [1]	3.10 (1.67)	4.42 (1.56)	2.52 (1.66)	3.18 (1.71)	4.09 (1.28)	3.87 (1.33)	3.84 (1.63)	4.06 (1.66)	3.15 (1.81) [1]	4.58 (1.82)

Note: superscript denotes number of missing values; Statistical values are based on univariate analyses to account for missing values.

3.4. Discussion

Using a beverage from a different category, the findings from Study 2 shed additional light on possible cross-modal correspondence effects between shapes and tastes [1]. The round cup, as in Study 1, failed to induce increased taste perception of sweetness and visual expectations based only on the cup's shape were also not found. However, the drink in the angular cup was perceived as more bitter in taste, a finding in line with the cross-modal correspondence effect relating angular shapes to bitterness [6,8]. Although the small effect size warrants caution, this positive finding might be interpreted as adding to the growing body of research on this topic. Additionally, although not significant, the difference of .40 for smoothness between the two groups might be interesting for future research to explore in more depth.

4. General Discussion

Correspondences across modalities (i.e., between vision and taste) are increasingly being researched and tested, with reports indicating a seemingly fundamental link between round shapes and sweet taste [1,13]. The goal of the studies reported here was to corroborate these findings by showing that beverages consumed from a cup with round design elements (i.e., a round cup) were perceived as sweeter than an identical beverage consumed from a cup with angular design elements (i.e., an angular cup). However, the results of the two experiments showed little evidence for the correspondence between round shapes and sweet taste. Moreover, not only was the drink in the round cup not perceived as sweeter, the angular cup failed to induce a more intense taste experience [8–10]. Additionally, the well-documented human preference for rounded designs and design features [14,15] did not increase liking for consumers drinking from the round cup. Or, more accurately, if there indeed was an increased liking for one of the cup's shape, this did not spill over to liking for the actual product.

Although these studies were mainly focused on sweetness perception, the results of Study 2 regarding bitterness show that drinking vessel shape has the ability to change basic taste perception. Hence, Study 2's findings, positively equating angularity with a more bitter taste, may readily be interpreted as additional evidence for this specific cross-modal correspondence [6], and the general discernibility of such effects in between-subject experiments (that is, without a direct comparison [8]). Interestingly, these findings are in line with a recent study that was unable to find effects of round latté art shapes on sweetness expectation in coffee, but where the effects of angular shapes on bitterness were found ([16], experiment 3). It is possible that the effects of angular shapes might be more deeply ingrained in the human mind, due to their association with threat [15]. However, assuming that the effect found is actually there, one has to conclude that individual cross-modal effects seem highly susceptible to change depending on the beverage category or sample population. One also has to wonder, then, why expectation effects (based on the beverage's visual inspection) did not surface here [11,16]. It is possible that other influences, like beverage color, might have played a larger role [17]. This limits the practical relevance of using shapes to communicate specific tastes, indicating that front-of-package design elements (i.e., typefaces [18,19] or simple shapes [14]) may not be sufficient to steer consumer response (i.e., expectations of taste) at the point of sale.

This leaves us to account for the null results regarding shape and sweetness across the two beverage categories. The first explanation involves the cups used; although it is to date unclear why cross-modal correspondences exist [13], it cannot be excluded that the round cup was insufficient to induce (the expected) sweetness in taste (and for the angular cup to induce intensity, for that matter [9]). Some might even argue that the cups used were not round enough to engage participants in what leads to cross-modality effects on sweetness perception. Indeed, although the round cups are probably as round as they can get, the haptic properties of the round and angular cups might not have been distinctively different. The 3D-molds used in van Rompay et al.'s study [8], where effects between round shapes and sweetness did show, had angular and round properties along the cups' complete outer surface. Contrast this with the cups used here, where participants might not have experienced the different haptic feedback of angularity and roundness, but instead may have only felt the same

smooth surface in both conditions. This might imply that, without the ability to rely on explicit visual contrasts (i.e., other, different shapes), visual perception alone is ineffective in establishing cross-modal correspondences between round shapes and sweet tastes without sufficient congruent haptic information. This might also have been a reason for other null results reported in recent studies investigating the relationship between round shapes and sweet taste in beverages [16,20].

A second explanation might lie within the product category. As mentioned, two recent studies also failed to confirm the hypothesized round equals increased sweetness correspondence [16,20], one for curved (versus straight-edged) beer glasses [20], the other for round (versus angular) shapes of chocolate sprinkled on coffee [16]. Although butter milk (Study 1), mate-based soft drinks (Study 2), coffee ([16], cf. 8) and beer [20] constitute only a fraction of the possible beverage categories, finding null results across these four beverage categories might indicate that these beverages are not suitable for investigating sweetness differences on the basis of visio-haptic information (roundness). Cross-modality effects between round shapes and sweet tastes might, of course, exist perhaps only for food products where taste consists of an intricate interplay of sweet, sour, or bitter components. Positive results, not relying on direct comparisons of shapes, have been reported for coffee and chocolate milk [8], although it is unclear how prominent the role of haptic feedback may have been. Therefore, it cannot be excluded that shapes elicit specific tastes only when consumers are actively engaging in taste searching on the basis of information provided, for example, when consciously examining new products [1], or when specifically instructed to do so in a laboratory setting. Moreover, effects for beverages are bound to rely on product-extrinsic cues like cups or packaging elements (e.g., see [21] for an overview of the different ways beverage containers may influence perception, for instance by changing how the liquid flows through the mouth), whereas for other food categories, like chocolates [11,12], the shape of the product itself can be manipulated.

The third implication of these null results might be the non-replicability of this specific correspondence effect for beverages. Although this possibility does not imply that the general tendency to equate round shapes with sweet taste is non-existent, it does limit the practical usefulness of varying shape properties to change taste perception. Moreover, effects of round shapes on increased sweetness perception have been reported to rely on boundary conditions such as color [17], hedonic preference [4], emotional valence [5], or even on the way answer scales are anchored [22], highlighting the difficulty of finding correspondence effects between shape and taste. As such, it might be a good idea for future research to focus on replication studies—either direct or conceptual—to solidify the foundation of cross-modal correspondence research.

The main limitation of the studies reported here, admittedly, is their sample size. Depending on effect size, in between-subjects experiments, the roughly forty participants per group may not have been enough to discern effects where they exist [23,24]. This limitation, then, also extends to the positive findings regarding bitterness in Study 2, which might either be easier discernable than effects for sweetness and therefore easier to find in smaller samples, or might constitute a statistical artifact.

5. Conclusions

Two studies focused on whether consumers' sweetness perception of two drinks could be altered by the shape of the cup the drinks were consumed from. Both studies failed to generate evidence for the commonly reported correspondence between round shapes and sweet tastes, raising important questions for future cross-modal correspondence research. It still remains unclear how, and to what extent, consumers use shapes as cues for a product's (expected) taste [1].

Readers should note that, on the basis of these two experiments, I am not claiming that this particular cross-modal correspondence effect is nonexistent. I am, however, cautioning against an over-reliance on relative effects (i.e., explicit contrasts) for its practical relevance. As such, it appears important that results like the present ones are made available to aid cross-modal correspondence researchers in further clarifying if, how, and when cross-modal effects are to be expected, notwithstanding making its practical relevance more clear.

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