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Abstract

The presence of a metallic surface or appearance of product packaging and servingware can impact both the sensory and hedonic perception of various different foods and beverages, including promoting the impression of quality, premiumness, and luxury. A total of 51 coffee experts and 132 consumers took part in the study. Metallic-coated ceramic cups were used to assess whether the outer coating of the cup would influence the perception of two distinct coffee profiles. Hedonic and sensory ratings were assessed. Given the known link between visual metallic surfaces and premium/luxury perception, we also assessed whether participants' impressions of elegance might be mediating between the cup and positive sensory and hedonic judgments. Interaction effects between coffee type and cup finish revealed that higher sensory and hedonic ratings were given to the Brazilian coffee when it was tasted from the bronze cup, and to the Kenyan coffee when sampled from the gold cup (as compared to all other cups). Interaction effects including 'expertise level' showed that experts (in contrast to consumers) gave higher ratings of sweetness for both Brazilian and Kenyan when tasted from the bronze cup. Moreover, 'elegance' was a predictor of positive judgments when the Brazilian coffee was served in the bronze cup (for both experts and consumers) and when the Kenyan coffee was served in the white cup (for experts only). Despite the preliminary nature of these results, they nevertheless merit consideration by the industry. In addition to innovation, it makes sense to create receptacles that convey some functional and/or perceptual benefit to the coffee drinking experience.

KEYWORDS: Specialty coffee; Metallic cup; Flavour perception; Hedonic response; Taste

1. Introduction

There has been a recent growth of interest in studying the impact of the drinking receptacle, be it cup or mug, on the coffee-drinking experience (see Spence & Carvalho, 2019, for a review). Recently, for example, we have investigated the impact of the shape (Carvalho & Spence, 2018), colour (Van Doorn, Willemin, & Spence, 2014; Carvalho & Spence, 2019), and texture of the cup (Carvalho, Moksunova, & Spence, 2020). The results of a number of such studies now demonstrate that the receptacle in which coffee is served can exert a significant influence over the coffee-drinking experience in both expert and consumers.

Separately, there is growing interest in the topic of multisensory material perception (Spence, 2020a), both how it is perceived (e.g., Komatsu & Goda, 2018) and its influence on the perception of a variety of other product attributes (see Spence & Piqueras-Fiszman, 2014). It has, for example, been shown that the material of the drinking vessel, in addition to setting expectations regarding taste/flavour, can affect the subsequent taste perception and hedonic appraisals of beverages (Schifferstein, 2009; Masson, Delarue, Bouillot, Sieffermann, & Blumenthal, 2016). When studying the effect of the material of the vessel on the contents, it is important to consider not only any physical interactions, but also psychological factors such as crossmodal associations and semiotic aspects that can prime flavour and quality information about a beverage (Spence & Wan, 2015; Machiels, Yarar, & Orth, 2019; Pramudya, Choudhury, Zou, & Seo, 2020).

1.1. Surface texture and perceived product quality

Throughout human history, drinking vessels have been manufactured from a range of different materials, with porcelain and ceramic becoming one of the preferred materials for cups and mugs (Monson-Fitzjohn, 1927; Woolgar, 2018).

In recent years, the use of disposable cups (paper, plastic, and also foam) has increased massively, with the majority either not being recyclable, or else not recycled, thus ending-up in landfills (Poortinga & Whitaker, 2018). The use of reusable cups as a solution for issues concerning waste has been adopted by a number of big companies

including Starbucks and McDonald's (Cadwalader, 2020)¹. Reusable mugs (and straws) made of stainless steel became widely available in a variety of outer metallic coatings such as bronze and copper². In fact, giving the outer wall of ceramic coffee cups a metallic coating³ has also become increasingly trendy in the last couple of years, with a revival of the 'metallics' (see Kingdon, 2018). The visual apprehension of metallic or metallic-coated tableware can help to set expectations about quality and elegance, not only of the tableware itself, but also the food or drink served in/on/from it.

A large body of empirical research has recently demonstrated that metallic surfaces exert a significant influence over consumers' product judgments. For instance, visual textures such as glossy, metallic, and silky can evoke positive aesthetic feelings and judgments, as well as priming associations of quality and elegance (Thumfart et al., 2008; Liu, 2015). This, then, can positively affect judgments of the sophistication and elegance of actual products (Yanagisawa & Yuki, 2011).

Prior to consumption, people tend to pay most attention to the visual properties of foods and drinks (Schifferstein, 2013). This usually includes product-extrinsic cues from servingware through to packaging. Certain visual elements are known to trigger strong expectations concerning the product that may subsequently affect sensory and/or hedonic ratings (see Piqueras-Fiszman & Spence, 2015; Spence & Wan, 2015, for reviews).

The use of glossy and shiny metallic colours in products and packaging can convey specific meanings to the consumer, which may differ as a function of culture (Burton, 2008; Heide & Olsen, 2017). Many adverts for luxury items including alcoholic beverages use extrinsic attributes such as gold and shininess in order to convey prestige and style (Kirmani & Zeithaml, 1993). Metallic appearance, such as gold and silver, have been used in food and drink packaging (Piqueras-Fiszman, Velasco, & Spence, 2012) and even in restaurant menu design (Magnini & Kim, 2016) in order to prime associations with luxury and expense (Sperdea & Criveanu, 2014). Interestingly, a

¹ This is a pilot program testing models of cups made mostly of plastic with unique QR codes or RFID chips, allowing them to be tracked. Once returned, the cups are collected, cleaned, and redistributed to partnering cafes for reuse (<https://www.nextgenconsortium.com/>).

² <https://www.starbucks.com.hk/coffeehouse/merchandise/starbucks-heritage-series>.

³ Several porcelain manufacturing companies offer coffee cups/mugs coated with metals such as gold, platinum, silver, bronze, and copper, for instance Walkure Porzellan, Germany (walkure-porzellan.com) and Wolff, Brazil (wolffbrasil.com.br).

golden appearance does not seem to be specifically associated with a particular product category (Labrecque & Milne, 2013), suggesting that it could be linked to more conceptual attributes (e.g., premiumness) instead of brand/category identity (see Velasco & Spence, 2019). In addition, the descriptor ‘elegance’ has been considered as a dimension of ‘premiumness’ or ‘luxury’ which, in turn, is associated with measures of ‘liking’ as well as ‘willingness-to-pay’ (Piqueras-Fiszman & Spence, 2012; Velasco & Spence, 2019). Regarding coffee, major coffee brands (e.g. Starbucks and Nescafe) have been using the colour gold and names such as “Gold Label” or “Gold Blend” to communicate their – usually 100% Arabica – premium or luxury product blends for decades (Elliott, 2001; Fitter & Kaplinksy, 2001).

In addition to purely visual cues, it has been shown that the haptic aspects of metallic materials can convey feelings of quality. Piqueras-Fiszman and Spence (2011) tested whether the material properties of cutlery would affect consumers’ quality and liking judgments of yoghurt. The yoghurt was rated as significantly more pleasant, and perceived to be of higher quality, when tasted with a heavier stainless steel spoon as compared to a metallic-looking plastic spoon. Despite the fact that both the weight and material properties of the spoons varied in this study, it was suggested that the difference in pleasantness ratings could be attributed to the participants’ perception of the stainless steel spoons being of higher quality than the plastic spoons. This possibly implicit judgment of quality may then have been transferred to the yoghurt itself, causing it to be perceived as being of higher quality when tested from the stainless steel spoon.

Cheskin’s (1957) early notion of ‘sensation transference’ might help to explain why it is that the product-extrinsic cues should influence the rated sensory and hedonic properties of food. Cheskin himself was mostly interested in the transfer of sensory attributes from product packaging to the perception of the contents. However, the same principle could equally well be applied to the observed transfer of a person's expectations and feelings concerning relevant product-extrinsic cues (e.g., metallic coating) to their evaluation of the intrinsic property of the product (e.g., its quality). In fact, the term “affective ventriloquism” has been coined to refer to those situations in which sensation transference influences hedonic ratings of products (Spence & Gallace, 2011).

1.4. On the emerging coffee culture

In recent years, the impressive rise of the specialty coffee industry has undoubtedly embraced new possibilities in terms of presenting and selling coffee to the consumer, which includes the drinking vessel. The term ‘specialty coffee’ is used to refer to those coffees that can be distinguished on the basis of quality and uniqueness of origin, according to the Specialty Coffee Association (SCA) and the international Q Coffee System protocols (Lingle & Menon, 2017). Similar to wine, specialty coffee is undoubtedly a chemically/perceptually complex beverage (Chambers & Koppel, 2013; Yeretjian, 2017; Spence & Wang, 2018). Being an agricultural product originating from a certain *terroir*, processed and roasted according to different methods, coffee can reach a huge variation of characteristics in terms of aroma and flavour complexity (Fisk, Kettle, Hofmeister, Virdie, & Kenny, 2012; Schwan, Silva, & Batista, 2012). Given that different styles/varieties of specialty coffee have different dominant/desirable qualities (e.g., acidity/sweetness), the challenge is to optimize the design of the receptacle in order to enhance the multisensory tasting experience for the end consumer, much as seen in the world of fine wine (Spence & Carvalho, 2019; Spence, 2020b). The cup in which the coffee is served is increasingly coming to be considered as an essential element in terms of turning the consumption of specialty coffee into a truly engaging multisensory experience (i.e., and moving it beyond being considered as little more than a hot beverage).

Despite a large number of studies having been published in recent years assessing the impact of the hue of the plateware/glassware on food evaluation, there has been surprisingly little research investigating the effect of metallic/shiny finishes. The nature of the present study is exploratory and this determines the general nature of our objectives and the preliminary nature of our results. The exploratory experiments reported here were designed to probe for influences of gold-, platinum-, and bronze-coated ceramic cups on hedonic and sensory judgments of specialty coffees. In addition to the three metallic coating cups, a white cup was also included in the experimental design for the sake of comparison to a baseline condition. Hedonic attributes included ratings of elegance and liking, whereas sensory attributes included ratings of aroma and flavour attributes. Given the aforementioned link between visual metallic surfaces and luxury, we were interested in investigating whether participants’ impressions of elegance could be working as a mediator between the cup and the participant’s sensory

and hedonic ratings. The present study will investigate whether perceived elegance mediates the conditional relationship between the (1) cup finish and liking ratings and (2) cup finish and positive sensory attributes. The general hypothesis is that participants would like the coffee in a metallic-coated cup more than the coffee in a white cup. This difference will be an indirect result of an increase in the perceived elegance of the cup which, in turn, leads to an increase in liking and positive attributes.

Based on previous results, it is known that different colours of coffee cup influence sensory and hedonic ratings differently depending on the overall flavour profile of the coffee that is being served (Carvalho & Spence, 2019). Thus, in the two experiments reported here, a pair of specialty coffees with very distinct flavour profiles was used to assess whether the effect of distinct metallic coatings would also vary as a function of the profile of the coffee. One coffee was high in sweetness (typical of Brazilian specialty coffees) whereas the other was high in acidity (common in Kenyan specialty coffees). The metallic-coated cups selected for testing are already on the market and are also trendy amongst specialty coffee shops, but no empirical assessment on whether the metallic coating can positively or negatively affect the coffee drinking experience has been conducted yet. Both consumers and coffee experts were tested in two separate experiments in Brazil.

2. Methods

2.1. Participants

A total of 186 participants gave their informed consent to take part in one of the two studies reported here. The study was approved by the Research Ethics Committee of the University of Campinas, Campinas, Brazil (CAAE 26669519.5.0000.5404). After data quality control, the data from 51 coffee experts were included in the final analysis of Experiment 1 (17 female; age: 36.1 ± 9.2 years-old, range = 22-59 years), and 132 consumers in the final analysis of Experiment 2 (70 female; age: 34.3 ± 8.8 years-old, range = 20-58 years). It is important to note that the level of expertise of participants in Experiment 1 was not assessed.

2.2 Stimuli

2.2.1 Coffee

Only single origin Arabica coffees were used. All of the coffees were assessed by SCA-certified sensory analysts (i.e., Q grader cuppers⁴). The same two coffees were used in both experiments. The first coffee was from Ambiental Fortaleza Estate, located in Mococa, Sao Paulo, Brazil (Mogiana region; altitude of 1300m). The cultivar was Obata processed as natural coffee, with an overall score of 85.5 points⁵, with high sweetness and low-to-medium acidity. The predominant coffee aroma/flavour notes were vanilla, caramel, and orange. The second coffee came from the Nyeri region, Kenya (altitude of 1600-1700m), and was a blend of four cultivars (SL28, SL34, Ruiru, and Batian). The post-harvest processing method used was the washed process. This coffee received an overall score of 88 points, with medium sweetness and high acidity, and with strong floral notes as well as blackberry and red apple notes.

The coffee beverage served to the participants in both experiments was a filter (pour-over) coffee. In Experiment 1, the coffee was prepared using the Bunn-O-Matic ICBA (BUNN; Springfield, USA) at a concentration of 70g/L. For Experiment 2, the coffee was brewed using the Hario V60 Kit (Hario V60; Tokyo, Japan) at a concentration of 66 g/L. For all preparations, mineral water at 93°C was used. In both studies, the coffee was brewed by a specialty coffee professional out of the sight of the participants. The mean temperature of the coffee served to the participants was 56.1°C (SD=4.2) in Experiment 1 and 58.2°C (SD=2.1) in Experiment 2.

2.2.2. Cups

The same four cups (Walkure; Bayreuth, Germany) were used in both experiments. On the outside wall, the cups could be white, or have a metallic finish in gold, platinum or bronze (see Figure 1a). All of the cups were white on the inside in order to keep the visual contrast between the coffee and the inner wall of the cup constant (Hurlbert,

⁴ Q-graders are the cupping certified judges according to the international Q Coffee System methodology (Lingle & Menon, 2017).

⁵ In coffee evaluation, grades on a scale of zero to ten are awarded for the attributes of fragrance/aroma, sweetness, acidity, body, flavour, balance, and aftertaste. A 100-point scale is then used to summarize the flavour and aesthetic qualities of a brewed coffee. It is important to note that dominant bitterness and astringency are negative attributes, and classified as primary defects. Specialty coffees have a cupping score of 80 or more points and with no primary defects.

1996; Spence, 2018). Outside colour was the only factor that varied between the cups – shape, material (ceramic), and weight [Mean(g)±SD for white (131.5±2.5), gold (132.7±2.3), platinum (131.4±2.9), and bronze (133.2±2.1)] were kept constant.

2.3. Design and procedure

Experiment 1 was conducted during the 2nd Roaster Camp of Brazil, an event for professional coffee roasters organized by Capricornio Coffees at the Agronomic Institute of Paraná in Londrina, Brazil. All of the attendees at the event were encouraged to take part in the study. They were all coffee experts, with 13 Q graders amongst them. The test took place in a large, well-lit, and quiet cupping room with three cupping tables. The participants were tested in groups of eighteen, with six participants at each cupping table, with at least one-metre spacing between adjacent tasters.

Experiment 2 took place in a quiet and well-lit testing room at Sofa Cafe, a coffee shop and school in Sao Paulo, Brazil, and only consumers were assessed. The majority of the participants were recruited primarily through social media websites with the online advert making clear the experimental procedure as well as the inclusion criteria, that is, consumers who had been drinking specialty coffee with no sugar added for at least a year. Prior to the start of the study, the participants filled in a short questionnaire on their familiarity with specialty coffee and their consumption frequency (low: 1-3 times/month; medium: 1-3 times/week; high: daily). The participants were led in groups of twelve into the testing room and were seated around six two-seater tables, with at least one-metre spacing between adjacent tasters.

For both Experiments 1 and 2, a sheet containing the rating scales (Figure S1), a pen, and a glass of water were placed in front of each participant's place prior to their arrival at the cupping/testing room. At the start of each session, the gathered group of participants received a three-minute briefing in order to ensure that all groups were given the same instructions. The tasting procedure followed a within-participants experimental design. The evaluation of the samples followed a sequential monadic presentation scheme with the order of presentation balanced amongst participants. The participants were informed that they were going to evaluate a total of eight (Experiment 1 – experts) or four (Experiment 2 – consumers, see Figure 1b) coffee samples of 50 mL each, one at a time. The participants were instructed to evaluate the aroma before tasting the coffee using the aroma rating scale. Next, they moved on to tasting and rating the

coffee's taste/flavour attributes (i.e., sweetness, acidity, metallic taste⁶, flavour – with the order counterbalanced across participants), and finally how much they liked the coffee and how elegant the coffee seemed to them. Ratings were made using 10-cm visual analog scales (VAS) anchored at 0 ('not at all') and 10 ('very'). The participants were instructed to rinse their mouths out with water between samples in order to cleanse their palates. One supervisor was present during the testing sessions in order to provide guidance if necessary. Upon completing the study, the participants were thanked for their involvement in the study and were instructed to leave the room. The consumers received a small sample of specialty coffee in return for having taken part in the study. Each testing session lasted around 15-20 min.

2.4. Data analyses

Experiments 1 and 2 followed the same design and procedure, and the participants were exposed to the same stimuli (i.e., cups and coffees). Thus, the data from both experiments were combined in a single database and analysed using the same statistical method. Individual three-way, mixed analyses of variance (mixed-ANOVAs) were conducted on the data from the two experiments for each dependent variable. The factorial analysis ($4 \times 2 \times 2$) included three independent variables, which were 'Cup' (gold, platinum, bronze, white) and 'Coffee' (Kenya, Brazil) as within-participant variables, and 'Expertise' (expert, consumer) as the between-participant variable. 'Testing location' could not be included as a fourth independent variable since it overlapped with 'expertise'. The mixed-ANOVAs tests assessed the main effects of cup finish, coffee type, and expertise as well as their interaction effects, on the participants' ratings of the seven dependent variables (i.e., aroma, sweetness, acidity, metallic taste, flavour, liking, and elegance). Simple effects were calculated in order to analyse significant interactions. Post-hoc pairwise comparisons were calculated for significant main effects. Follow-up tests were Bonferroni corrected⁷, and differences were considered significant at $p \leq .05$.

⁶ For the sake of simplicity, we call 'metallic taste' the oral metallic perception. Despite metallic perception has occasionally been proposed as a primary taste or an additional legitimate taste category, the debate over metallic being a taste, trigeminal or flavour response is still ongoing (Skinner, Lim, Tarrega, Ford, Linforth, Thomas, & Hort, 2017; cf. Reith & Spence, 2020).

⁷ For each dependent variable, multiple pairwise comparisons were corrected by a factor of 6 for 'cup' main effect and 'expertise vs. coffee' interaction effect; a factor of 28 for 'cup vs. coffee' and 'expertise vs. cup' interaction effects; and a factor of 120 for 'cup vs. coffee vs. expertise' interaction effect.

Mediation analysis (regression-based approach) was also carried out. A simple mediation model seeks to identify the process underlying an observed relationship between an independent variable (referred as ‘X’) and a dependent variable (referred as ‘Y’) via a third variable, known as a mediator variable, or ‘M’. This model reflects a sequence in which X affects Y *indirectly* through the mediator M (Shrout & Bolger, 2002). Here, a simple mediation analysis was conducted in order to examine whether the variable ‘elegance’ could mediate the effect between ‘cup finish’ and all other dependent variables (i.e., aroma, sweetness, acidity, metallic taste, flavour, and liking). In this way, the hypothesised simple multi-categorical mediation model was tested. In this approach, all four levels of the ‘cup finish’ are used as a single independent variable in the mediation (as a multi-categorical ‘X’) (Hayes & Preacher, 2014). The mediation role of the dependent variable ‘elegance’ between the four cup categories (i.e., types) and the dependent variables was assessed for the two expertise levels and the two coffees in separate analyses. Thus, the same multi-categorical mediation model was run with four separate datasets, namely, “Expert-Brazil”, “Expert-Kenya”, “Consumer-Brazil”, and “Consumer-Kenya”. The data were analysed using IBM SPSS Statistics version 22.0 and macro-program PROCESS 3.4 (Hayes, 2013)⁸.

3. Results

3.1 Mixed-ANOVA: Interaction effects

Expertise vs. Coffee vs. Cup. Significant interactions between expertise, coffee type, and cup finish were observed in terms of aroma [$F(3,183) = 10.75, p = 1.00\text{e-}6, \eta^2_p = 0.06$], sweetness [$F(3,183) = 7.14, p = 1.23\text{e-}4, \eta^2_p = 0.04$], acidity [$F(3,183) = 6.83, p = 2.19\text{e-}4, \eta^2_p = 0.04$], flavour [$F(3,183) = 11.67, p < 2.78\text{e-}7, \eta^2_p = 0.06$], liking [$F(3,183) = 5.23, p = 1.71\text{e-}3, \eta^2_p = 0.03$], and ratings of elegance [$F(3,183) = 6.39, p = 4.00\text{e-}4, \eta^2_p = 0.03$]. Table S1 (supplementary material) provides a summary of the significant results of the simple effects tests.

Cup vs. Coffee. Univariate tests revealed a significant interaction between coffee type and cup finish on aroma [$F(3,183) = 14.03, p = 1.79\text{e-}8, \eta^2_p = 0.07$], flavour [$F(3,183) =$

⁸ Since the independent variable tested has 4 levels (i.e., it is multicategorical), the PROCESS macro was used instead of the MEMORE macro (Montoya & Hayes, 2017).

7.66, $p = 6.10\text{e-}5$, $\eta^2_p = 0.04$], liking $[F(3,183) = 6.95, p = 1.74\text{e-}4, \eta^2_p = 0.04]$, and ratings of elegance $[F(3,183) = 6.45, p = 3.66\text{e-}4, \eta^2_p = 0.03]$ (Figure 2). The results of the simple effects tests are summarized in Table S2 (supplementary material).

Expertise vs. Coffee and Expertise vs. Cup. Significant interaction between expertise and coffee type was observed on aroma $[F(1,185) = 14.03, p = 7.84\text{e-}16, \eta^2_p = 0.07]$, sweetness $[F(1,185) = 14.03, p = 1.72\text{e-}9, \eta^2_p = 0.07]$, flavour $[F(1,181) = 7.66, p = 2.60\text{e-}5, \eta^2_p = 0.04]$, liking $[F(1,185) = 6.95, p = 1.37\text{e-}10, \eta^2_p = 0.04]$, and elegance $[F(1,185) = 6.45, p = 3.82\text{e-}12, \eta^2_p = 0.03]$ ratings. Simple effects analyses showed that the Kenyan coffee received significantly higher ratings by the experts for aroma, flavour, liking, and elegance than by the consumers (all $p < 0.001$). On the other hand, the consumers judged the Brazilian coffee as being significantly more aromatic, more elegant, and it was more liked when compared to the ratings given by the experts (all $p < 0.001$).

Significant interactions between expertise and cup finish were also reported for aroma $[F(3,183) = 10.12, p = 2.00\text{e-}6, \eta^2_p = 0.05]$, acidity $[F(3,183) = 12.97, p = 4.68\text{e-}8, \eta^2_p = 0.07]$, flavour $[F(3,183) = 4.83, p < 3.83\text{e-}3, \eta^2_p = 0.03]$, liking $[F(3,183) = 4.37, p = 5.22\text{e-}3, \eta^2_p = 0.02]$, and ratings of elegance $[F(3,183) = 2.94, p = 3.14\text{e-}4, \eta^2_p = 0.04]$. Simple effects tests revealed that the coffees tasted from the white cup were given significantly higher ratings in terms of their aroma, acidity, flavour (all $p < 0.0001$), liking and elegance (all $p < 0.05$) by the experts when compared to those scores given by consumers. The experts also rated the coffees from the bronze cup as being significantly more acidic ($p = 2.94\text{e-}4$), and from the platinum ($p = 5.40\text{e-}5$) and bronze ($p = 7.46\text{e-}3$) cups to have more flavour. On the other hand, consumers judged the coffees tasted from the gold cup to be significantly more acidic ($p < 8.70\text{e-}7$), more elegant ($p = 2.93$), and also liked more ($p = 3.32\text{e-}2$) when compared to the ratings given by the experts (see Figure 2).

3.2 Mixed-ANOVA: Main effects

Cup finish. The cup finish exerted a significant effect over ratings of aroma $[F(3,183) = 8.48, p = 2.20\text{e-}5, \eta^2_p = 0.04]$, sweetness $[F(3,181) = 21.91, p = 5.43\text{e-}13, \eta^2_p = 0.11]$, metallic taste $[F(3,181) = 20.08, p = 1.13\text{e-}11, \eta^2_p = 0.10]$, flavour $[F(3,181) = 12.66, p = 1.28\text{e-}7, \eta^2_p = 0.06]$, as well as liking $[F(3,181) = 3.97, p = 8.14\text{e-}3, \eta^2_p = 0.02]$, and elegance $[F(3,181) = 5.09, p = 1.89\text{e-}3, \eta^2_p < 0.05]$ of the coffees. By contrast, no

significant main effect of the finish of the cup was observed on judgments of the coffee's acidity ($p = 0.11$).

Follow-up post-hoc comparisons revealed that, for coffee aroma ratings, there was no significant difference between the gold and bronze cups, nor between the platinum and white, but a significant difference was observed between these two pairs (i.e., gold = bronze > platinum = white) (all $p < 0.01$). Coffee sweetness ratings were significantly higher for the bronze cup than for the other three colours (all $p < 0.0001$), with the gold cup also being rated as significantly sweeter than the platinum ($p = 1.01\text{e-}3$) and white cups ($p = 2.42\text{e-}3$), with no significant difference between them (i.e., bronze > gold > platinum = white). For ratings of metallic taste in the coffee, there was no significant difference between gold and bronze cups, but both were rated as significantly more metallic than the white cup (all $p < 0.05$) and less metallic than the platinum cup (all $p < 0.0001$) (i.e., platinum > gold = bronze > white). As per the flavour of the coffee, there was no significant difference between gold and white cups, but both had significantly higher flavour ratings than the platinum cup (all $p < 0.01$) and lower flavour ratings than the bronze cup (all $p < 0.01$) (i.e., bronze > gold = white > platinum). For the hedonic measures, both coffee liking and judgments of the coffee's elegance followed the same pattern. That is, there was no significant difference between gold and bronze cups, and platinum and white, but a significant difference between these two pairs was observed (i.e., gold = bronze > platinum = white) (all $p < 0.05$ for liking and elegance).

Coffee type. The coffee type significantly affected participants' ratings of the sensory attributes of aroma [$F(1,181) = 104.57, p = 1.33\text{e-}19, \eta^2_p = 0.37$], sweetness [$F(1,181) = 55.13, p = 4.48\text{e-}12, \eta^2_p = 0.24$], acidity [$F(1,181) = 140.41, p = 2.96\text{e-}24, \eta^2_p = 0.24$], and flavour [$F(1,181) = 109.70, p = 2.65\text{e-}20, \eta^2_p = 0.38$], with no significant effect on metallic taste ($p = 0.69$). There were also significant effects on hedonic judgments of liking [$F(1,181) = 61.56, p = 3.83\text{e-}13, \eta^2_p = 0.26$] and elegance [$F(1,181) = 57.41, p = 1.86\text{e-}12, \eta^2_p = 0.24$].

Further post-hoc tests revealed that the Kenyan coffee was judged as significantly more aromatic, less sweet, more acidic, more flavourful, and also received significantly higher liking and higher ratings of elegance than the Brazilian coffee (all $p < 0.0001$).

Expertise. Significant main effects of expertise level were identified on ratings of the following sensory attributes: aroma [$F(1,181) = 6.86, p = 9.59\text{e-}3, \eta^2_p = 0.03$],

sweetness [$F(1,181) = 26.72, p = 6.27\text{e-}7, \eta^2_p = 0.13$], acidity [$F(1,181) = 8.19, p = 4.71\text{e-}3, \eta^2_p = 0.04$], metallic taste [$F(1,181) = 63.07, p = 2.17\text{e-}13, \eta^2_p = 0.26$], and flavour [$F(1,181) = 33.02, p = 3.88\text{e-}8, \eta^2_p = 0.15$], with no significant effect on hedonic judgments of liking ($p < 0.33$), nor on ratings of elegance ($p < 0.89$).

Post-hoc tests revealed that the expert participants gave significantly higher scores to the sensory attributes of aroma, acidity (all $p < 0.01$), sweetness, metallic taste, and flavour (all $p < 0.0001$) than did the consumers.

3.2 Mediation analyses

We explored whether elegance ratings mediated between cup type and the ratings of all other assessed measures in four datasets. No significant mediation effect of elegance ratings was observed for the dataset “Consumer-Kenya”. For all other three dataset, ratings of elegance were a significant mediator between one cup type and at least one of four positive attributes. For these three datasets, values of path-c’ are lower than those of path-c (see Figure 3). This indicates a reduction in the effect of the relationship between X (i.e., cup finish) and Y (i.e., dependent measures) in the presence of the mediator (i.e., elegance). Thus, ‘elegance’ partially mediates between X and Y. Next, to test if this mediation is significant, measures for the indirect effect of X on Y were carried out, showing values greater than zero (i.e., 95% confidence intervals which did not include zero). For these three datasets, lower and upper 95% confidence interval, standard error, and total indirect effect (a-path * b-path) are reported in Table 1. For the dataset “Expert-Brazil”, significant total indirect effects of elegance between of cup type and aroma, flavour, acidity, and liking ratings were observed only for the bronze cup. For the dataset “Expert-Kenya”, significant total indirect effects of elegance was also found for aroma, flavour, sweetness, acidity, and liking ratings only for the white cup. Finally, for the dataset “Consumer-Brazil”, significant total indirect effects of elegance were observed for aroma, flavour, acidity, and liking ratings only for the bronze cup.

As expected, no significant mediation effect of elegance ratings was observed for metallic taste ratings in any of the four tested datasets. In addition to the total indirect effect (i.e., mediation), the total and direct effects of cup type on dependent variables are also reported (i.e., c’-path and c-path, respectively) (see Figure 3).

399 **Discussion**

400 The present study constitutes a first attempt to investigate whether metallic-coated cups
401 would positively or negatively affect the perception of specialty coffees. Four ceramic
402 cups (gold, platinum, bronze, and white) were used to test whether the metallic coating
403 would influence hedonic and sensory ratings of two distinct coffee profiles (Brazil and
404 Kenya) given by coffee experts and consumers. Given previous reports documenting the
405 impact of metallic servingware on hedonic responses towards different products, our
406 main hypothesis was that participants' ratings of elegance could act as a mediator
407 between the cup and the other assessed positive attributes. In addition to the mediation
408 effect, the factorial design of the experiments allowed us to test for the main effects of
409 the variables cup, coffee, and level of expertise, as well as for interactions between
410 these factors.

411 Our findings show that the metallic coating affected hedonic and sensory judgments of
412 both coffees by experts and consumers. Interaction effects between coffee type and cup
413 finish show that the Brazilian coffee received significantly higher ratings of aroma,
414 flavour, liking, and elegance when tasted from the bronze cup (as compared to the other
415 three cups). On the other hand, the Kenyan coffee was given significantly higher ratings
416 of aroma, liking, and elegance when tasted from the gold cup (instead of any of the
417 other three cups). These results are interesting and could as well be interpreted in terms
418 of the hue (i.e., colour spectrum) instead of colour reflectance (i.e., the shininess of the
419 metallic colour) (Matsumoto, Fukuda, & Uchikawa, 2016). The hue of the bronze cup,
420 despite being on the brown spectrum, seems to contain a significant proportion of red,
421 giving it an aspect of reddish-bronze (see Figure 1a) instead of the dark brown aspect of
422 the actual bronze alloy. As for the gold cup, the predominant hue is clearly on the
423 yellow spectrum. One way to understand these findings could be in terms of crossmodal
424 associations (or correspondences). It is well known that people match basic tastes to
425 colours in a consistent manner (see Spence et al., 2015, for a review). The pairings
426 between basic tastes and colours have been understood in terms of crossmodal
427 correspondence in which apparently unrelated sensory features, or dimensions, are
428 perceived or described as “going together” (see Spence, 2011, for a review). Amongst
429 the strong colour-taste correspondences, sweet has been associated with red and pink

whereas sour has been associated with green and yellow instead (Dérivé, 1978). Despite not having significantly affected the ratings of coffee sweetness and acidity *per se*, the bronze and the gold cups increased the ratings of aroma, elegance, and liking for the Brazilian and Kenyan coffees, respectively. This observation suggests that a congruent pairing between the colour of the cup and flavour profile of the coffee may have enhanced the overall coffee drinking experience. These results corroborate and extend those of Carvalho and Spence's (2019) recent study in which consumers' liking ratings of Brazilian and Kenyan coffees significantly increased in conditions where the colour of the cup (pink, yellow or green) was congruently paired to the predominant taste of the coffee (sweet or acidic). However, another way in which to interpret the high ratings given by consumers to the Kenyan coffee tasted from the gold cup is that the Kenyan coffee could have been perceived as an exotic coffee by Brazilian consumers. Specialty coffees from origins other than Brazil are rarely available in Brazilian coffee shops due to regulations on coffee imports (e.g., Pelupessy, 2007). The exotic flavour of the Kenyan coffee as a positive novelty could perhaps have been associated to premiumness, which in the context of coffee consumption has been paired with gold labels (Elliott, 2001; Fitter & Kaplinksy, 2001).

The level of expertise also affected hedonic and sensory responses. Interaction effects amongst coffee type, cup finish, and expertise show that the experts gave the Kenyan coffee higher ratings of aroma, flavour, liking, and elegance when tasted from the white cup than did the consumers. On the other hand, consumers judged the Kenyan coffee as tasting sweeter, more acidic, more elegant, and liked the beverage more when they tasted it from the gold cup (in contrast to experts). Simply put, these findings demonstrate that the overall experience of the Kenyan coffee was enhanced significantly by the white cup for the experts, and by the gold cup for the consumers. In addition, the bronze cup increased the ratings of sweetness for both Brazilian and Kenyan coffees by the experts (in contrast to the consumers). The enhanced overall experience of the Kenyan coffee sampled from the gold cup (for the consumers) and the increased perception of sweetness of both coffees when tasted from the bronze cup (for the experts) is certainly consistent with the aforementioned colour-taste crossmodal congruency hypothesis. Moreover, it is important to note that, in the case of experts, the bronze cup affected the perception of sweetness itself, showing the effect of the colour on the corresponding taste. One might expect that experts would be somewhat less

likely to be influenced by extrinsic cues or alteration of intrinsic cues (e.g., wine colouring), at least within their area of expertise. However, several studies indicate this does not necessarily appear to be the case (Spence, 2020b). Our results on the bronze cup affecting the experts' ratings of sweetness may be taken to suggest that the professionals, who have been trained to identify and verbally report flavour sensations, would be more attuned to subtle differences in flavour attributes and more susceptible to product-extrinsic influences (Hughson & Boakes, 2001; Carvalho et al., 2020).

As expected, the mediation analyses revealed that the attribute elegance mediated between cup type, on one hand, and sensory and hedonic measures, on the other hand. The mediation results show that, when the Brazilian coffee was served in the bronze cup, elegance was a predictor of aroma, flavour, acidity, and liking ratings for both consumers and experts. Likewise, when the Kenyan coffee was served in the white cup, elegance was a predictor of aroma, flavour, sweetness, acidity, and liking ratings for experts only. A type of sensation transference effect called "affective ventriloquism" (Spence and Gallace, 2011) provides one mechanism which could be used to explain how a visual cue (i.e., cup) perceived as elegant could go on to influence people's coffee evaluations, especially when it comes to liking ratings. It is important to note that the significantly higher sweetness ratings of the Brazilian coffee when tasted from the bronze cup (as compared to any other cup) were not mediated by 'elegance'. This suggests a direct effect of the bronze colour on perception of sweetness in the Brazilian coffee. However, 'elegance' as a predictor of positive attributes was only observed for the bronze cup paired with the Brazilian coffee, suggesting a not so general influence of the metallic colour on flavour and hedonic ratings. It is relevant to highlight the fact that certain metallic colours may not necessarily connote the concept of "quality" (Piqueras-Fiszman & Spence, 2011), or may connote quite specific meanings across cultures (e.g., silver is associated with dairy products in the U.S. and with fresh seafood in Norway; Burton, 2008; Heide & Olsen, 2017).

The reported metallic taste sensation was also impacted by the type of metallic coating, in both coffees and in experts and consumers alike. The coffees sampled from the platinum cup were judged as having a significantly stronger metallic taste than those sampled from the any other cup. In addition, the coffees tasted from the gold and bronze cups were also perceived as tasting significantly more metallic than those sampled from the white cup. These results suggest that the metallic properties of the cups were

somehow transferred to the coffees. In fact, Laughlin, Conreen, Witchel, and Miodownik (2011) investigated the sensory-discriminative effects of metallic sensation arising from spoons that had been coated with different metals. The results revealed that gold, silver, zinc, copper, tin, chrome, and stainless steel plated spoons alone yielded different taste sensations in the participants..

Beyond the tastes caused by metal spoons themselves, Piqueras-Fiszman, Laughlin, Miodownik, and Spence (2012) asked blindfolded participants to rate sweet, sour, bitter, salty, or plain cream samples using spoons that had been plated with the metals gold, copper, zinc, and stainless steel. The zinc and copper spoons transferred a metallic and bitter taste to the cream and were found to enhance each cream's dominant taste. Nevertheless, the presence of the metallic taste did not influence participants' pleasantness ratings to any great extent. Gold and stainless steel spoons, by contrast, did not affect the flavour of the different creams. Since the present exploratory study did not include a blindfolded control condition, it remains for future research to determine to what extent the perception of metallic taste was caused by the visual appearance or by oronasal sensation from the metal of the finish of the cups itself.

Limitations of the present research, in addition to the lack of visual control condition, include the possibility that the significant effects attributed to the level of expertise alone could have also been influenced by testing location. Despite possible location effects (as a confounder) cannot be ruled out, it is important to consider that experts and consumers have been tested in locations which were as close as possible to their real life coffee consumption context (a cupping room for the experts and coffee shop for consumers). In addition, both testing rooms were controlled for external ambient conditions, such as light and sound.

In the future, it will be desirable to conduct more controlled experiments in order to determine the exact parameters that influenced the differences found in the sensory and hedonic perception of the coffee samples. Nevertheless, that said, the preliminary results of the two experiments reported in the present study demonstrate, for what may well be the first time, that the metallic properties of the outer surface of the cup in which coffees were evaluated exerted a significant influence over the ratings of both experts and consumers. These results contribute to our knowledge of how contextual variables affect the perception of specialty coffees. They are of great relevance to vessel and packaging

design in order to potentially enhance the consumption experience. In addition to specialty coffee, premium marketing strategies have been successful for beverages perceived as an indulgence such as craft beer and sparkling wine (Quelch, 1987). Shiny and metallic colours seem to provide an important element in creating prestige in the beverage industry (Heine, Phan & Atwal, 2016). It has been shown that heraldic colours on wine labels, such as gold and silver, represent authenticity in consumers' perceptions of wines which, in turn, may affect both pleasure and purchase intent (Pelet, Durrieu, & Lick, 2020). Both material and design are important elements of the consumption experience of beverages and provide a tool to create enhanced consumption concepts (Billing, Öström & Lagerbielke, 2008; Ingvarsdóttir & Balkenius, 2020).

Conclusion

In summary, the results reported in the present study demonstrate that the metallic properties of the outer surface of coffee influenced sensory and hedonic ratings of both coffee experts as well as consumers. These results contribute to our knowledge of how contextual variables affect the perception of specialty coffees, and argue that the drinking vessel is a necessary part of the multisensory coffee drinking experience. These findings are of relevance to servingware and packaging design for coffee in order to potentially enhance the experience of the consumer.

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Table 1. Total indirect effect (a-path*b-path) (IND), standard error (SE), and lower and upper 95% confidence interval (CI) for elegance ratings between bronze cup (Brazilian coffee, both experts and consumers), white cup (Kenyan coffee, experts) and all other dependent variables.

Measure	Experts						Consumers		
	Brazilian coffee			Kenyan coffee			Brazilian coffee		
	IND (a*b)	SE	95% CI	IND (a*b)	SE	95% CI	IND (a*b)	SE	95% CI
Aroma	0.20	0.11	[0.02, 0.46]	0.44	0.15	[0.15, 0.74]	0.11	0.05	[0.01, 0.24]
Flavour	0.52	0.23	[0.08, 1.01]	0.66	0.21	[0.23, 1.09]	0.20	0.08	[0.06, 0.38]
Sweetness	n.s.	n.s.	n.s.	0.17	0.09	[0.02, 0.40]	n.s.	n.s.	n.s.
Acidity	0.34	0.17	[0.04, 0.74]	0.35	0.14	[0.11, 0.66]	0.13	0.06	[0.03, 0.27]
Liking	0.93	0.39	[0.17, 1.70]	0.94	0.28	[0.35, 1.47]	0.39	0.14	[0.14, 0.69]

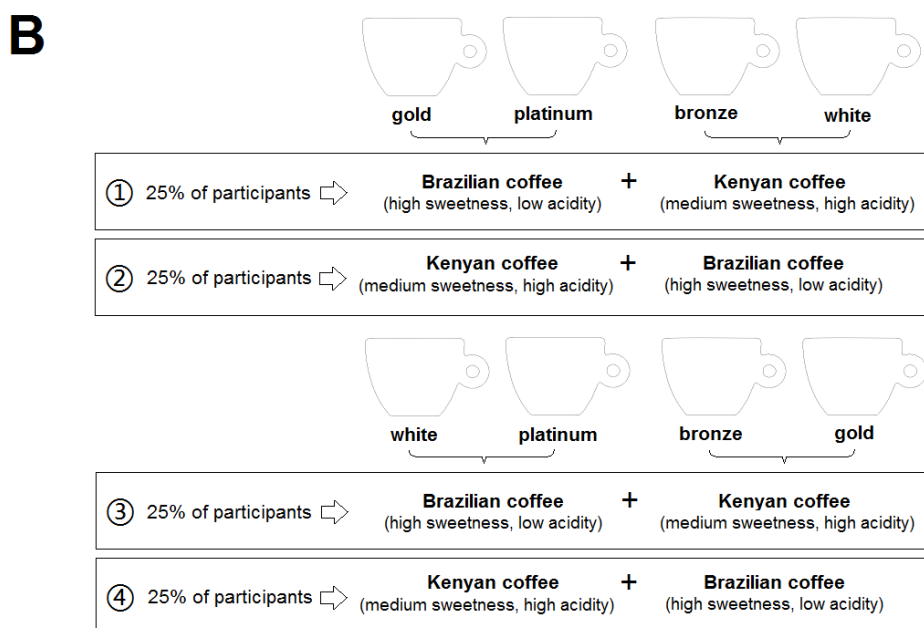


Figure 1. (A) Cups used in Experiments 1 and 2. **(B)** Diagram representing the experimental procedure adopted in Experiment 2 (consumers). Each participant evaluated four samples (cup colour + coffee type) in one of the four possible coffee-cup combinations depicted above (1–4) (as in Carvalho & Spence, 2019). Please note that the eight possible sequences from each one of the combinations were presented to participants.

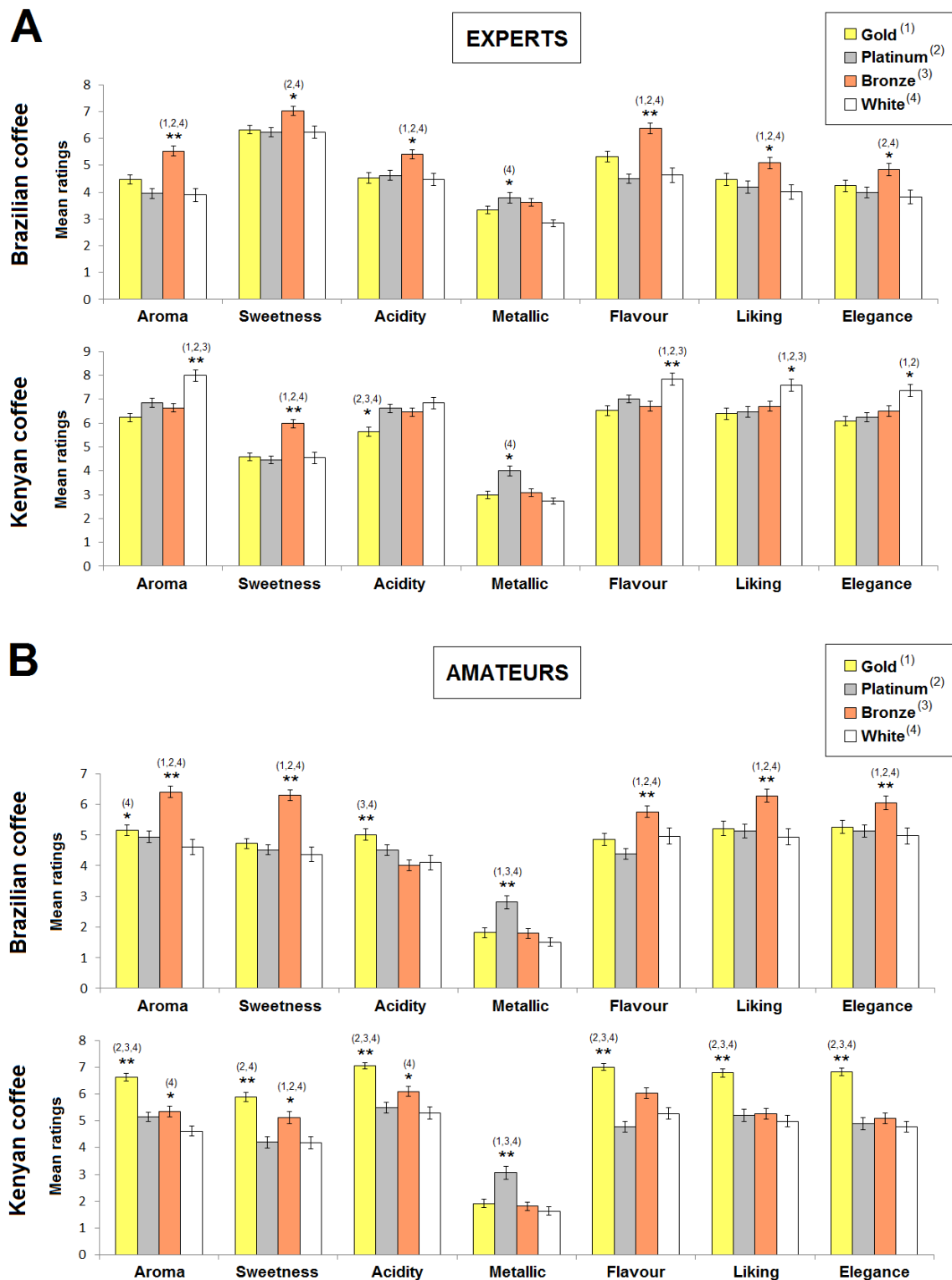


Figure 2. Mean ratings (\pm SE) of rating type (aroma, sweetness, acidity, metallic taste, flavour, liking, and elegance) for all four cup colours tested (gold, platinum, bronze, and white) for of **(A)** experts (Experiment 1) and **(B)** consumers (Experiment 2). Both **A** and **B** panels show separate plots for Brazilian and Kenyan coffees. Asterisks indicates statistical significance at $p < 0.05$ (*) or $p < 0.001$ (**). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

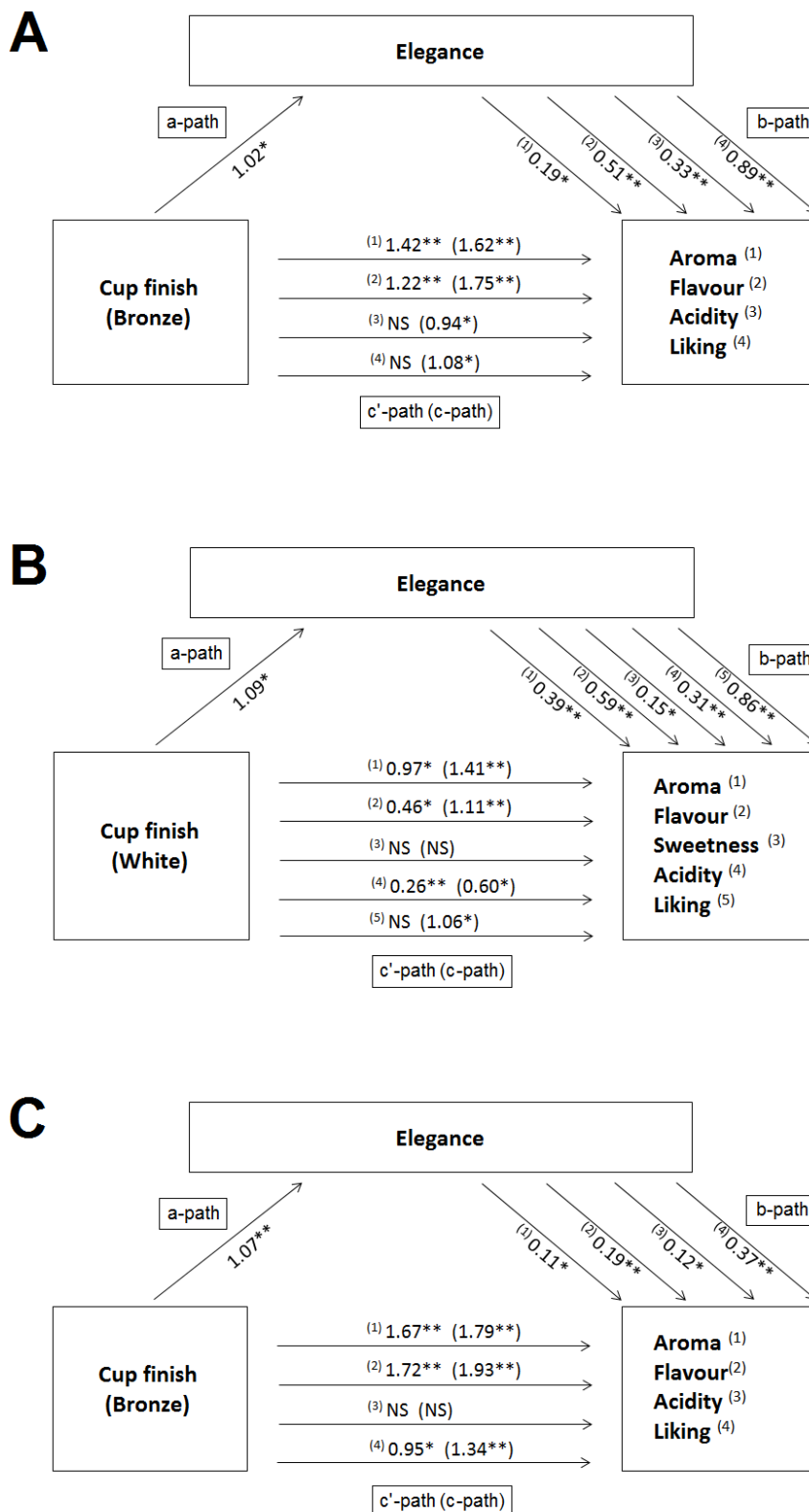


Figure 3. Associations between variables by means of a-path, b-path, c'-path, and c-path unstandardized coefficients obtained from the simple multi-categorical mediation model applied to the datasets. **(A)** Expert-Brazil for bronze cup, **(B)** Expert-Kenya for white cup, and **(C)** Consumer-Brazil for bronze cup. β values for Consumer-Kenya dataset are not shown since no significant mediation was observed. Asterisk indicates statistical significance at $p < 0.05$ (*) or $p < 0.001$ (**).

Table S1. Post-hoc comparisons of significant results for interaction effects between expertise, coffee type, and cup finish on all dependent variables (for Experiment 1 and Experiment 2).

Measure	Cup	Coffee	Expertise
AROMA	Platinum	Brazil	C>E ($p < .01$)
		Kenya	E>C ($p < .0001$)
	Bronze	Brazil	C>E ($p < .05$)
		Kenya	E>C ($p < .001$)
	White	Kenya	E>C ($p < .0001$)
SWEETNESS	Gold	Brazil	E>C ($p < .0001$)
		Kenya	C>E ($p < .0001$)
	Platinum	Brazil	E>C ($p < .0001$)
	Bronze	Brazil	E>C ($p < .05$)
		Kenya	E>C ($p < .05$)
	White	Brazil	E>C ($p < .0001$)
ACIDITY	Gold	Kenya	C>E ($p < .0001$)
	Platinum	Kenya	E>C ($p < .01$)
	Bronze	Brazil	E>C ($p < .0001$)
	White	Kenya	E>C ($p < .0001$)
FLAVOUR	Platinum	Kenya	E>C ($p < .0001$)
	White	Kenya	E>C ($p < .0001$)
LIKING	Platinum	Brazil	C>E ($p < .05$)
		Kenya	E>C ($p < .01$)

ELEGANCE	Bronze	Brazil	C>E ($p < .05$)
		Kenya	E>C ($p < .0001$)
	White	Kenya	E>C ($p < .0001$)
	Gold	Brazil	C>E ($p < .01$)
		Kenya	C>E ($p < .05$)
	Platinum	Brazil	C>E ($p < .01$)
		Kenya	E>C ($p < .01$)
	Bronze	Brazil	C>E ($p < .01$)
		Kenya	E>C ($p < .0001$)
	White	Brazil	C>E ($p < .05$)
		Kenya	E>C ($p < .0001$)

758 C=consumer; E=expert
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Table S2. Follow-up simple effects tests for interaction effects between coffee type and cup finish on all dependent variables.

	Brazilian coffee** (high sweetness; low acidity)	Kenyan coffee* (medium sweetness; high acidity)
Aroma	Bronze > Gold > Platinum = White	Gold > Platinum = Bronze Gold = White
Flavour	Bronze > Gold > Platinum = White	Gold = White = Bronze > Platinum
Liking	Bronze > Gold = Platinum = White	Gold > Platinum Gold > Bronze Gold = White
Elegance	Bronze > Gold = Platinum = White	Gold > Platinum, Bronze White > Platinum

* $p < 0.05$; ** $p < 0.001$

The scales below represent gradually the INTENSITY of the attributes you should rate.
The zero (0) indicates absence of the attribute, whereas ten (10) indicates the maximum possible of that attribute.

Please indicate with a vertical tick on the scale the level of your SENSORY PERCEPTION of the following attributes:

How AROMATIC is this coffee to you?	
0	10
Not at all	Extremely aromatic

How SWEET is this coffee to you?	
0	10
Not at all	Extremely sweet
How ACIDIC is this coffee to you?	
0	10
Not at all	Extremely acidic
How METALLIC is this coffee to you?	
0	10
Not at all	Extremely metallic
How FLAVOURFUL is this coffee to you?	
0	10
Not at all	Extremely flavourful

Now, please indicate the level of your PERCEPTION of the following attributes:

How much do you LIKE this coffee?	
0	10
Not at all	Extremely
How ELEGANT is this coffee to you?	
0	10
Not at all	Extremely elegant

Figure S1. The tasting ballot used by participants to assess the coffee samples in Experiment 1 and Experiment 2. The order of attributes in the ballot was counterbalanced between participants. It is important to note that, in addition to the written instructions, the participants were briefed at the beginning of each tasting session (before starting the sample evaluation).