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Highlights

- Black packaging made consumers expect chocolates to be more bitter.
- Pink and yellow packaging made consumers expect chocolates to be sweeter.
- The effect of a packaging color on expected liking depended on chocolate type.
- Warm and cold classification of colors did not explain the effects of packaging color.
- The effects of packaging color were not significantly different between cultures.

Abstract

Recent research has shown that the colors of plateware, glassware, cups, packaging, and even the room and its lighting are able to influence consumers' preferences, expectations and perceptions of taste, flavor and texture of food and beverages. This study contributes to the subject by investigating how packaging colors affected the expectations of sweetness, bitterness, fruitiness, melting, and liking for chocolates in Brazil and France. Two groups of 210 consumers (N = 420) from each country evaluated samples of milk and dark chocolate packaged in seven colors: black, blue, brown, green, red, pink and yellow. Analyses of variance (ANOVA) indicated that there were multiple significant effects of packaging color on consumers' expectations. Multiple factor analysis (MFA) showed that expected sweetness, fruitiness and liking were correlated to each other and inversely correlated to expected bitterness. While milk and dark chocolate were expected the least sweet and the most bitter when in black packaging, they were expected the sweetest and the least bitter when in yellow or pink packaging. Interestingly, the same black packaging made the milk chocolate the best rated and the dark chocolate the worst rated on expected liking, showing that a color may have inverse effects on expected liking depending on the type of chocolate. Although French consumers eat more chocolate and with higher cocoa content than Brazilians, the effects of packaging color were not significantly different between cultures.

Keywords

Consumer perception; Cross-cultural; Visual cues; Packaging; Color; Chocolate.

1. Introduction

Research has shown that not only the color of the product itself, but also the colors of the tableware, packaging, and environment can influence expectations and perception of a food or a drink (Spence, 2018). According to the predictive coding theory, this happens because when consumers see a product, such as a bar of chocolate, their brains immediately search for cues that match previous experiences and try to anticipate what it is and what are its characteristics (Piqueras-Fizsman & Spence, 2015). This process creates expectations that have been shown to affect behavioral response, sensory perception, and neural activation (Litt & Shiv, 2012; Okamoto & Dan, 2013), making the subject fundamental for food industries and food services interested in building a complete experience for their consumers.

It is argued that color is the most distinctive visual cue in a packaging (Singh, 2006), but its effects depend on many factors such as the level of attention (Brignell et al., 2009), the

frequency of consumption of the product (Lick et al., 2017), the cultural context (Piqueras-Fiszman et al., 2012), the consumers' sensitivity to design (Becker et al., 2011), and the product itself (Zellner et al, 2018). A recent review (Spence and Velasco, 2019) summarized the multiple roles of packaging color on consumers' expectation and perception of identity, taste, flavor, fragrance, healthiness, and willingness to pay. After the review, new contributions on the effects of packaging color reported that it may influence the emotions evoked by a burger (Merlo et al., 2018), its inside color (i.e., the side in contact with the product) may influence the desirability of yogurt (van Esch et al., 2019), and the color of the label may influence the expected taste of specialty coffee (de Sousa et al., 2020).

Specifically on the subject of this study, several significant effects of packaging color were reported on expected flavor, somatosensory sensations, and liking of food. Studies commonly associated these effects with the warm and cold classifications of colors. The first group includes colors of long length waves, like red, pink, and yellow; the second includes colors of short length waves, like blue, purple and green (Huang & Lu, 2015). First, Deliza and MacFie (2001) showed that an orange box made consumers expect passion fruit juice to be sweeter and less sharp, refreshing, and liked than a white box. Then, it was found that a dairy dessert in a yellow packaging was expected to be sweeter, creamier, and more liked than the same dessert in a black packaging (Ares & Deliza, 2010). Rebollar et al. (2012) reported that chewing gums in warm-colored packaging were expected to be sweeter, fruitier, and sourer than in cold colors or scale of grey; and Huang and Lu (2015) reported that cereal, ice cream, iced tea, and yogurt in red packaging were expected to be sweeter than in green or blue. Tijssen et al. (2017) found that a dairy drink in a red box was expected sweeter, creamier, more flavorful and liked than in a purple or a blue box; and that a sausage in a red box was expected to be saltier than in a green or blue box. Comparing juice, sorbet, and gums in red and yellow packaging, Matthews et al. (2019) showed significant effects on sourness and sweetness expectations. Finally, Rosa et al. (2019) reported that red-to-yellow, blue-to-green, and greyscale packaging influenced consumers' expectations for cookies tastes and liking in multiple directions.

Thus, besides protecting physically, chemically, and microbiologically a food product, packaging is a communication tool that draws attention, expresses identity, induces appetite, intensifies emotions, and conveys messages about the products' attributes (Velasco & Spence, 2019). Its potential to communicate might be particularly relevant for the 7.3 million tons of chocolate consumed globally (Conway, 2018), since they are usually eaten straight from the packaging and since there is a wide range of attributes that could be interesting to communicate: aromas (floral, fruity, nutty), tastes (bitterness, sweetness, sourness), oral sensations (snap, melting, silky), types (white, milk, dark), categories (confectionary, compound, bean-to-bar), varietals (forastero, criollo, trinitario), and countries of origin (Colombia, Madagascar, Ivory Coast) (Beckett, 1994).

There are very few studies on the effects of packaging color on the expectations of chocolate taste, flavor, texture, and liking. A master thesis (van Lith, 2015) showed that a chocolate in red packaging was expected to be significantly healthier than in yellow packaging and a chocolate in dark brown was expected to be significantly more natural than in yellow or pink, but significant effects were not found regarding attractiveness or tastiness. Another research (Kovač et al., 2019) reported that strawberry-flavored chocolate was

significantly more attractive when presented in vivid pink packaging than in a less saturated color. As these two studies did not tackle the effect of packaging color on tastes and texture of chocolate, further research could help pastry chefs, chocolatiers, designers, artisans, and industries to choose colors to their products' background, either it is a plate, a packaging or a shop window.

The purpose of this study was to evaluate the effects of seven different colors of packaging on expected sweetness, bitterness, fruitiness, melting, and liking of milk and dark chocolates. As color and taste associations were shown to vary among cultures (Wan et al., 2014), the questionnaire was simultaneously answered by a group of Brazilian and a group of French consumers. There are also expressive differences in the chocolate consumption between the two countries, although chocolate is commonly considered the most desired food in all the Western world (Richard et al., 2017). While the French eat 7.3 kg of chocolate per capita/year, with dark chocolate representing 30% of consumption among adults (Cohen, 2018), Brazilians eat 2.8 kg and only 3% of it is dark chocolate (Sebrae, 2018).

Based on the framework described above, the hypotheses were:

H1: the packaging color affects the expectations of sweetness, bitterness, fruitiness, melting, and liking of chocolate;

H2: Cold-colored packaging increase the expected bitterness (H2a), warm-colored packaging increase expected sweetness (H2b) and fruitiness (H2c);

H3: packaging colors differently affect expectations for milk and dark chocolates;

H4: packaging colors differently affect expectations of Brazilian and French consumers.

2. Methods

2.1 Stimuli

The stimuli (Figure 1) were pictures (958 x 958 pixels) of Lindt (Lindt & Sprüngli AG, Kilchberg, Switzerland) milk chocolate (min. 30% cocoa) and dark chocolate (min. 70% cocoa) in black, blue, brown, green, red, pink and yellow packaging. The packaging were folded rectangular (10.5 x 4 cm) pieces of Maldor's 130 g/m² colored paper (Clairefontaine, Etival Clairefontaine, France). The images are photographs, all taken in less than 5 minutes with a Galaxy S7 (Samsung, Manaus, Brazil) in an open space with direct sunlight. They were cropped, resized and had their contrast increased by 30% on Photoshop CS6 (Adobe, San José, CA, USA).

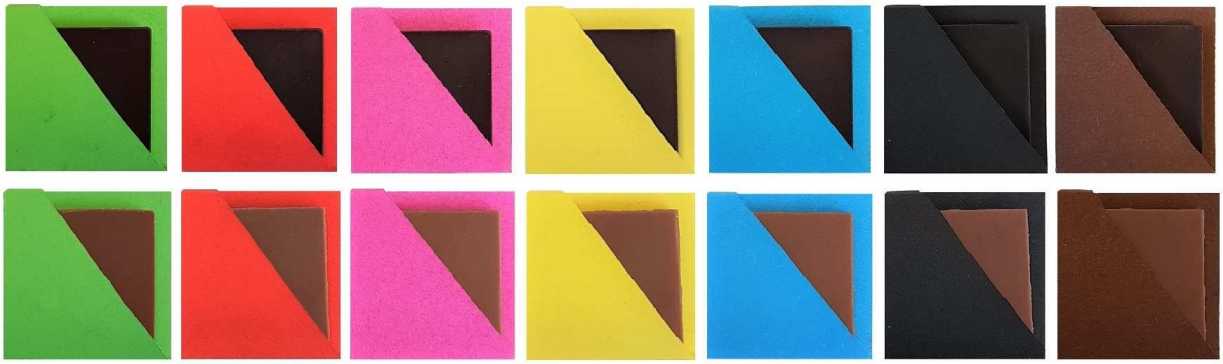

Figure 1. Dark chocolate (above) and milk chocolate (below) in green, red, pink, yellow, blue, black and brown packaging.

2.2 Participants

An email inviting chocolate consumers to participate in the research was sent to students and staff from AgroSup Dijon and the School of Biology, Earth and Environment Sciences of the University of Burgundy in France, and from the University of Campinas' School of Food Engineering and School of Agricultural Engineering in Brazil. They were informed that they were going to "answer a questionnaire about four chocolates" and nothing else on the subject or aim of the study. Together with the invitation, they received a link that directed to an online survey designed and hosted on Compusense Cloud (Compusense, Guelph, Canada). Before starting the questionnaires, respondents read and were given the choice to accept or decline an informed consent form. This study was approved by the University of Campinas' Ethic in Research Committee (protocol 20489019.4.0000.5404).

Using their own devices (i.e., smartphones, tablets or computers), 445 chocolate consumers in France and 245 in Brazil completed the questionnaire during the first two weeks of March 2020. From them, 32 in France and 27 in Brazil were not included in the study for being underage, not being French or Brazilian, or giving an invalid answer to any of the questions. The first 210 valid respondents from Brazilian group were selected. This N was chosen so the maximum of data was used and the number of evaluations for each sample was balanced. Then, French participants were also selected in "first in, first included" criterium to match the Brazilian group in number (210), age range (18-60 y.o.), gender distribution (146 female), and mean age (26.40±8.32 y.o. in France, 26.40±6.69 y.o. in Brazil). This screening process was performed to obtain comparable groups across cultures (Ares, 2018).

2.3 Data collection

If respondents accepted to participate in the study, one of the samples from Figure 1 was shown without any other information on the purpose of the study or on the sample brand, cocoa content, packaging color etc. Then, participants were asked to rate their expectation of sweetness, bitterness, fruitiness and melting using a 9-point intensity scale (1 = not at all, 9 = extremely) and expected liking using a 9-point hedonic scale (1 = extremely dislike, 9 = extremely like). The questions were "How sweet/bitter/melting/fruity do you think this chocolate is?" and "How much do you think you would like this chocolate?". All communication and questionnaires were in Portuguese in Brazil and in French in France, the

translation to French was independently checked by three native speakers familiar with sensory analysis of food, but no equivalency test was performed.

Each participant monadically evaluated two samples of dark chocolate and two of milk chocolate, therefore, four of the14 different samples. The balanced incomplete block was a Williams design provided by Compusense with 98 sets created by modifying a 14 x 14 Latin Square (Williams, 1949). The presentation of the chocolate types and the order of appearance of the attributes were balanced between participants. After evaluating the samples, they were asked about what type of chocolate they usually eat ("white", "milk", "dark > 60% cacao", and/or "dark < 60%"), with which frequency ("once a month", "2 to 4 times per month", "2 to 6 times per week", or "everyday"), which are their nationality (open answer), gender ("masculine", "feminine", or "other"), and age (open answer).

2.4 Statistical analysis

Three-way mixed design analyses of variance (ANOVA) (model GLM, SAS Institute, Cary, USA) at 5% significance level were performed separately for each attribute, so Holm-Bonferroni was used to correct for multiple comparisons. ANOVA was performed on least square (LS) means to compensate for the incomplete block, with block as random factor because of the subjective nature of human behaviour, with country as between-subject fixed factor because each group has a different nationality and it was a controlled factor, and with sample as within-subject fixed factor because participants had different samples and it was also a controlled factor. When the sample effect was significant, Tukey-Kramer's test was used for pairwise comparison, also corrected by Holm-Bonferroni. Further contrast analysis opposing dark and milk chocolate samples was performed using Excel 2010 (Microsoft, Remond, USA). Multiple factor analysis (MFA) was then performed on the samples by attributes by country matrix to provide a synthetic view of the data. MFA was followed by hierarchical cluster analysis (HCA) using the Ward's agglomeration criterion on the first two dimensions of the MFA. Both MFA and HCA were performed using FactoMineR (Lê et al., 2008) for R (R Core Team, 2020).

3. Results

3.1 Participants

Type of chocolate consumed and frequency of consumption were both significantly different ($\chi^2 = 27.85$, df = 3, $p < .01$ and $\chi^2 = 10.48$, df = 3, $p = .02$, respectively) between the two groups. As shown in Table 1, more French participants reported eating dark chocolate (> 60% cocoa) and more Brazilians reported eating white, milk, and dark (< 60% cocoa) chocolates. Also, while French participants are well distributed between all frequencies of consumption (1/month to everyday), most Brazilians eat chocolate on intermediary frequencies (2-4/month and 1-6/week). Furthermore, the French showed more specificity regarding the type of chocolate eaten (1.79 versus 2.05 types of chocolate per person, $\chi^2 = 9.67$, df = 3, $p = .03$).

Table 1. Chocolate consumption profiles of the Brazilian (N = 210) and French (N =210) groups, in percentage.

		Brazil %	France %
Type	White	31.90	20.00
	Milk	67.62	60.95
	Dark (<60%)	66.19	49.52
	Dark (>60%)	39.05	49.05
Frequency	1/month	8.10	15.24
	2-4/month	39.52	28.10
	2-6/week	44.76	33.81
	Everyday	7.62	22.86

3.2 ANOVA

The performed analyses of variance (Table 2) showed that significant main effects of country were found for all attributes but sweetness (means 5.08±1.94 vs. 4.98±1.85, in Brazilian and French groups, respectively). Brazilian participants expected the chocolates to be fruitier (5.20±1.85 vs. 4.73±1.94), more bitter (5.02±1.99 vs. 4.47±2.34), melting (4.07±0.51 vs. 3.65±0.28), and liked (6.45±0.42 vs. 6.04±0.43) than French. ANOVA also revealed significant main effects of sample for all descriptors, but no significant sample by country interaction was found.

The mean ratings given by participants to the milk and dark chocolate samples in different packaging colors are shown in Table 3. Chocolate packaged in pink and yellow were generally expected to be sweeter, less bitter, more melting, and fruitier. On the other hand, black packaging increased bitterness ratings and lowered sweetness, fruitness, and melting ratings. Scores for red, blue, and green samples were rarely significantly different from other samples. Brown packaging had the greatest number of significant differences, being rated as the sweetest, the least bitter, and most melting and liked among dark chocolates, as well as the most bitter and the least sweet among milk chocolates.

Black, blue, and green packaging had the lowest liking ratings among dark and the highest ratings among milk chocolates, while the opposite happened to pink and yellow, that is, they received the lowest ratings among milk and the highest among dark. Regarding fruitiness, the dark chocolate in pink and red packaging received the highest mean rates, they were significantly different from milk chocolate in blue and black packaging.

Table 2. F values and p-values for each dependent variable from the three-way ANOVA with block, country and sample as factors. Significance of 5% after Holm-Bonferroni's correction for multiple comparison is p < .01.

	Sweetness		Bitterness		Fruitiness		Melting		Liking	
Effects	F	*p*	F	*p*	F	*p*	F	*p*	F	*p*
Block	1.7	< .01	1.44	< .01	2.6	< .01	1.99	< .01	1.77	< .01
Country	0.83	.36	22.43	< .01	10.33	< .01	17.98	< .01	12.06	< .01
Sample	197	< .01	196.42	< .01	4.19	< .01	108	< .01	6.62	< .01
Sample* Country	1.3	.20	1.81	.04	0.74	.73	1.49	.11	.78	.68

Table 3. Least square means and standard deviation for sweetness, fruitiness, melting, and liking of dark and milk chocolates in seven packaging colors (1 = not at all, 9 = extremely). Values with the same letters in each column were not significantly different according to Tukey-Kramer's test at 5% significance corrected by Holm-Bonferroni for multiple comparison.

		Sweetness	Bitterness	Fruitiness	Melting	Liking
Dark	Black	2.27 ± 1.33^{e}	7.77 ± 1.49^{a}	3.49 ± 2.43^{bc}	2.92 ± 1.70^{e}	5.45 ± 2.28^{c}
	Blue	2.94 ± 1.64^{de}	7.07 ± 1.96^{abc}	3.59 ± 2.13^{bc}	3.12 ± 1.64^{de}	5.68 ± 2.02^{bc}
	Brown	4.11 ± 1.69^{c}	5.89 ± 1.85^{d}	3.53 ± 2.15^{bc}	4.48 ± 1.87^{c}	6.54 ± 1.74^{a}
	Green	2.88 ± 1.62^{de}	7.27 ± 1.73^{ab}	4.05 ± 2.22^{abc}	3.22 ± 1.76^{de}	5.63 ± 2.25^{bc}
	Pink	3.75 ± 1.63^{c}	6.31 ± 1.95^{cd}	4.62 ± 2.21^{a}	3.79 ± 1.15^{cd}	6.25 ± 1.79^{abc}
	Red	3.33 ± 1.68^{cd}	6.73 ± 1.90^{bcd}	4.40 ± 2.26^{ab}	3.48 ± 1.77^{de}	6.08 ± 1.78^{abc}
	Yellow	3.57 ± 1.64^{cd}	6.31 ± 1.90^{cd}	4.19 ± 2.06^{abc}	3.70 ± 1.89^{cde}	6.09 ± 1.89^{abc}
Milk	Black	6.62 ± 1.49^{ab}	3.06 ± 2.00^{efg}	3.41 ± 1.92^{c}	6.32 ± 1.54^{ab}	6.80 ± 1.45^{a}
	Blue	7.20 ± 1.44^{ab}	2.21 ± 1.34^{fg}	3.44 ± 1.99^{c}	6.50 ± 1.74^{ab}	6.53 ± 1.70^{a}
	Brown	6.43 ± 1.53^{b}	3.25 ± 1.88^{e}	3.50 ± 1.97^{bc}	6.42 ± 1.70^{ab}	6.62 ± 1.53^{a}
	Green	6.43 ± 1.61^{b}	3.15 ± 1.79^{e}	4.09 ± 2.17^{abc}	5.86 ± 1.93^{b}	6.30 ± 1.71^{ab}
	Pink	7.14 ± 1.24^{ab}	2.17 ± 1.39^{g}	4.08 ± 2.04^{abc}	6.71 ± 1.73^{ab}	6.45 ± 1.54^{ab}
	Red	6.60 ± 1.58^{ab}	3.00 ± 1.77^{ef}	3.98 ± 2.20^{abc}	6.29 ± 1.86^{ab}	6.60 ± 1.55^{a}
	Yellow	7.31 ± 1.32^{a}	2.30 ± 1.36^{fg}	3.82 ± 2.22^{abc}	6.74 ± 1.49^{a}	6.35 ± 1.70^{ab}

3.3 Contrast analysis

Further contrast analysis opposing dark and milk chocolate samples showed that type of chocolate had a greater significant influence on sweetness ($F(1,1342) = 2,395.42$, $p < .01$), bitterness ($F(1,1342) = 2,390.83$, $p < .01$), and melting ($F(1,1342) = 1,304.47$, $p < .01$); and a smaller significant effect on fruitiness ($F(1,1342) = 4.24$, $p < .05$) and liking ($F(1,1342) = 44.77$, $p < .01$). In addition to the contrast analysis, the greater standard deviations of the mean ratings (0.62 vs 0.38 in sweetness, 0.65 vs 0.48 in bitterness, 0.45 vs 0.30 in fruitiness, 0.52 vs 0.30 in melting, 0.39 vs 0.17 in liking) and the greater number of significant differences between samples (27 vs 9 in total) indicate that packaging color affected more the expectations for dark chocolate than for milk chocolate.

3.4 MFA and HCA

The correlation circle (Figure 2A) indicates small differences between the Brazilian and French groups. The first dimension explains 72.85% of the variance and is negatively correlated to bitterness (-.99 and -.99) and melting (.23 and -.32), while positively correlated to sweetness (.99 and .99), fruitiness (.99 and .99), and liking (.85 and .67) in Brazil and France, respectively. The second dimension is mostly correlated to melting (.93 and .90) and explains 17.43% of the variance so that the first two components of the MFA account for 90.28% of total variance.

The individual factor map (Figure 2B) shows a clear separation between the milk (right) and the dark chocolates (left) on the first dimension. As shown by Table 3, milk chocolates were generally expected to be sweeter (means 6.82±0.38 vs. 3.26±0.62), less bitter (2.73±0.48 vs. 6.76±0.65) and fruity (3.76±0,30 vs. 3.98±0.45), more melting (6.41±0.30 vs. 3.53±0.52) and liked (6.52±0.17 vs. 5.96±0.39) than dark chocolate. The second dimension shows both chocolates packaged in pink, red, yellow, and green (up) in opposition to blue, black, and brown (down). Overall, the projections of each country for a same sample are more distant vertically than horizontally, indicating that melting is an important attribute to discriminate the answers from the Brazilian and French groups.

HCA revealed three clusters, the first with all milk chocolate samples (left), the second with dark chocolate samples in pink, red, yellow and green packaging (right/up), and third with dark chocolate packaged in brown, blue and black (right/down). The first cluster is correlated with sweeter, fruitier, and more liked samples; the two others are correlated with more bitter samples. The difference between the second and the third clusters is on the second dimension, the former being positively correlated to melting and the latter negatively.

Figure A

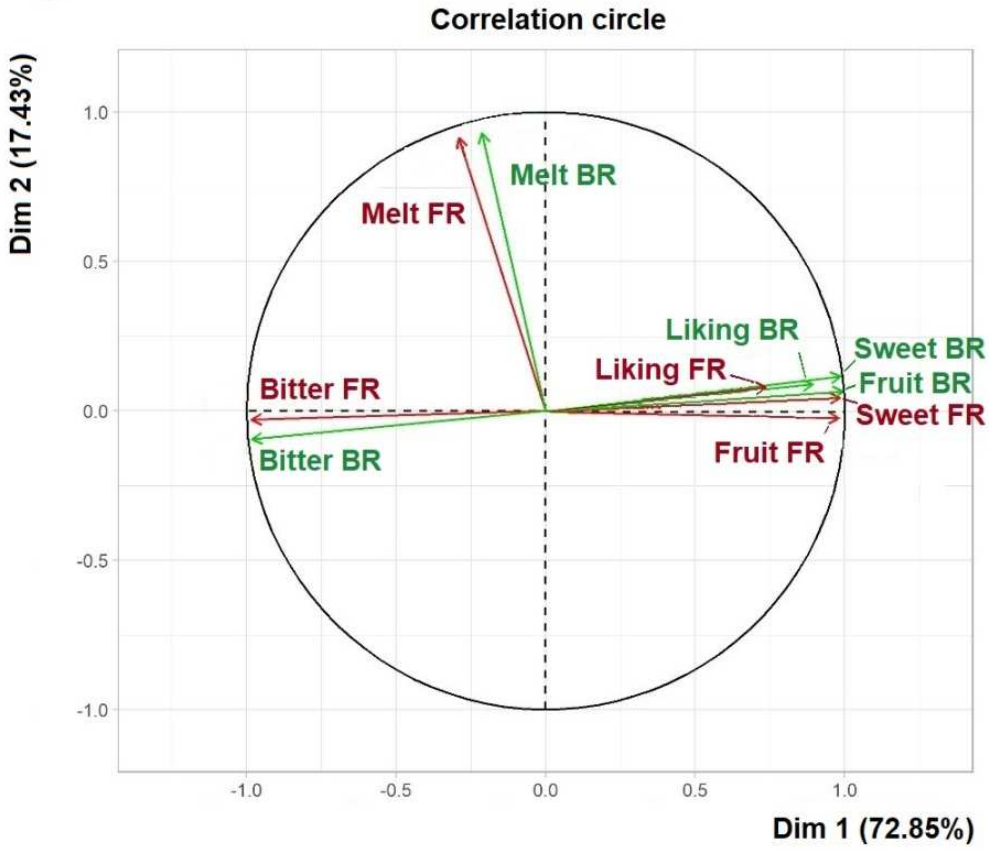

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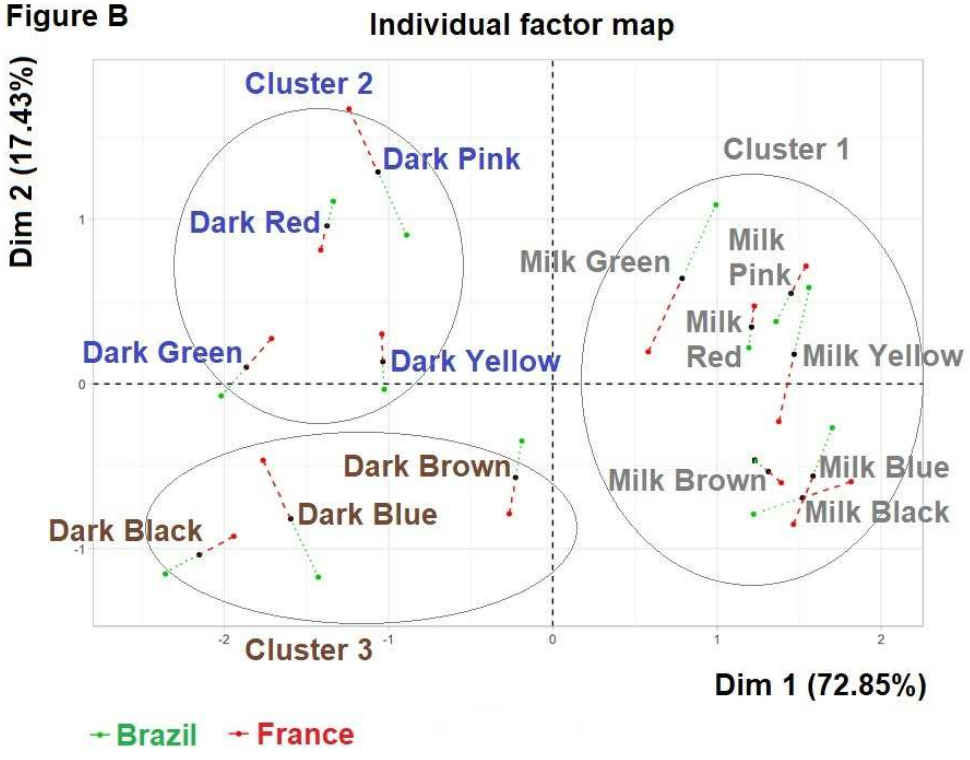
Figure B



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274 **Figure 2**. Multiple factor analysis: (A) Correlation circle of variables in Brazil and France;
275 (B) Individual factor map with HCA clusters.

4 Discussion

4.1 Color

The first hypothesis (H1) was confirmed, that is, packaging colors significantly affected the expectations of sweetness, bitterness, fruitiness, melting and liking. A review of Spence and Velasco (2018) showed significant effects of packaging colors on other food and beverage products, but the only previous research on chocolate (van Lith, 2015) with 23 participants in Netherlands reported no significant effect of seven different colors of packaging on tastiness and attractiveness. Reasons why the present study found significant differences in liking, while the previous did not on tastiness and attractiveness, might be: the colors used, a cultural difference, the lack of other information (i.e., logo, label, illustrative picture) and/or just a greater number of participants.

As dark and milk chocolate were shown interleaved to make the aim of the study less obvious to participants, the sample effect accounted for the influence of chocolate type and of packaging color at the same time. All attributes were significantly affected by sample, but sweetness, bitterness and melting were more strongly than fruitiness and liking. On one hand, it is evident that type of chocolate was more relevant for sweetness, bitterness and melting, because all milk chocolate samples were significantly different from all dark chocolate samples in these attributes, regardless of packaging color. On the other hand, color was more relevant for fruitiness than type of chocolate, because none of the samples were rated significantly fruitier than the other type packed in the same color, while there were some significant effects between samples with different colors. On liking, effects of type and packaging color were dependent and can not be separated.

ANOVA revealed that black packaging is correlated to bitterness, while pink and yellow packaging are correlated to sweetness. Spence et al. (2015) indicated that the associations black-bitter and pink-sweet are commonly reported in different cultures, but not the yellow-sweet association, as this color is generally correlated to sourness. Yet, the yellow-sweet association is somehow coherent with the findings that Uruguayan consumers expected milk dessert in black packaging to be more bitter than in yellow or white (Ares & Deliza, 2010); that Spanish consumers expected chewing gum in grayscale (black to white) packaging to be less sweet than in warm (red to yellow) or cool (blue and green) colors (Rebollar et al., 2012); and that Brazilians expected and perceived two coffees as sweeter when in a yellow cup (Carvalho & Spence, 2019).

Previous studies (Rebollar et al., 2012; Spence et al., 2015; Huang & Lu, 2015; Tijssen et al., 2017) reported that red packaging consistently increases expectations of sweetness, creaminess, and fruitiness in food products, but both chocolate samples in red packaging in this study received intermediary rates. Red was only significantly different from black on bitterness among dark chocolate and from pink on sweetness among milk chocolate. The faible effect might be due to the brightness and/or saturation used in this experiment, but van Lith (2015) also did not find significant effects for red packaging. Spence and Velasco's (2018) argued that it could be due to the Dutch association between red packaging and dark chocolate, the finding of the same result in France and Brazil indicates the lack of effect is more general in Western cultures.

Brightness and/or saturation could also be relevant to understand why samples in green packaging were rated significantly more bitter than in brown, pink, and yellow among

dark chocolate, and blue and pink among milk chocolate. Two out of five studies reviewed by Spence et al. (2015) reported an association between green and bitterness, while four reported association with sourness. This ambivalence is not rarely explained by the prevalence of limes or lemons in the participants' culture (Carvalho & Spence, 2019), but in this study Brazilians distinctly associated green to bitterness. So, it is possible that the use of a brighter or darker shade of green might also play a role in the ambiguity, as a same culture might associate the first with the color of lime and the second with the color of dark green vegetables like broccoli and spinach.

The dark chocolate in brown packaging received the most ambivalent ratings, being the sweetest and the least bitter among dark chocolates, while it got the highest rating for bitterness and the lowest for sweetness among milk chocolate. This might be due to a dual effect of packaging color depending on chocolate type or, more likely, a miscalibration of the lighting by the camera used in this study, as the dark chocolate seems slightly brighter in the brown packaging than the other dark chocolate samples. This unbalanced lighting was unnoticed by the researchers before the conclusion of the data collection. Other samples might also have lighter differences, but these differences varied according to the device used by the participant and are, at least in part, an effect of the contrast with the packaging color.

As the stimuli showed both chocolate and packaging, the samples were combinations of two colors. It has been shown that the combination of two congruent colors can be more strongly associated to a taste than the colors alone, especially when one is dominant and the other is auxiliary (Woods & Spence, 2016; Woods et al., 2016). In the present study, stronger effects of chocolate type indicate that the color of the chocolate was more important than the color of the packaging, suggesting that the former was perceived as foreground and the latter as background. That is understandable, since participants were asked to rate their expectations for the chocolate, not for the packaging. Thus, the results in this study are the effects of the combination of the packaging color with the color of chocolate and they might not be replicable in packaging that do not show the chocolate by transparency or illustration.

4.2 Warm and cold colors

The hypothesis that cold colors would increase bitterness ratings (H2a) and warm-colored packaging would increase sweetness (H2b) and fruitiness (H2c) ratings was not confirmed. First, MFA separated almost perfectly between cold and warm colors, except for both samples in green, that are together with pink, red and yellow on the upper part of the individual map (Figure 2B). Then, the milk chocolate in red packaging received much closer ratings to black, blue, green, and brown than to pink and yellow in sweetness and bitterness, being rated significantly more bitter than pink. In the other direction, the milk chocolate in blue packaging, a cold color, was rated the second most sweet and the second less bitter, being expected significantly less bitter than brown and green. Among dark chocolate the distinction was stronger, as all warm colors were rated-although not always significantly-as sweeter and less bitter than all cold colors, except brown, whose results are questionable.

Based on the cold and warm distinction, most studies compare and find significant effects on expectation and perception of food and drinks in red and blue packaging (Rebollar et al., 2012; Huang & Lu, 2015; Tijssen et al., 2017; van Esch et al., 2019; Rosa et al., 2019). This study found no significant difference between these two packaging colors in any

attribute of any chocolate type. These unusual results might be particular to chocolate packaging, to Brazilian and French cultures, or to the brightness and saturation used by this experiment, but they resemble the results on single colors reported by Woods & Spence (2016). Thus, researchers, industries, artisans, chefs, baristas, mixologists, packaging designers, food bloggers and photographers might consider contrasting black to pink or yellow, instead of red to blue when willing to influence the consumer's expectations.

4.3 Chocolate type

The third hypothesis (H3) was confirmed: packaging colors affected milk and dark chocolate differently. The greater standard deviation of the mean ratings and the greater number of significant differences indicate that packaging color affected more the expectations for dark chocolate than for milk chocolate. HCA also evidences that, as dark chocolate samples were separated in two clusters, while the milk chocolate samples were all grouped in one single cluster. This difference might be a consequence of a stronger and wider flavor and texture profile found in chocolates with higher cocoa content, and/or of the adding effect of shape and color congruency (de Sousa et al., 2020). As dark chocolate is related to squared-shapes and milk chocolate to round-shapes (Ngo et al., 2011), results could be different if the chocolate samples were rounded.

Regarding liking, packaging colors influenced the types of chocolate differently, even in opposite directions. Table 2 shows that while the black packaging made the milk chocolate the most liked of all samples, the same packaging made the dark chocolate the least liked. The pink packaging had an opposite effect, making the dark chocolate the second most liked-only behind the one packed in brown, whose results are questionable as mentioned on the previous item-and the milk chocolate the second least liked among its type. Other colors, except brown, had similar ambivalent effects, increasing liking in one of the types and decreasing on the other.

If at first it would be intuitive and congruent to use dark packaging colors for dark chocolates and light colors for milk chocolates, this study shows that contrasting the chocolate type and the packaging color might make it more appealing for consumers. This might be an explanation for why some industries in Europe use red packaging for dark chocolate, as mentioned before. Perhaps the incongruity between packaging color and chocolate type increases liking by making the product look more balanced, that is, "sweet colors" make dark chocolate look not too bitter, and "bitter colors" make milk chocolate look not too sweet.

This result does not necessarily mean that consumers individually prefer balanced chocolates, but that the group preference converges on balanced chocolates, something natural if we expect to have individuals with preferences normally distributed through all the spectrum of bitterness to sweetness. Therefore, food industries and services that use visual cues to sell their products to a broad public, such as chocolate bars in a supermarket or a chocolate-based pastry on a shop window, could improve their overall expected liking by using the right packaging or background color to the right type of chocolate. This resource should be used with care, though, since great disconfirmation of expectation may lead to a penalty on post-comsumption liking (Cardello & Sawyer, 1992).

4.4 Cross-cultural effects

The hypothesis that packaging color would affect Brazilian and French consumers differently (H4) was not confirmed. ANOVA combining the effects of country and sample showed no significant difference between groups, indicating that packaging colors affected ratings in the same general way in both groups. This understanding is also supported by the proximity between groups of the angles on the correlation circle (Figure 2A) and of the projections on the individual map (Figure 2B). For practical applications, it evidences that no change in packaging or context colors might be necessary for exporting chocolate products or offering a chocolate pastry dish in Brazil, France, and possibly many other Western cultures.

It is interesting to add that ANOVA found significant effects of country alone in all attributes except sweetness. These results show that the overall rating of bitterness, fruitiness, melting, and liking was different between groups, but not that packaging colors had different effects. For example, the Brazilian mean rating for bitterness of all samples was significantly higher than the French, probably a consequence of the smaller percentage of Brazilians that reported eating chocolate with more than 60% cocoa. As they are less familiar to bitter chocolates, they rated bitterness higher than the French.

In the other direction, it is unexpected that there was no significant difference for sweetness between countries with such different relationships with sugar, as Brazilian desserts are known for being distinctly sweet and sugar being part of the cultural, economic and political history of the country (Freyre, 2007). But the lack of difference does not necessarily indicate that they perceive sweetness equally, it only shows that both groups had similar expectations of sweetness when seeing images of chocolate samples. What Brazilian consumers would rate as a moderately sweet chocolate when tasted might still be too sweet for French consumers.

4.5 Limitations

As recent studies showed that the lightning and chroma may affect emotions more than the hue alone (Schloss et al., 2020) and, as color-taste effects might occur via emotions correspondences (Palmer et al., 2013), they were a relevant uncontrolled factor in this study. Further studies should investigate the effects of colors in more complex and realistic packaging, including more than one hue, brightness and/or saturation. As the aim of this study was to explore the color effect, no other detail was included in the packaging, such as brand, weight, claims, product description or illustration. Participants of both groups were recruited from institutions that teach and research Food, Biology and Agriculture, therefore their background knowledge of scientific methods and/or food likely influenced the results. This study also did not check participants for color blindness, nor controlled the final resolution and color balance of the pictures since participants used their own devices to answer the questionnaire. To make the goal of the experiment less obvious to participants, this study chose to collect and analyze data on milk and dark chocolate samples together. This might have led to a smaller number of significant differences, particularly among milk chocolate samples, because the effects of packaging color on dark chocolate were stronger. Another step forward on the subject would be testing if these effects on expectation affect consumers' actual perception, because that is not always the case (Zellner et al., 2018).

5. Conclusion

This study was the first to find significant effects of several packaging colors on expected taste, flavor, texture and liking of chocolate. It was also the first to evaluate that for two types of the same food product with opposing sensory qualities (bitter x sweet) among two different cultures. Another difference was showing both the product (chocolate) and the packaging on the picture. Significant interactions between chocolate type, packaging color and culture showed that effects are co-dependent, making it important to consider and control all these variables together. It is possible to conclude that black packaging induces greater expectation of bitterness and yellow and pink packaging induce greater expectation of sweetness and melting in chocolate. Also, that the effects of a packaging color on expected liking might take opposite directions for milk and dark chocolate. The effects of context color on food must be further investigated to understand how industries, artisans, chefs, baristas, mixologists, packaging designers, food bloggers and photographers may use it to influence the consumers' expectations for its products and services.

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