Colors and emotions: a comparison between Spanish and Mandarin

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Abstract

This study aims to determine if there are differences in color-emotion association between monolingual speakers of Spanish and Mandarin, also depending on how colors are presented (either verbally or visually). With this aim, we tested two groups of 25 speakers of these two languages in two different tasks using the Geneva Emotional Wheel, which encompasses 20 types of emotions. In Task 1, 13 colors were presented to participants as color terms, whereas in Task 2 the same colors were presented as color patches from the Munsell chart. Overall, differences between languages were not significant, either regarding the type of emotion, or individual dimensions of emotion (valence, arousal, or power), although significant differences were observed for specific colors. Also, Spanish speakers tended to attribute higher intensity values and higher numbers of emotion values to colors. At the same time, speakers of both languages reacted similarly to the mode of color presentation, with color terms being associated to the same emotions than color patches, but eliciting stronger reactions with respect to intensity and number of emotion values. Finally, we found less variability in color-emotion associations within the Spanish-speaking group. Overall, our study points to a mixed pattern of universality and culture-specificity regarding how colors are used for conveying emotions.

Keywords

color-emotion associations; universality; cultural specificity; color terms; color patches; Geneva Emotional Wheel.

1. Introduction

Across languages and cultures, colors are often used to convey emotional states (Adams & Osgood, 1973; Soriano & Valenzuela, 2009; Jonauskaite et al., 2020a). Culture shapes these color–emotion associations, with differences impacting in turn on the perceptive, cognitive, and behavioral dimensions of color experience (Elliot et al., 2007; Mehta & Zhu, 2009; Jiang et al., 2013). Although color-emotion associations have been described for selected languages and cultures, more comparative research is needed to identify universal and culture-specific factors mediating color-emotion associations in the world's societies (Hanada, 2018).

More specifically, ongoing research has tried to identify specific dimensions of color that might relate to specific dimensions of emotion. Color dimensions that are typically considered include hue, brightness, and saturation, whereas emotion dimensions that are usually analyzed include valence (i.e. the pleasantness of the emotion, ranging from strongly negative to strongly positive), arousal (i.e. the level of activation resulting from the emotion, ranging from strongly calmy to strongly excited), and power (i.e. the sense of dominance brought about by the emotion, ranging from strongly powerless to strongly powerful) (for details, see Scherer, 2005; Fontanie et al., 2007; Soriano & Valenzuela, 2009; Yu, 2009; Fontanie, 2013; Forceville & Renckens, 2013; Safarnejad et al., 2014; Takei & Imaizumi, 2022, among many others). As a general rule, more saturated and brighter colors tend to result in higher arousal and valence ratings, with hue having a lesser impact (Wilms & Oberfeld, 2018). Also, according to Soriano and Valenzuela (2009), arousal and power ratings tend to be less variable than valence ratings, which appear to be more context-sensitive, seemingly because the former are more dependent from our physiology.

Therefore, it frequently happens that different cultures associate the same color to different emotions. Hence, white is typically associated to positive emotions in English, French, Spanish, Turkish, or Japanese (Kaya & Epps, 2004; Jonauskaite et al., 2020b; Soriano, 2005; Demir, 2020), whereas it conveys diverse negative meanings in

Mandarin, as in *baishi* ‘white event’, for funeral; *baiyan* ‘white eyes’, for scorn; or *baiyanlang* ‘white eyed wolf’ for ungratefulness (Xing, 2009; Zhou, 2010; He, 2011). Still, cross-cultural differences in color-emotion associations do not appear randomly. A recent study by Jonauskaite and colleagues (2020a) have found that these associations are more similar in cultures that are geographically closer (although see Jiang et al., 2013 for some striking differences between Mainland China and Hong Kong).

A related concern is the effect of language on color-emotion associations. Whereas the perception of color can be regarded as similar in all human beings, languages differ in the number of basic color terms, ranging from a couple to more than a dozen (Berlin & Kay, 1969; Paramei; 2005, Lillo et al., 2007; Uusküla & Sutrop, 2007; Wu, 2011; Gao & Sutrop, 2014; Hsieh et al., 2020; Xu et al., 2023, among others). Moreover, the color lexicon impacts, even if subtly, on color perception and categorization (Winawer et al., 2007; González-Perilli et al., 2017). Language is also known to play a crucial role in shaping emotional associations (Lindquist et al., 2015). Color terms and emotions often intertwine, metaphorically or metonymically (Kövecses, 2000; Soriano &Valenzuela, 2009). As a reflect, to a great extent, of these cross-cultural differences in color-emotion association, different languages can use different color terms for referring to one specific emotion or associate one particular color term to different emotions. For instance, envy is associated to green in Spanish (e.g. *estar verde de envidia* ‘to be green with envy’), but with red in Mandarin (e.g. y*anhong* ‘red eyes’); by contrast, red is associated to anger in Spanish (*estar rojo de ira* ‘to be incandescent with anger’), whereas in Mandarin, anger is black (as in *hei zhe lian* ‘black(darker) face’) (Li, 2020).

A final concern is whether the mode of presentation of color impacts on color emotion-associations. A study by Wang and colleagues (2014) with Mandarin speakers found differences in valence ratings for red and blue depending on whether the stimuli encompassed color patches or color terms. These authors further found that whereas some color patches activate both biologically-based associations (i.e. metonymical, e.g.

red to blood, fire, or danger) and culturally-based associations (i.e. metaphorical, e.g. red to envy), others can activate only one type. By contrast, a recent study by Jonauskaite and colleagues (2020b) with French speakers found no differences between color patches and color terms in a color-emotion association task.

In this paper, we aim to delve into the potential differences in color-emotion association between native speakers of Spanish and Mandarin. Contrary to previous research that focused either on a few colors (e.g. red and blue in Wang et al., 2014) or a few emotions (e.g. happiness and sadness in Takei & Imaizumi, 2022), here we examine an ample set of colors, as well as a comprehensive set of emotions. In addition, we try to determine the factor(s) that promote(s) the use of one (or more) specific color(s) for referring to a particular emotion. In order to do so, consider the three fundamental dimensions of emotion as characterized above: valence, arousal, and power. Finally, we try to clarify whether color-emotion associations differ when colors are presented visually or verbally.

Materials and methods

For examining the research questions posited above, we mostly replicated the study by Jonauskaite and colleagues (2020b) with monolingual speakers of Spanish and Mandarin. In brief, we asked participants to associate color terms in their language (Task 1) or color patches (Task 2) to a set of emotion concepts (and intensities of emotion), as found in the Geneva Emotion Wheel.

Stimuli

For Task 1, we used the 11 basic color terms in Spanish and their Mandarin equivalents (Spanish, *negro* 'black', *blanco* 'white', *rojo* 'red', *amarillo* 'yellow', *verde* 'green', *azul* 'blue', *marrón* 'brown', *naranja* 'orange', *rosa* 'pink', *morado* 'purple', *gris* 'gray'; Mandarin *hei* 'black', *bai* 'white', *hong* 'red', *huang* 'yellow', *lü* 'green', *lan* 'blue', *zong/he* 'brown', *cheng/jü* 'orange', *fen* 'pink', *zi* 'purple', *hui* 'gray'). We also included Spanish *celeste* 'light blue' (Mandarin *qianlan*) and Spanish *lila* 'light

purple' (Mandarin *qianzi*), since in our previous research we found evidence that *celeste* could be a 12th basic color in Spanish, whereas *lila* is quite consistently used by Spanish speakers to refer to light purple (with *morado* being used for darker tones) (see Xu et al. 2023 for details). For Task 2, we presented participants with 13 color patches corresponding to the best examples of the color terms used in Task 1. These are the color patches that subjects use more consistently for referring to a specific color, as found in our previous research too (see Xu et al., 2022 for details). Color patches were retrieved from The World Color Survey (Kay et al, 2010; https://www1.icsi.berkeley.edu/wcs/data.html). The Munsell values for each of the color patches used in this task can be found in Supplemental table 1. With regards to the set of emotions considered in both tasks and their distinctive dimensions (i.e. valence: positive-negative, arousal: high-low, and power: strong-weak), we made use of the Geneva Emotion Wheel (GEW, version 3.0) (Scherer, 2005; Scherer et al., 2013) (see Supplemental table 2 for details), via the interface that is usually considered as the easiest to use and understand by participants (see Caicedo & Van Beuzekom, 2006; Warpechowski et al., 2019 for details).

Participants

The Spanish sample consisted of 50 monolingual speakers (22 males) with a mean age of 28.56 years (95% confidence interval [CI] = [26.04, 31.08]). 25 individuals (10 males) participated in Task 1 (M_{age} = 28.53, 95% CI_{age} = [24.36, 32.70], range: 18-58) and the remaining 25 individuals (12 males) participated in Task 2 (M_{age} = 28.6, 95% CI_{age} = [23.92, 33.28], range: 18-62). An independent samples *t* test showed that the age was comparable between both groups ($t(48) = 0.03$, $p = .98$, $d = .009$), as well as the gender ($\chi^2 (1) = .08$, $p = .78$, $V = .04$). The Mandarin sample consisted of 50 monolingual speakers (25 males) with a mean age of 29.34 years (95% confidence interval [CI] = [26.69, 31.99]). 25 subjects (10 males) took part in Task 1 (M_{age} = 29.04, 95% CI_{age} = [24.95, 33.13], range: 18-59), and the remaining 25 subjects (15 males) participated in Task 2 (M_{age} = 29.64, 95% CI_{age} = [25.96, 33.32], range: 20-55). An independent samples *t* test showed that the age was comparable between groups ($t(48) = .23$, $p = .82$,

d = .07), as also was the gender distribution (χ^2 *(1) = 1.28, p = .26, V = .16*). Additionally, an independent samples *t* test showed that the age of the participants was comparable between the two groups (Spanish vs. Mandarin) participating in Task 1 (*t*(48)=0.18, *p* = .85, *d* = .053) and Task 2 (*t*(48)=0.36, *p* = .72, *d* = .10). The same was true for gender distribution (Task1: (χ^2 *(1) = 0, p =1, V =0*); Task 2: (χ^2 *(1) = .32, p = .57, V = .08*)). Using different subsets of participants for these two tasks helps avoiding biases and confounding effects.

Procedure

In both tasks, the experimenter first introduced the procedure and participants then signed an informed consent document. Before starting with the tasks, participants provided the experimenter with some socio-demographic information of interest about themselves: age, gender, education level, the language(s) they spoke, and a confirmation that they did not suffer from color vision problems.

In Task 1, color terms were randomly presented to the participants in writing, using white pieces of sheet and black ink. In Task 2, color patches (15 x 15 cm) were also presented randomly in sufficient natural daylight (thus avoiding direct sunlight or deep shade) and using a grey base as the background (N5, Munsell color notation). During the tasks, Correlated Color Temperature (CCT) oscillated between 4000 and 4500 K and illimitation ranged from 1750 to 2000 luz. Participants observed color patches at a distance of around 60 cm with an average visual angle of 3.5 degrees. As noted, depending on the task, participants had to associate color terms or color patches to one (or more than one) of the 20 types of emotion included in the GEW (for details, see Figure 1 and Supplemental table 2). Participants were allowed to associate colors to emotions not included in the GEW. They could also refuse to associate colors to any emotion. Additionally, they were requested to rate the intensity of the emotion(s). For this, they had to choose one among the different circle sizes also included in the GEW, which range from the smallest one (for the weakest emotion, coded as 1) to the biggest (for the strongest emotion, coded as 5).

Figure 1. The GEW used for testing the association of color terms or patches to emotions by Spanish speakers. Emotions are displayed in the outer part of the wheel (in Spanish). The intensity of each emotion correlates with the size of the circles in the inner part of the wheel (reproduced from Jonauskaite, et al., 2020a).

Data analysis

For both tasks, we first determined the number of participants associating a specific color term (Task 1) or color patch (Task 2) to a specific emotion. We also calculated the number of participants associating a specific color to a specific emotion regardless of the mode of presentation. If a particular color term or color patch was not associated to any emotion, we coded this as 0. If a color was associated to an emotion not included in the GEW, we coded this as a missing value. We then used autocluster analyses for uncovering the most prominent color-emotion associations for each task and for each language. We employed Fisher's test to look for significant differences between conditions (i.e. between types of emotion, between languages, and between modes of presentation). We further used the Pearson Correlations Coefficient to determine the similarity in color-emotion associations between languages and between tasks. In this latter case, the higher the PCC value, the more similarity (for $p < 0.05$). Second, for each task, we calculated the average intensity assigned to each color-emotion association. If no emotion was associated to the color, or if the subject associated the color to an emotion not shown in the GEW, we coded this as a missing value, since

intensity ranges from 1 to 5. We then conducted a series of independent-samples t tests to find differences in color-emotion associations and intensity ratings between speakers of Spanish and Mandarin, and also between Task 1 and Task 2. Finally, we conducted a mixed-design multivariate analysis of variance (MANOVA) to identify the dimension(s) that impact(s) mostly on color-emotion association. Accordingly, we set the broadness of valence (i.e. the number of positive emotions and negative emotions), arousal (i.e. the number of high emotions and low emotions), and power (i.e. the number of strong emotions and weak emotions) as dependent variables, with color presentation mode, color type, and language as independent variables (see Supplemental table 2 for details). Additionally, we calculated the biases in valence, arousal, and power when it comes to rate emotions. Our aim was determining whether specific colors tend to significantly evoke specific emotional responses in any of these two languages. Valence bias is the difference between the positive mean and the negative mean for valence ratings by participants and was calculated as follows: Valence bias = (sum of the intensity of all negative emotions / number of negative emotions) – (sum of the intensity of all positive emotions / number of positive emotions). We calculated the arousal bias and the power bias similarly: Arousal bias = (sum of the intensity of all low arousal emotions / number of low emotions) - (sum of the intensity of all high arousal emotions / number of high emotions), and Power bias = (sum of the intensity of all weak power emotions / number of weak emotions) – (sum of the intensity of all strong power emotions / number of strong emotions). The intensity of negative emotions, low arousal, or weak power, all received a negative sign, whereas the intensity of positive emotions, high arousal, or strong power, all received a positive sign. Individual mixed-design ANOVAs were then conducted for each of these three dimensions of emotion to determine the effect of diverse factors (languages, color, and mode of presentation), with the aim of understanding how these factors impact, solely or coordinately, on each dimension of emotion.

Results

Type of emotion

Autocluster analyses revealed that Spanish speakers tend to agree more than Mandarin speakers when it comes to associate specific colors to specific emotions in general, with this difference being significant ((F=.43, 95% CI = [0.34, 0.56], $p < .001$). The strongest differences between languages were observed for white (F =.26, 95% CI = [0.10, 0.65], $p = .005$), red (F = .27, 95% CI = [0.11, 0.69], $p = .007$), yellow (F = .25, 95% CI =[0.10, 0.64], $p = .004$), blue (F= .29, 95% CI =[0.12, 0.73], $p = .009$) and light blue (F=.33, 95% CI =[0.13, 0.85], $p = .02$) (see Supplemental table 3 for details). At the same time, both Spanish speakers and Mandarin speakers converge more on color-emotion associations when colors are presented verbally instead of visually (F=.61, 95% CI = [0.48, 0.78], $p < .001$ for Spanish; F=.55, 95% CI = [0.43, 0.71], $p < .001$ for Mandarin). This difference is mostly attributable to the remarkable differences observed for some specific colors: red and light purple for Spanish speakers, and red, white, yellow, and orange for Mandarin speakers (see Supplemental table 3 for details).

Figure 2 shows the heatmaps for general color-emotion associations (above), color term-emotion associations (middle), and color patch-emotion associations (below) for both languages.

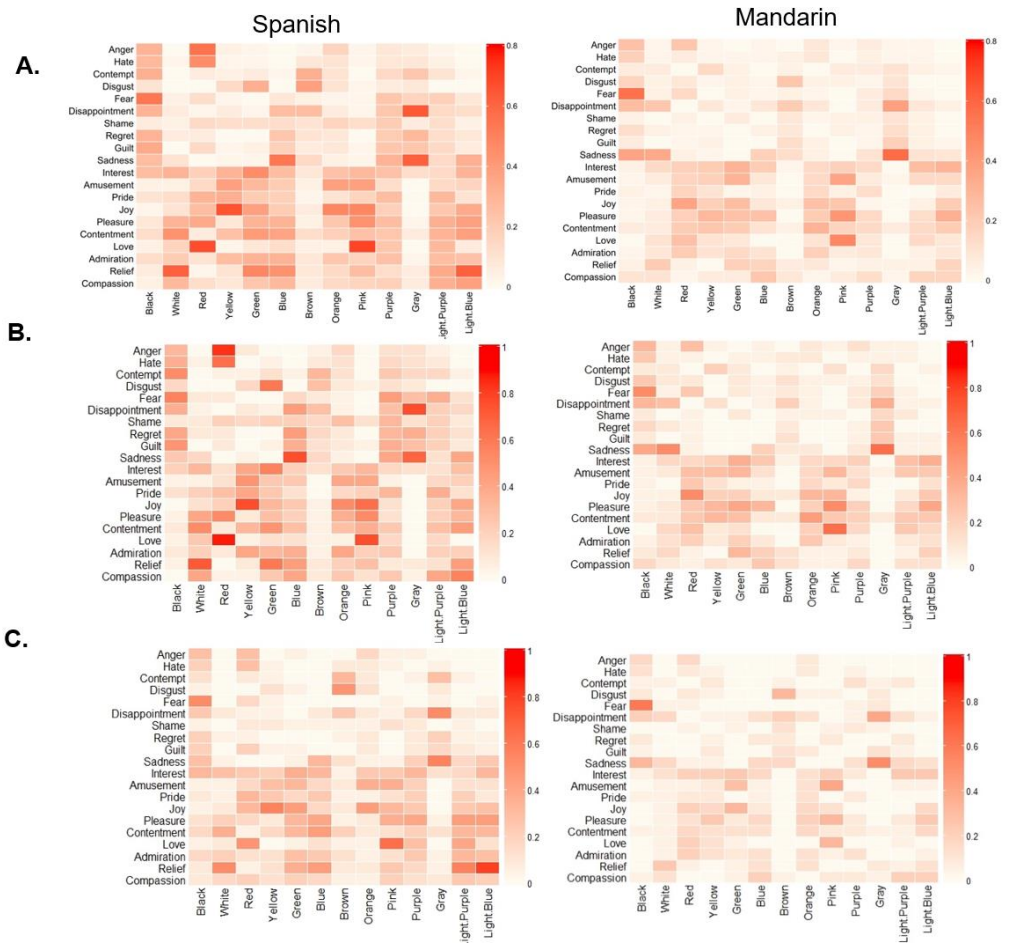

Figure 2. Heatmaps of color-emotion associations for Spanish and Mandarin. A. Color-emotion associations. B. Color term-emotion associations. C. Color patch-emotion associations.

We performed Pearson Correlations Analyses and found a similarity between both languages in overall color–emotion associations ($r(258) = .69$, $p < .001$), color term-emotion associations ($r(258) = .55$, $p < .001$) and color patch-emotion associations ($r(258) = .62$, $p < .001$). However, significant differences were observed for specific colors (see Table 1). Across these three conditions, differences were significant for light purple only.

Spanish vs Mandarin			
	PCC (overall)	PCC (Task 1)	PCC (Task 2)
Red	.52*	**.38**	.51*
Yellow	.53*	.51*	**.40**
Green	.81***	.70***	.78***
Blue	.74***	**.36**	.73***
Brown	.71***	.54*	.64**
Orange	.63**	.62**	**.45**
Pink	.90***	.91***	.82***
Purple	.55*	**-.24**	**.24**
Gray	.94***	.90***	.89***
Black	.74***	.58**	.62***
White	**.35**	**.14**	.83***
Light purple	**.32**	**.07**	**.10**
Light blue	.77***	.56*	.69***

Table 1. Pearson Correlation Coefficients (PCCs) for the similarity in color-emotion associations between speakers of Spanish vs Mandarin. Three conditions are compared: overall color-emotion associations, color term-emotion associations (Task 1) and color patch-emotion associations (Task 2). Significant differences are highlighted in bold.

With regards to the mode of presentation, Pearson Correlations Analyses indicate that both Spanish speakers ($r(258) = .66$, $p < .001$) and Mandarin speakers ($r(258) = .73$, $p < .001$) tend to associate the same emotions to the same colors, with the exception of purple and light purple, which are associated to different emotions in each language, either presented verbally or visually (see Supplemental Table 4 for details).

Intensity of emotion

Concerning the intensity of emotion, an independent samples *t* test showed that Spanish speakers attribute a higher mean intensity to colors than Chinese speakers do (M=3.72,

SD=.86 for Spanish; M=3.27, *SD*=1.0 for Mandarin), with this difference being statistically significant between groups (t (1164) = -8.17, $p < .001$, $d = -.48$). At the same time, both groups tend to attribute a higher mean intensity to color terms than to color patches (M=3.82, *SD*=.85 vs M=3.62, *SD*=.87 for Spanish; M=3.43, *SD*=.94 vs. M=3.12, *SD*=1.04 for Mandarin), with this difference being statistically significant between groups too (t (615) = -2.78, $p = .006$, $d = -.22$ for Spanish; t (547) = -3.78, $p = .0001$, $d = -.32$ for Mandarin). Still, this disparity is mostly driven by differences in selected colors, that differ between the two languages: black, gray, and yellow for Spanish; green, orange, and purple for Mandarin (see Supplemental table 5 for details).

Dimensions of emotion

Finally, a mixed-design MANOVA analysis of our data indicated that Spanish speakers tend to associate a higher number of emotion values (broadness of emotion) to colors (M= 3.46, *SD* = 2.24 for Spanish; M = 1.84, *SD* = 1.93 for Mandarin), $F(1, 1229) = 36.41$, p<.001 (see Supplemental table 6 for details). The MANOVA analysis further suggested that this difference is significant for the three basic dimensions considered in our study: valence, arousal, and power (Pillai's trace value =.15, $F(6, 1224) = 34.61$, $p < .001$, $\eta_p^2 = .15$). Likewise, our analysis suggested that for both languages, there is a significant effect of the mode of presentation (Pillai's trace value =.21, $F(18, 3672) = 15.54$, $p < .001$, $\eta_p^2 = .07$), so that participants tend to give higher numbers to color terms than to color patches. Also, for both languages, the interaction between color and mode of presentation was significant too (Pillai's trace value =.11, $F(72, 7086) = 1.8$, $p < .001$, $\eta_p^2 = .02$). This means that the effect of the mode of presentation depends on the color. Lastly, for both languages, the tree-way interaction between language, mode of presentation and color was also significant (Pillai's trace value =.09, $F(66, 7086) = 1.66$, $p = .001$, $\eta_p^2 = .02$). This means that the number of emotion types depends on the combined effect of language, mode of presentation, and color.

At the same time, an individual mixed-design ANOVA on valence bias revealed no significant difference between groups ($F (1, 1138) = .49$, $p = .48$). This means that colors

evoke, on average, the same positive or negative emotions in both languages. Still, we found a significant interaction between language and color (F (12, 1138) = 3.68, p <.001). This suggests that some specific colors impact on valence bias differently depending on the language. To identify the most impacting colors in each language, we carried out post hoc comparisons. We found that red evokes more negative emotions in the Spanish speakers compared to Mandarin speakers (β = -1.76, SE = .71, p =.01), whereas white evokes more positive emotions (β = 2.12, SE = .75, p =.004) (see Figure 3A and Supplemental table 7). We also found a significant interaction between color and mode of presentation, but only for the Spanish group (F (12, 591) = 2.48, p =.004), and not for the Mandarin group (F (12, 523) = 1.13, p =.34) (see Figure 3B and Supplemental table 7)

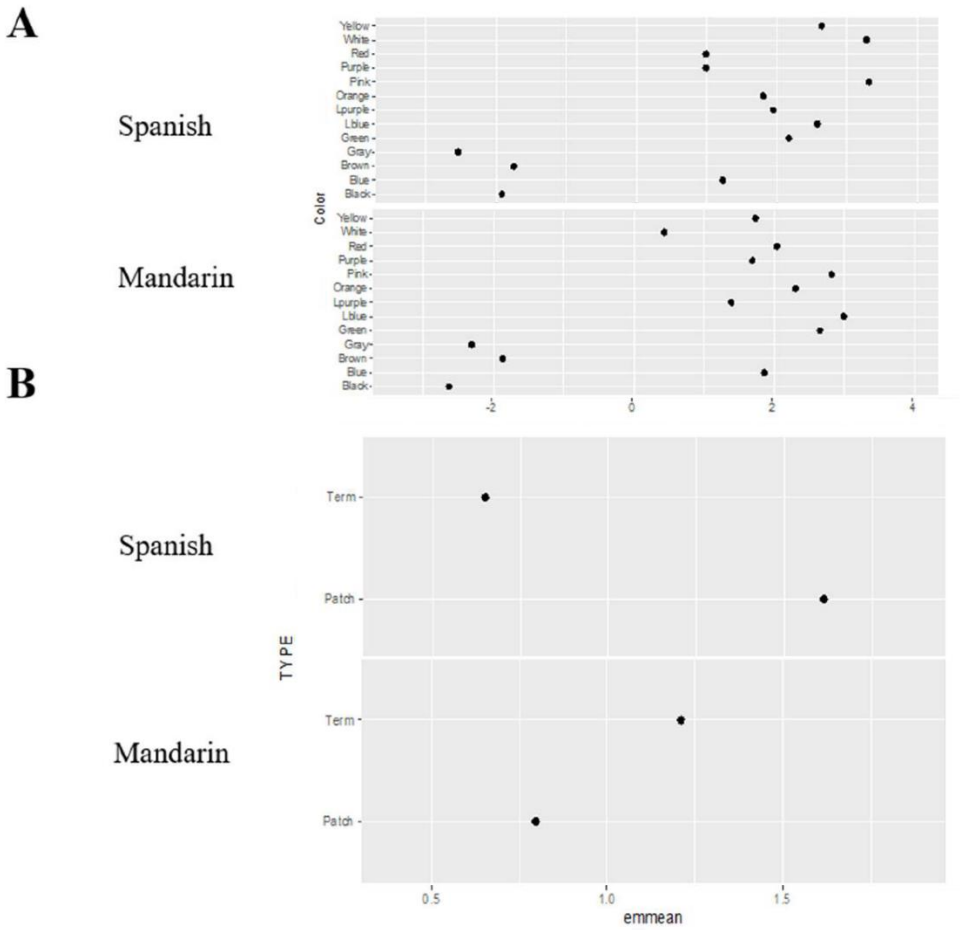

Figure 3. A. Valence of the emotions associated to different colors in Spanish (above) and Mandarin (below). B. Comparison of valence according to the two modes of presentation (color terms vs. color patches) in Spanish (above) and Mandarin (below).

Likewise, the difference was not significant for arousal bias (F (1, 1138) = 8.48, p =.52), which means that colors evoke, on average, the same arousal (either high or low) in both languages. However, as with valence, we also observed a significant interaction between language and color (F (12, 1138) = 2.12, p <.001). Post hoc comparisons revealed that several colors evoke a lower arousal in the Mandarin groups compared to Spanish speakers: red (β = -1.49, SE = .7, p =.03), yellow (β = -1.69, SE = .72, p =.02) and purple (β = -1.47, SE = .73, p =.04) (see Figure 4 and Supplemental table 8). However, contrary to valence, we found no significant interaction between color and mode of presentation (F (12, 523) = 1.13, p =.34 for Spanish; F (12, 523) = 1.13, p =.34) for Mandarin).

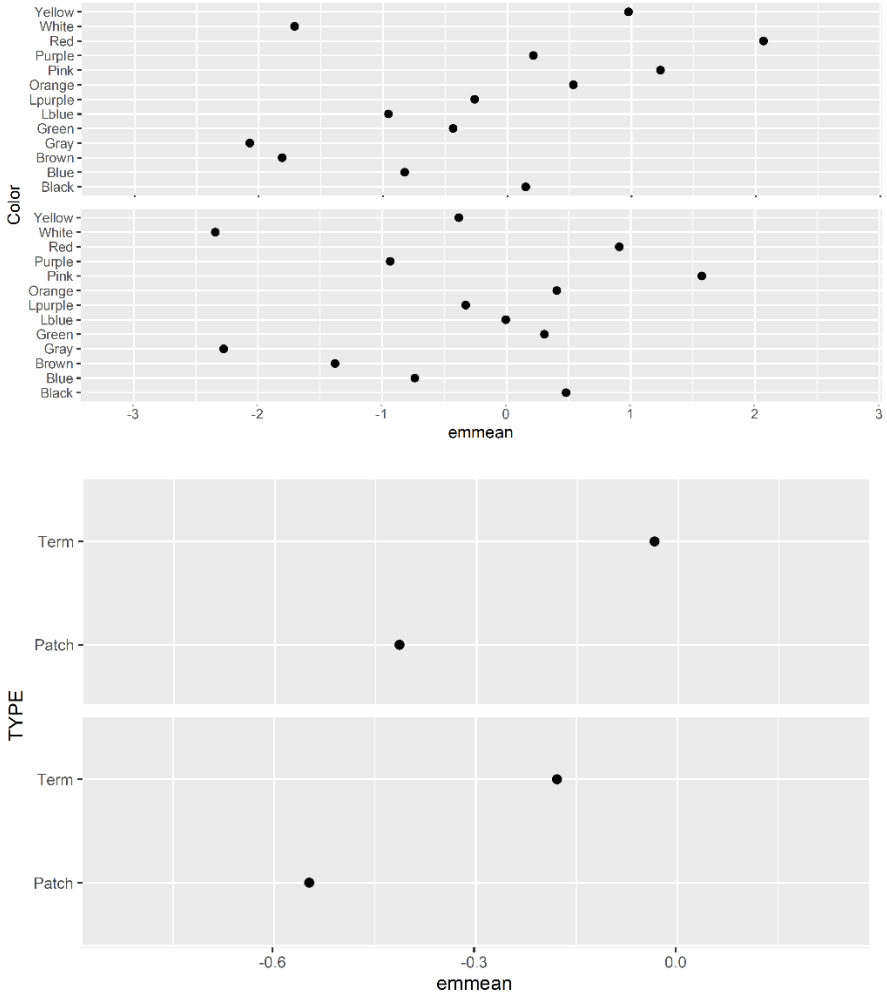

Figure 4. A. Arousal of the emotions associated to different colors in Spanish (above) and Mandarin (below). B. Comparison of arousal according to the two modes of presentation (color terms vs. color patches) in Spanish (above) and Mandarin (below).

Finally, the difference was not significant either for power (F (1, 1138) = 1.71, p =.19). This entails that for both languages, color evoke, on average, the same emotional strength. Nonetheless, we found a significant interaction between language and color (F (12, 1138) = 2.35, p =.006). Post hoc comparisons revealed that light blue evokes weaker emotions in Spanish speakers compared to Mandarin speakers (β = -1.75, *SE* = .72, p =.02) (see Figure 5 and Supplemental table 9). Similarly to arousal (but not to valence), we found no significant interaction between color and mode of presentation (F (12, 591) = 1.21, p =.27 for Spanish; F (12, 523) = 1.69, p =.06), for Mandarin).

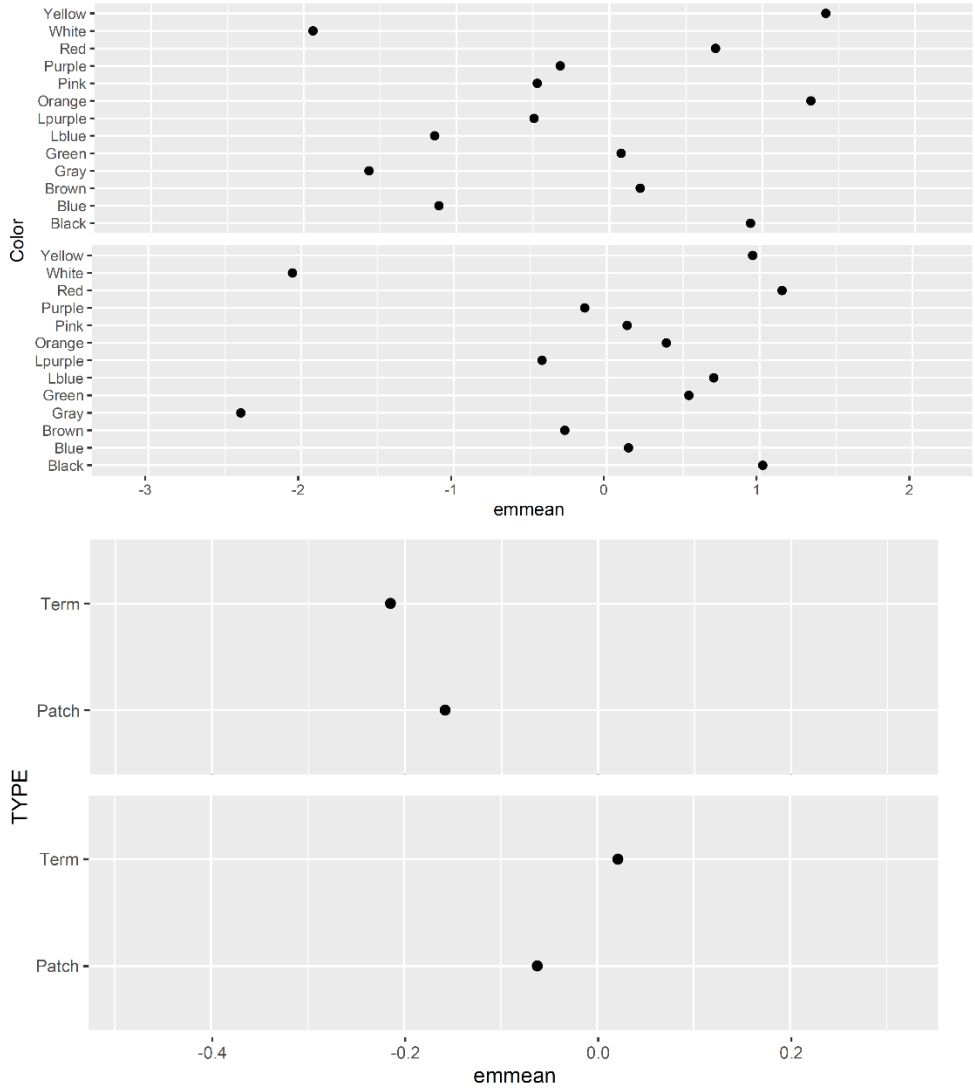

Figure 5. A. Power of the emotions associated to different colors in Spanish (above) and Mandarin (below). B. Comparison of power according to the two modes of presentation (color terms vs. color patches) in Spanish (above) and Mandarin (below).

Discussion

Overall, our findings point to some commonalities and some differences in how colors are used to convey emotions by speakers of Spanish and Mandarin.

To begin with, Mandarin speakers tend to be more variable than Spanish speakers when it comes to associate specific colors to specific emotions, to the extent that only two color-emotion pairs (grey-sadness and black-fear) are used by more than 50% of our participants. One reason for this could be that basic color terms are also employed less consistently by Mandarin speakers generally (Xu et al., 2023). Another reason could be that because of their Confucian cultural background, Chinese people are less used to share their thoughts or feelings to others (Fu, 2012).

We further found that overall color-emotion associations are similar in both groups, although significant differences can be observed for specific colors. This finding is in line with previous findings by Adams and Osgood (1973), who identified similar patterns of color-emotion associations across 23 different cultures. In our study, significant differences concern to white and blue. White was overwhelmingly associated to positive emotions by Spanish-speakers, including relief, contentment, pleasure, interest, or compassion, as previously observed by Soriano (2005), and similarly to English (Kaya & Epps, 2004), or Turkish (Demir, 2020). By contrast, Mandarin speakers tend to associate white to negative emotions, including sadness or disappointment, as also observed by Jonauskaite et al. (2019, 2020a), or Wang (2013). In Chinese culture white is also linked to death or despise (Xing, 2009; Zhou, 2010; He, 2011; Wang 2013). For blue, the trend was the opposite. It was associated to positive feelings by Mandarin speakers, including pleasure or compassion, while it was associated to negative emotions by Spanish speakers, including sadness and disappointment. This finding is also in line with previous research by Soriano and Valenzuela (2009), but contrasts with findings by Bazán (2018), who attested the association of blue to concepts like calm, peace, or relax. Interestingly, red evoked potentially contradictory emotions in our Spanish speakers, including love, anger, and

hate, this also in line with previous studies (e.g. Soriano, 2005). By contrast, it evoked more similar (and positive) emotions in the Mandarin group, like joy, love, contentment, or admiration, in line with previous findings too (Jiang et al., 2013). In Chinese culture, red is often used metaphorically to represent positive things, as in *hongxishi* 'red affair' (related to wedding), or *hongren* 'red man' (to refer to a popular man) (Lee, 2017), whereas in Spanish, as in other many languages, it is frequently used to refer metonymically to anger, as in *verlo todo rojo* 'to see in anger' or *estar rojo de ira* ('to be in anger') (see Soriano, 2005 for discussion). Interestingly too, in our sample, colors like purple, light purple, and brown did not get the negative connotations found by previous research, like purple related with rage in English (see Steinvall, 2007). Actually, 32% of our Mandarin speakers did not associated brown to any emotion.

Regarding to the different dimensions of emotions considered in our study, our results are in line with the study by Soriano and Valenzuela (2009), who also found that valence is more variable than arousal and power. These authors explained this variability by the greater sensitivity of valence to cultural differences. Overall, we found in both groups of speakers a negative bias towards black, gray and brown, but a positive bias towards chromatic colors. This is also in line with previous findings by Jonauskaite et al. (2020a; 2020b; 2021), and Wilms et.al. (2018). These latter authors argue that valence depends on a combination of hue, saturation, and brightness, with increased lightness resulting in higher positive ratings. We have found evidence of this effect, since in our sample e.g. pink is associated to more positive emotions than red, pretty much as light blue is associated to more positive emotions than blue. Still, we detect some potential effect of cultural factors on valence, since e.g. red gets quite positive appreciations by both groups, particularly by the Mandarin group. If the valence of a color depended on environmental factors only, we would expect that red receives more negative values (and more similarity between samples), since red is universally related to danger (Elliot et al., 2007; Elliot & Maier, 2014; Pravossoudovitch et al., 2014), and particularly, make animals and humans alert, nervous and anxious (Wells, et al., 2008). This potential effect of culture on color

valence is particularly notable in (and expected for) the Mandarin sample, since in Chinese culture red is highly appreciated (see Chung, 2011; Lee, 2017 for discussion and examples). Regarding arousal and power, we also found a mixture of universality and cultural dependency. Accordingly, on average, colors evoke the same emotional arousal and power in both groups of speakers, but at the same time, there are significant differences for some specific colors, which seemingly have a cultural origins. For instance, both groups give high arousal values to red, as observed in many other languages and cultures (Soriano & Valenzuela, 2009; Zielinski, 2016; Wilms et al. 2018). However, Mandarin speakers tend to give lower arousal values to yellow and purple compared to the Spanish-speaking group. In Chinese culture, yellow and purple are the colors related to the Imperial power (e.g. the emperor's clothes were called *huangpao* 'yellow robes') (Xing, 2009). Yellow is also a symbol for harvest. These circumstances might contribute to explain why speakers tend to associate yellow to contentment. By contrast, Spanish speakers tend to associate this color to joy, hence probably the higher arousal values it gets by this group.

Finally, we found no significant impact of how colors are presented (verbally vs. visually) on the type of emotion they are associated to. Certainly, language plays an important role in how emotions are construed, and ultimately, in how we interpret and understand sensations of the body (Lindquist et al., 2015, Jonauskaite et al, 2019; Jonauskaite et al, 2020a; Giraud & Nava, 2023). However, this effect seems to be subtle, and it is more noticeable with regards to the intensity of emotion than to the type of emotion. Accordingly, we found that both Spanish speakers and Mandarin speakers tend to associate more intense emotions to color terms than to color patches, although this difference depends on the effect of different colors for each group. This somehow contrasts with previous results by Jonauskaite et al. (2020b), who found that for their French speakers, a difference between terms and patches is only observed with black. Uusküla and Eessalu (2018) have suggested that this difference might result from some methodological caveat, particularly, if the color patch used in the experiment is not representative of the color. We do not think this is the case with our samples, since in

our previous research we found that both Spanish and Mandarin speakers are able to name color patches consistently (see Xu et al., 2023 for details). In our opinion, this differential effect of color terms vs color patches might derive from the richer connotative meanings associated to the former, since there are usually dozens of linguistic expressions in which color terms appear, each with a different meaning. Also, color terms normally refer to a whole portion of the chromatic space, so that different shades can be associated to different types of emotions while still being referred to with the same color term. By contrast, when confronted to a color patch, subjects see one specific shade only (see Jonauskaite et al., 2020a for discussion). Finally, and related to this last concern, our finding that both groups tend to attribute higher mean intensity values to color terms than to color patches might be also due to the more abstractness of the former. Previous research suggests that the more abstractness the more intensity of self-conscious emotions (like guilt and shame) and the less intensity of basic emotions (like anger and fear), and vice versa (see Bornstein et al., 2020 for discussion). Still, in our research we found no evidence of a significant interaction between the mode of presentation and the type of emotion as far as intensity is concerned. Lastly, and regarding the potential effect of the mode of presentation on valence bias, our study is in line with Wang et al.'s (2014), who found that red is rated equally (positive) under both modes of presentation.

Conclusion

Summarizing our results and our discussion above, the main findings of our research about color-emotion association in Spanish vs Mandarin can be summarized as follows:

- Spanish speakers tend to agree more than Mandarin speakers when it comes to associate specific colors to specific emotions;
- there are no overall significant differences between both groups with regards to the type of emotion associated to colors (when presented either verbally or visually); at the same time, significant differences exist for specific colors;
- as a general rule, Spanish speakers attribute higher intensity values to colors; at the same time, both groups attribute higher intensity values to color terms

compared to color patches, although this difference is driven by different colors in each group;

- as a general rule, Spanish speakers tend to associate a higher number of emotion values (valence, arousal and power) to colors; at the same time, both groups attribute higher numbers to color terms than to color patches;
- on average, colors evoke the same emotional polarity in both languages, although significant differences exist for specific colors;
- on average, colors evoke the same emotional arousal in both languages, although significant differences exist for specific colors;
- on average, colors evoke the same emotional strength in both languages, although significant differences exist for specific colors.

Overall, our study points to a mixed pattern of universality and culture-specificity regarding how colors are used for conveying emotions.

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