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Gender difference in color preference across cultures: An archetypal pattern modulated by a female cultural stereotype

Valérie Bonnardel[1,2] | **Sucharita Beniwal[1]** | **Nijoo Dubey[1]** | **Mayukhini Pande[1]** | **David Bimler[3]**

[1] AP-NID Color Research Lab, National Institute of Design, Ahmedabad, India
[2] University of Winchester, Winchester, United Kingdom
[3] Massey University, New Zealand

Correspondence
Valérie Bonnardel, University of Winchester, Winchester SO22 4NR, United Kingdom.
E-mail: Valerie.bonnardel@winchester.ac.uk

Abstract

A gender difference in color preference among British participants has been repeatedly reported, in which both males and females show a preference for blue-green colors, while females express an additional preference for pink-purple colors. To investigate the robustness of gender difference in color preference in a different culture, we tested 81 young adult Indians from a school of design and compared them to 80 young British students in Psychology. The 35-item International Personality Item Pool (IPIP) and Bem Sex Role Inventory (BSRI) questionnaires were also administered to explore possible links between personality traits, gender schemata, and color preferences. Results confirmed a gender difference in both cultures; participants collectively expressed a preference for cool over warm colors, while in addition females showed a preference for pink colors, with a warm bias for Indian females and a cool bias for British females. While these results extend gender difference to Indian culture and support the universality of an underlying pattern they also reveal a culture-specific contribution essentially observed in females. In British participants, color preference was correlated exclusively with BSRI scores in females and overwhelmingly with IPIP scores in males; this gender-specific pattern of correlation was not replicated in the Indian sample. Results point to an archetypal pattern of gender difference in color preference with a remarkable cross-cultural similarity in men and a subtle but significant cultural difference in women whose origin is yet to be explained.

KEYWORDS
color preference, cultural difference, gender difference, principal component analysis

1 | INTRODUCTION

In context-free situations, people are willing to rank colors in order of preference or to indicate a preferred color out of several different options. However, studies are not unanimous as whether or not robust gender differences on color preference exist nor, if they do, the extent to which they are pan-cultural. Eysenck[1] emphasized the strong agreement between males and females in color choice and Granger[2] remarked on the lack of obvious difference between genders. Likewise, Camgöz et al.[3] found no significant gender difference among Turkish subjects. In contrast, Child et al.[4] indicated that hue preferences differed between boys and girls, though the way that their data were aggregated does not allow any detailed scrutiny on the nature of the difference, and McManus et al.[5] reported a greater preference for red among females.

Hurlbert and Ling[6] tested 171 British participants (92 females) and 37 Chinese participants (18 females) using eight different hues spaced around the hue circle, displayed on a color monitor. Subjects indicated their preferred color in a speed two-alternative forced choice task, with the proportion of trials in which a given sample was chosen providing each subject's color preference curve. Data were subjected to principal component analysis (PCA) to reduce the eight variables into three principal components (PCs) accounting for 79% of total variance. Noting the high resemblance of the two first PCs to theoretical color-opponent mechanisms used in psychophysical models of color discrimination (blue vs. yellow and red vs. green), the authors showed that preference predictions based on blue-yellow (b-y) and red-green (r-g) components could still account for 70% of the variance. An overall increase of preference of reddish colors was observed in Chinese participants indicating a cultural specificity, but on average, British and Chinese females had positive weights on the r-g component, accounting for their shifts in peak preference. These results were interpreted in favor of a universal origin of gender difference in color preference, rooted in biological color-opponent mechanisms shaped by the evolution of gender-specific uses of color vision.

Recently, Al-Rasheed[7] replicated Hurlbert and Ling's study with 38 British and 71 Arabic participants. Across gender, Arabic rated reddish color higher while British showed a preference for bluish-green colors. Culture difference was mostly observed in females, with a greater preference for reddish colors in Arabic women compared to greater preference for purple to bluish-green colors in British women. Based on color preference curve profiles, the author concluded that color preference varies with gender, in a way that depends on culture, however, these differences were not tested for statistical significance. Witzel[8] reanalyzed data from Refs. 6 and 7 using sexual contrast (preference of women—preference of men) as a measure. Correlations between Arabic and British sexual contrasts from Ref. 7, and between British and Chinese sexual contrasts from Ref. 6 reached significance. A significant correlation was also obtained between British observers from the two studies, but correlations were not significant between Chinese and the two British samples. Excepting the absence of significant Chinese/British correlations, taken together these results—in agreement with a comparison of sexual contrasts for Polish and Yali (a nonindustrialized Indonesian tribal community)[9]—point to the existence of a regular trans-cultural pattern of sexual dimorphism in color preference.

Bonnardel et al.[10] tested 103 British observers (50 young and 53 older adults) with a larger set of stimuli comprising 21 Munsell samples (equally spaced around the hue circle in Munsell hue units) presented in triads. Color preference curves revealed a gender difference confirming females' secondary, superimposed preference for pink-purple colors, although male–female difference tended to tone down in elderly people. Using the same triadic task, composed this time of 16 printed Munsell samples,[11] a similar gender difference in color preference was replicated with 80 young British adults.[12] This latter study included International Personality Item Pool[13] and Bem Sex Role Inventory[14] to explore possible correlations between personality traits, gender schemata and color preference. Relationships between color preference and personality have long been suggested, albeit controversial, with the Lüscher test of personality based on color preferences as a good example.[15] Likewise, a female preference for pink and purple is suggestive of the use of pink in British society as a gender and sexuality marker in visual communication,[16,17] and preference for this color could partly be associated with BSRI measures of femininity and masculinity. In Ref. 12, color rankings were exclusively correlated with masculinity and femininity BSRI scores in females and mostly correlated with IPIP scores in males, although no clear pattern in these correlations could be directly related to the gender difference in color preference *per se*.

The present study seeks to extend the color preferences pattern observed in British participants[12] to young adults from India to examine the cross-cultural expression of gender differences, and to investigate further possible links with personality traits and gender schemata in different cultures.

2 | METHOD

2.1 | Subjects

Participants in the experiment were 80 (43 females) first year Psychology students at the University of Winchester (UK) (x^{-} = 23.8 years, σ = 4.9) and 81 (42 females) students from the National Institute of Design (NID) Ahmedabad (Gujarat India) ($\bar{x}$ = 25.8 years, σ = 4.8). All participants had normal color vision as assessed by the Ishihara Pseudo-isochromatic Plates, 24-plate edition for British (BR) and 38-plate edition for Indians (IND) participants.

Considering the diversity of Indian culture and the nature of the training of our Indian participant sample, supplementary demographic information regarding geographical location, level of color education, and interest and hobbies were collected in the attempt to identify potential confounding variables. The geographical location of formative influence was recorded, dividing India into five regions: North (number of participants, N = 26), West (N = 24), East (N = 11), South (N = 16) and Central India (N = 4). Their level of color education was reduced to a binary scale. Participants were identified as 'color-educated' (Color-Ed) if engaged in disciplines with significant formal color education such as Fine Art or Fashion Design, or any course in which theoretical or practical classes on color were taught (N = 69); the remainder, whose curricula did not include color courses (i.e., Design Management), were classified as 'noncolor educated' (N = 12). Finally, participants were asked to indicate their interests and hobbies. These had to be selected from a checklist of 24 activities classified as 'color interest' (Col-Int) where engagement with color is central (e.g., painting),

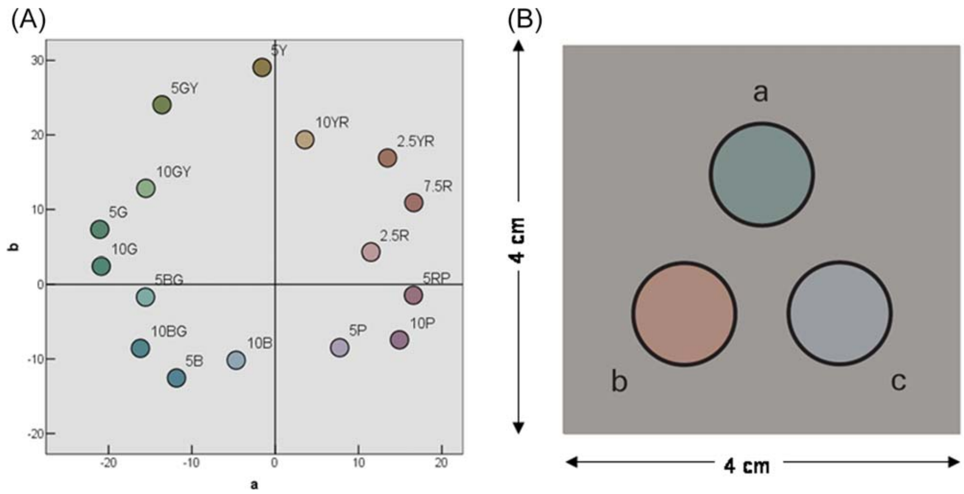

FIGURE 1 (a) Chromaticities of the 16 stimuli plotted in the CIE-Lab diagram ($L^*a^*b^*$ chromaticity, with D65 illuminant). Axes a and b are red/green and blue/yellow color dimensions. (b) Example of a triadic arrangement of 3 of the 16 color stimuli. Participants indicate their preferred color in each triad as '*a*', '*b*', or '*c*'

'color neutral' (Col-Neut) where color may not be central to the activity (e.g., movies) or 'not color oriented' (Non-Col) where color is not concerned (e.g., current affairs). For each participant the proportion of checked activities was computed per category.

2.2 | Stimuli

Sixteen stimuli based on the Farnsworth D15 color vision panel test were used, taken from Bimler and Kirkland.[11] Ten stimuli (5B: 'blue', 10BG: 'turquoise', 10G: 'green', 5G: 'dull green', 5GY: 'olive green', 5Y: 'brown', 2.5YR: 'tan', 7.5R: 'coral', 5RP: 'pink', and 10P: 'purple')* had Munsell Value of 5 and Chroma of 4. The other six stimuli, or "pastel" samples, noted with an asterisk (10B*: 'light blue', 5BG*: 'light turquoise', 10GY*: 'light green', 10YR*: 'beige', 2.5R*: 'light pink' and 5P*: 'lavender'), were lighter and less saturated with value = 6.5 and Chroma = 3 (Figure 1a). The stimuli were printed in triads on 4 × 4 cm neutral grey background cards (Figure 1b). Seventy-five triadic combinations (out of 560) were selected to approximate a balanced design,[†] with the criterion that each stimulus appeared in a similar range of contexts (i.e., sometimes with close neighbors around the color circle, sometimes with diametrical opposites).

2.3 | Questionnaires

The Bem Sex Role Inventory (BSRI) consists of 60 adjectives, 20 for each subscale (femininity, masculinity, and neuter) with a Likert-type seven-point scale. Thirty-five items were drawn from the International Personality Item Pool (IPIP)[‡] to cover the Big-Five factors of Openness to Experience (**O**), Neuroticism (**N**), Extraversion (**E**), Conscientiousness (**C**), and Agreeableness (**A**). Each item was presented as a Likert-type 5-point response scale. In both instruments, respondents indicated how well the adjective or the statement applied to themselves.

A Supporting Information questionnaire was given to Indian participants asking them to rate the importance of color in choice within nine classes of artifacts: clothing, interior painting, exterior painting, automobiles, furniture, furnishing, accessories, gadgets, and households (along a 5-point scale from 'not-at-all' to 'very-much').

2.4 | Procedure

Instructions were presented in English to all participants. They were first provided with BSRI and IPIP questionnaires, followed by Supporting Information questionnaires for the Indian sample, which they filled in at their own pace. Color vision was assessed with the Ishihara test. Finally, in the color preference task, subjects indicated their preferred color out of the three samples comprising each card, with the experimenter recording their choice. In Winchester, cards were presented on a large table of uniform grey (Munsell Neutral Value *N*/5), illuminated by a D65 ceiling lighting panel providing a reflected luminance of 150 cd/m^2. In Ahmedabad, the same set of cards was used but participants were tested in a light booth (Macbeth Judge II) with a uniform grey surround (Munsell Neutral Value *N*/6.75) under the D65 fluorescent illuminant. The experiment was approved by the appropriate Ethics Committee boards.

*Color names were assigned by the authors as loose, illustrative descriptions of the stimuli.

[†]Listed in Table S1 (Supporting Information Material)

[‡]The 35-items are listed in Table S2 (Supporting Information Material)

3 | RESULTS

3.1 | Color preference profiles

Each subject's triad responses were translated into a preference rating by assigning each sample +2 when preferred and −1 otherwise, and averaging scores over the number of triads (between 13 and 15) in which it appears. For each sample, the resulting values were a good approximation to a normal distribution, allowing the use of parametric statistics in the following analyses.

Inspection of the 161 individual color preference curves revealed that some of the Indian participants systematically assigned the highest or the lowest ranks to the 6 "pastel" samples irrespective of their hue. This preference pattern was observed for 24 participants (13 females); 8 of them selected the "pastel" samples as most preferred (3 females), and 16 as the least preferred colors. The remaining 57 Indian participants exhibited a color preference pattern consistent with hue as the criterion for choice, as did all 80 British participants. Since the objective of the study was comparison of color preference between two culturally different samples with all else being equal, including the choice attributes, data from the 24 participants were processed separately and subjected to independent analysis. By analogy with the mechanisms underlying color discrimination or color appearance, color preference profiles based on hue criteria will be referred to as "color-opponent", whereas preference profiles based on saturation and lightness will be referred to as "pastel" profiles.

We applied three-way mixed-factorial ANOVA to these 137 profiles, with gender and culture as between-subject factors. As expected, the main effect of color was significant ($F_{(6.4,\ 851)} = 27.95$, $P < 0.001$) with a medium effect size ($\eta_p^2 = 0.174$). The three interactions were significant, albeit with small effect size: Color × Gender ($F_{(6.4,\ 851)} = 5.98$, $P < 0.001$, $\eta_p^2 = 0.043$); Color × Culture ($F_{(6.4,\ 851)} = 2.64$, $P = 0.013$, $\eta_p^2 = 0.019$) and Color × Gender × Culture ($F_{(6.4,851)} = 2.46$, $P = 0.02$, $\eta_p^2 = 0.018$). That is, there were group differences between males and females, and between Indian and British in color preferences.

To characterize these differences, mean preference profiles were calculated for Indian females ($N = 29$), Indian males ($N = 28$), British females ($N = 43$), and British males ($N = 37$), and plotted in Figure 2 in pair comparisons. Mean ranking scores and the standard error of the mean are plotted as a function of the color samples' sequence from light blue (10B*) to lavender (5P*). Corresponding polar graphs are presented to emphasize the hue-circle nature of the preference patterns.

These color preference curves show that in both the Indian and the British samples, males' preferences are limited to blues and greens, whereas females show an additional liking for pinks and purples. Compared to males, females' average preferences exhibit more prominent maxima and minima (Figures 2a and 2b). The Indian and British females shared the brown color (5Y) as their least preferred color (Figure 2c). In males, Indians differ from British in respect to their greater liking for the olive green color (5GY) (Figure 2d).

To investigate statistically significant pairwise differences further, a multivariate analysis of variance (MANOVA) was conducted with colors as dependent variables and Gender and Culture as factors. There were large and significant effects of Gender ($F_{(16,118)} = 4.62$, $P < 0.001$, $\eta_p^2 = 0.35$) and Culture ($F_{(16,\ 118)} = 4.91$, $P < 0.001$, $\eta_p^2 = 0.4$), and their interaction ($F_{(16,\ 118)} = 2.39$, $P = 0.004$, $\eta_p^2 = 0.245$).

Across the two cultures, males display a significantly higher preference for light blue (10B*: difference $\delta = 0.28$, $P = 0.013$), brown (5Y: $\delta = 0.44$, $P < 0.001$), beige (10YR*: $\delta = 0.37$, $P < 0.001$), and olive green (5GY: $\delta = 0.34$, $P = 0.002$), while females show a significantly higher preference for turquoise (10BG: $\delta = 0.43$, $P = 0.002$) and pink (5RP: $\delta = 0.49$, $P < 0.001$)[§]. Checking for gender differences within each culture's sample, the higher male preference for brown and beige remains significant for Indian and British in isolation (5Y: IND: $\delta = 0.41$, $P = 0.009$ and BR: $\delta = 0.42$, $P = 0.009$; 10YR*: IND: $\delta = 0.44$, $P = 0.002$ and BR: $\delta = 0.32$, $P = 0.024$). In addition, a higher male ranking appears in the Indian sample for light blue (10B*: $\delta = 0.52$, $P = 0.001$) and lavender (5P*: $\delta = 0.39$, $P = 0.02$), and in the British sample, for tan (2.5YR*: $\delta = 0.27$, $P = 0.031$) and coral (7.5R: $\delta = 0.34$, $P = 0.013$). Conversely, only the higher female preference for pink remains significant in both cultures separately (5RP: IND: $\delta = 0.67$, $P < 0.001$ and BR: $\delta = 0.30$, $P = 0.016$). In addition, Indian females rate turquoise more highly than males (10BG: $\delta = 0.53$, $P = 0.004$) and British females rate light turquoise (5BG*: $\delta = 0.45$, $P = 0.008$), purple (10P: $\delta = 0.32$, $P = 0.028$) and lavender (5P*: $\delta = 0.37$, $P = 0.013$) more highly than males.

To summarize: the two cultures converge on a gender difference in the form of a higher male preference ranking for brown and beige colors and a higher female preference ranking for pink color. Other differences are culture-specific (Indian males' higher ranking for light blue and lavender, Indian females' higher ranking for turquoise, British males' higher ranking for tan and coral and British females' higher ranking for light turquoise, purple and lavender).

For males, cross-cultural difference is limited to the Indian higher liking of olive green (5GY: $\delta = 0.43$, $P = 0.004$). In contrast, numerous cultural differences are observed in females. British females manifest higher preference rankings for four "pastel" colors: light blue (10B*: $\delta = 0.53$, $P < 0.001$), light turquoise (5BG*: $\delta = 0.42$,

[§]Bonferroni adjustment for multiple comparisons.

FIGURE 2 Color preference curves and color circles. In polar plots the inner circle divides disliked (within) and liked (outside) colors; polar angles were determined from the Munsell hue circle. In online edition, colors of profiles encode subgroups: orange = Indian females, pink = UK females; blue = UK males, green = Indian males. Symbols distinguish females (circles) from males (squares) and Indian (empty) from UK (solid). Comparison between females and males in India (a) and UK (b) and comparison between India and British females (c) and males (d). Error bars correspond to standard error of the mean

$P = 0.003$), light green (10GY*: $\delta = 0.34$, $P = 0.023$), and lavender (5P*: $\delta = 0.73$, $P < 0.001$). The Indian females' higher preference rankings involve olive green (5GY: $\delta = 0.53$, $P < 0.001$), coral (7.5R: $\delta = 0.35$, $P = 0.007$), tan (2.5YR: $\delta = 0.37$, $P = 0.003$), and pink (5RP: $\delta = 0.41$, $P = 0.001$). The cultural difference in respect to "pastel" is corroborated by the low number of Indian females ($N = 3$) using the "pastel" criterion, who choose the "pastel" samples as their most preferred colors (see section below).

The MANOVA was followed by a Discriminant Function Analysis, resulting in three functions that explained 52.2% ($R^2 = 0.44$), 31.8% ($R^2 = 0.32$), and 15.9% ($R^2 = 0.19$) of the variance. In combination, the three significantly differentiated the four groups ($\bigwedge = 0.31$, $\chi^2_{(45)} = 148.7$, $P < 0.001$), although the contribution of the third function in itself had a lower significance level ($\bigwedge = 0.81$, $\chi^2_{(13)} = 26.9$, $P = 0.013$). Overall, 73.7% of the original grouped cases were correctly classified, with more misclassifications happening within the same culture rather than within the same gender; British males were never misclassified with Indian females. The first discriminant function distinguished Indian females from the other three groups, with high positive loadings on pink 5RP and light pink 2.5R*, and high negative loadings on light blue 10B* and light green 10GY* (its correlations with those stimuli were $r = 0.54, 0.21, -0.33$, and -0.21, respectively). The second discriminant function separated Indian males from the two remaining groups, with high positive loadings on olive green 5GY, beige 10YR* and brown 5Y, and negative loadings on turquoise 10BG and light turquoise 5BG* (correlations were $r = 0.59, 0.49, 0.41, -0.28, -0.19$, respectively). The third discriminant function separated British males and females with high positive loadings on coral 7.5R and tan 2.5YR, and negative loadings on purple 10P and light turquoise 5BG* ($r = 0.55, 0.34, -0.37$ and -0.30, respectively).

Finally, it is worth noting that the total variance among Indians is more than twice as large as that in the British sample ($t_{(46.65)} = 8.3$, $P < 0.001$). This variance disparity reflects the lack of consensus observed among Indians. Indeed, subjecting the data to Cultural Consensus Analysis (CCA)[18] revealed a general consensus of 45.7% for the 137 "color-opponent" participants. Across cultures, the consensus

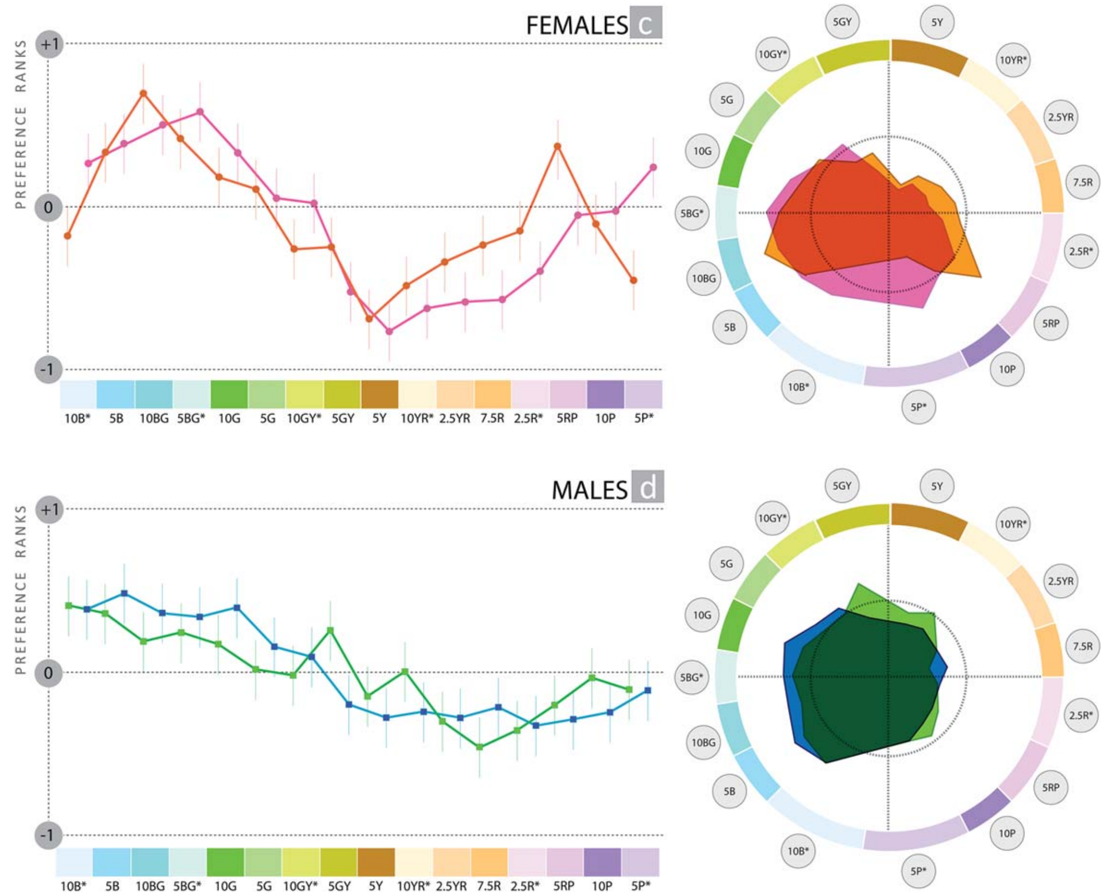

FIGURE 2 Continued

between females is 49.7%, hence the *specific to females'* consensus has a value of 4% (consensus between females – general consensus); the consensus between males is equal to 34% (no male-specific consensus). Across gender, Indian consensus was 26.9% and the British consensus was 52.2% indicating a British-specific consensus of 6.5%. In Indian females, consensus was 46.9% (consensus specific to Indian females of 1.2%); the British females' consensus was 66.4% (consensus specific to British females of 20.7%), and British males' consensus is equal to 45.9%. A consensus of 21% indicates an absence of consensus specific to Indian males. In summary, there is a strong consensus specific to British females (20.7%), indicating how much more accurately a random subject's preferences can be predicted if she is identified as female and British, there is a smaller consensus specific to British (6.5%), to females (4%), to Indian females (1.2%) and to British males (0.4%) but there is no specific consensus among males, among Indians or among Indian males.

Color preference curves based on "pastel" criterion show typical saw-tooth profiles where maxima or minima correspond to "pastel" colors (Figure 3). "Pastels" were most preferred by eight participants, and saturated hues most preferred by 16. Blue (5B), turquoise (10BG), olive green (5GY), and brown (5Y) elicit the highest preference ranking among the 10 more saturated colors, and except light turquoise (5BG*), the five other colors elicit high preference ranks among "pastel" colors. Between "pastel"-like and "pastel"-dislike preference patterns, significant statistical differences were obtained for all colors but coral (7.5R) and purple (10P). No gender difference was observed in this subsample.

As expected, the "pastel" sample ($N = 24$), subjected to CCA, showed an absence of general consensus between "pastel"-like and -dislike; all correlations are negative. Consensus specific to "pastel"-like is 80.7% and that specific to "pastel"-dislike is equal to 74.5%.

3.2 | Principal component analysis

It is useful to reduce the extensive catalog of specific differences to more molar, robust trends, by summarizing individual preference profiles in terms of fewer than 16 parameters. This also facilitates comparison with the other information collected about subjects (i.e., BSRI and IPIP scores). Principal component analysis (PCA) was used for both purposes, to explore the underlying data structure and to clarify the group differences.

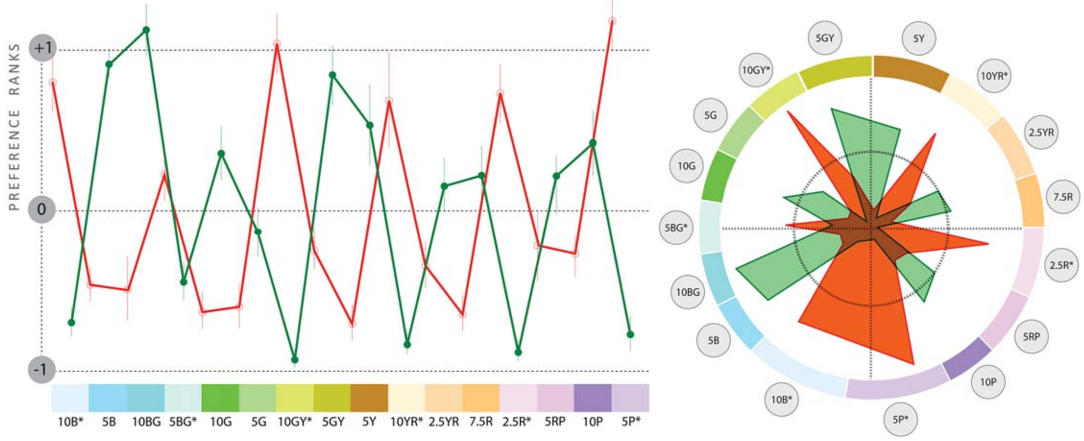

FIGURE 3 Color preference curves and color circles for two subgroups among Indian sample whose choice criteria was preference (empty symbol, red curves) or dislike (solid symbols, green curves) for pastel colors. Error bars correspond to standard error of the mean

Applying PCA to the 137 "color-opponent" subjects across the 16 color samples, four un-rotated principal components (PC) were retained, with eigenvalues λ ranging from 4.27 down to 2.08 (dropping abruptly to $\lambda < 1$ for further components). In essence, these are prototypal preference profiles, from which any given subject's preferences can be approximated by combining them with appropriate weights. A similar component structure emerged from earlier analyses of data from British young adults.[12] All four PCs, together accounting for 71.2% of the variance, were bipolar with negative and positive loadings. If the 24 "pastel" subjects are included in the analysis, a fifth PC becomes necessary to capture the lightness/saturation distinction and variations in its salience.

The first two PCs—accounting for 26.7 and 17.7% of variance—have a dipole nature, with their positively-loading samples forming a single peak on one side of the hue circle diametrically opposite a trough of negatively-loading samples (Figure 4). PC1 contrasts warm to cool colors, the warm peak running from beige 10YR* through red to lavender 5P*, the cool trough from 5B through turquoise to 5G. For PC2, positive loadings include olive green and brown (5GY, 5Y), in contrast to the negative trough, encompassing pink-purple-lavender (5RP, 10P, 5P*). These two prototypal preference profiles are about 90° out of phase, allowing them—combined with the right weights—to approximate any single-peak profile of preferences.

Conversely, PC3 and PC4—accounting for 13.8 and 13% of the variance—are quadrapole profiles, each containing two peaks of preferences and two troughs of dislike around the hue circle. For PC3, the two positive-loading peaks are tan-coral and blue-turquoise (2.5YR–7.5R, and 5B–10BG, respectively), while the troughs are light green-olive green (10GY*, 5GY) and lavender (5P*). For PC4, the complementary peaks are green and dull green (10G, 5G) and light

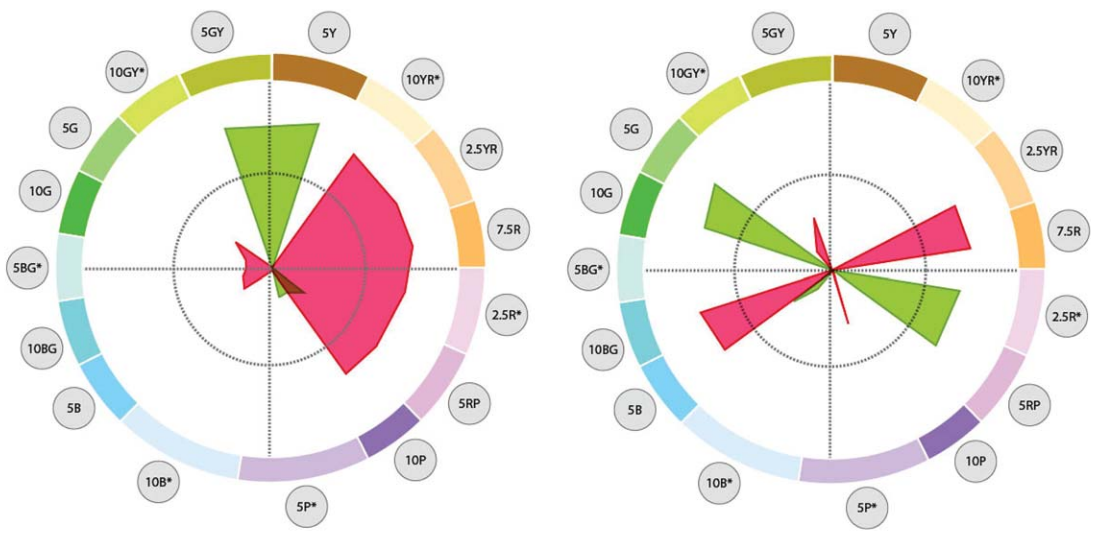

FIGURE 4 Polar representation of absolute values of factor loading on color samples. The inner dashed circle draws the zero line between positive and negative loading. Left: PC1 (red shade) opposes warm to cool colors and PC2 (green shade) oppose green-brown to pink-lavender. Right: PC3 (red shade) and PC4 (green shade). Non-significant loadings are not plotted, producing discontinuous profiles

pink and pink (2.5R*, 5RP) while the troughs consist of lavender-light blue and blue (5P*, 10B*, 5B) and olive green and brown (5GY, 5Y). These prototypes are 45° out of phase, enabling their combinations to approximate any double-peaked profile of preference for complementary hues and dislike for the intermediate hues.

Participant PC scores considered as dependent variables were subjected to MANOVA with Gender and Culture as factors. There was a significant effect of Gender ($F_{(4,130)} = 9.66$, $P < 0.001$, $\eta_p^2 = 0.23$) and Gender × Culture interaction ($F_{(4,\ 130)} = 3.78$, $P = 0.006$, $\eta_p^2 = 0.104$).

In pairwise comparisons across cultures, males' PC2 scores are significantly higher than those of females ($\delta = 0.62$, $P < 0.001$), reflecting male's liking for olive green and brown over pink-purple-lavender. Females' PC4 scores are significantly higher than those of males ($\delta = 0.65$, $P < 0.001$), reflecting their preference for greens and pinks over blues and olive green and brown. Considering gender difference within each culture, the trend towards higher PC2 scores among males was limited to the British sample ($\delta = 0.80$, $P < 0.001$). The higher PC4 scores from women are greater among Indians ($\delta = 1.03$, $P = 0.005$) than among British ($\delta = 0.26$, $P = 0.024$), while Indian women also show higher PC3 scores than men (PC3: $\delta = 0.78$, $P = 0.032$).

Significant cultural differences are only observed in females, with higher Indian scores in PC2, PC3, and PC4 (PC2: $\delta = 0.41$, $P = 0.035$; PC3: $\delta = 0.61$, $P = 0.004$; PC4: $\delta = 0.47$, $P = 0.031$). These reflect their greater preference for tan-coral and blue-turquoise over light green-olive green and lavender, and greens and pinks over blues-lavender and olive green and brown, compared to British females.

3.3 | IPIP and BSRI score comparisons[¶]

In the absence of significant differences in the ranking of personality attributes to distinguish the "pastel" from the "color-opponent" subgroups, IPIP, and BSRI scores are considered for the overall dataset of 161 subjects,

3.3.1 | IPIP scores

A multivariate analysis of variance (MANOVA) was conducted with personality traits as dependent variables and Gender and Culture as factors. There were significant effects of Gender, $F_{(5,153)} = 54.06$, $P = 0.002$, $\eta_p^2 = 0.117$ and Culture, $F_{(5,\ 153)} = 58.86$, $P < 0.001$, $\eta_p^2 = 0.66$, but their interaction was not significant. More specifically pairwise comparisons reveal that Indians have significantly higher scores in **O** ($\delta = 4.10$, $P < 0.001$) and **A** ($\delta = 8.80$, $P < 0.001$) and significantly lower scores in **N** ($\delta = -5.1$, $P < 0.001$) and **E** ($\delta = -4.57$, $P < 0.001$); all these differences are observed in both females ($\delta_{\mathbf{O}} = 4.35$, $\delta_{\mathbf{A}} = 8.9$, $\delta_{\mathbf{N}} = -4.76$, $\delta_{\mathbf{E}} = -5.70$, $P < 0.001$) and males ($\delta_{\mathbf{O}} = 3.76$, $\delta_{\mathbf{A}} = 8.76$, $\delta_{\mathbf{N}} = -5.47$, $\delta_{\mathbf{E}} = -3.43$, $P < 0.001$). Consequently, Indians' personality attributes are ranked as follows, from the highest to lowest scores: Openness to experience (**O**), Agreeableness (**A**), Conscientiousness (**C**), Extraversion (**E**), and Neuroticism (**N**), summarized as **OACEN**. A different pattern held across the British sample (**ECONA**).

Across cultures, females' scores are significantly higher than males in **N** ($\delta = 1.97$, $P = 0.006$) and **E** ($\delta = 1.79$, $P = 0.007$). In the Indian sample, females have significantly higher scores in **N** ($\delta = 2.36$, $P = 0.02$), but females and males retain the same personality trait rank order. British females' personality rank is different from that of males (**ECNOA**) with their scores significantly higher in **E** ($\delta = 2.92$, $P = 0.002$).

3.3.2 | BSRI scores

A multivariate analysis of variance (MANOVA) was conducted with BSRI categories as dependent variables and Gender and Culture as factors. There was a significant effect of Gender, $F_{(5,153)} = 9.5$, $P < 0.001$, $\eta_p^2 = 0.155$ and Culture × Gender, $F_{(5,\ 153)} = 5.42$, $P = 0.001$, $\eta_p^2 = 0.095$. Across the overall sample, as expected, **Femininity** scores are higher for females (4.83 vs. 4.46, $\delta = 0.37$, $P < 0.001$) and **Masculinity** scores are significantly higher for males (4.87 vs. 4.52, $\delta = 0.344$, $P = 0.004$). However, these differences are only significant in the British sample (**Femininity**: $\delta = 0.699$, $P < 0.001$ and **Masculinity**: $\delta = -0.5$, $P = 0.003$), producing the interaction term. **Gender Neutral** scores are higher for females (5.04 vs. 4.49) but the difference was not significant in either British or Indian samples in isolation. Pairwise comparisons further indicated that Indian females compared to British females scored significantly lower in **Femininity** ($\delta = -0.29$, $P = 0.019$) and higher in **Masculinity** ($\delta = 0.36$, $P = 0.007$). No cultural difference was observed in males.

3.4 | Correlations

3.4.1 | Correlations among IPIP and BSRI scores

To illuminate further the cultural and gender differences in the IPIP and BSRI scales, we examined the pattern of correlations among them. To simplify the correlations, we

[¶]The use of the scales for the two samples was comparable as indicated by the median and the range. IPIP scores: Median Indian (24) versus British (23); semi-interquartile range SIQR 4.25 versus 3.88, respectively. BSRI scores: Median Indian (4.60) versus British (4.53); SIQR 0.45 versus 0.39, respectively. Median and SIQR are provided for the four subject groups in Table S3 (Supporting Information Material).

TABLE 1 Pearson coefficient of correlation (and p values) between IPIP and BSRI scores

	UK		IND	
	F(43)	M(37)	F(42)	M(39)
M		0.53 (.001) **O**	0.328 (.034) **ES** 0.579(<.001) **E**	0.382 (.016) **F**
Neu		0.611(<.001) **F** 0.394 (.016) **M**	0.327 (.035) **E** 0.35 (.023) **M**	0.577(<.001) **F** 0.409 (.01) **M**
A	–0.6(<.001) **O** –0.316 (.039) **E**	–0.5 (.002) **E**		0.434 (.006) **ES**
C	0.311 (.043) **ES**	0.389 (.017) **A**	0.314 (.043) **ES** 0.39 (.011) **M**	0.546(<.001) **ES** 0.432 (.006) **M**
O		–0.42 (.01) **F**		

reversed the polarity of 'Neuroticism' to create a score of Emotional Stability (**ES**).

Looking first at the Indian participants, the general pattern of correlations was the same for males and females. Summarizing this pattern with PCA (not shown) the first two components arrange the eight scales along a continuum with the three BSRI scales at one extreme (the first component) and **C**, **ES,** and **A** at the other (the second component). The main gender difference was in the use of **E**, which lay among the BSRI scales when self-ascribed by females, and among the cluster of IPIP scales in male self-ascriptions. Responses are best explained by two broad factors of amenability toward the putatively gender-oriented, and the trait-oriented questions. More specifically, the three BSRI scales were all positively and significantly correlated, except for **Masculinity** and **Femininity** rankings from Indian females (where $r = 0.13$). At least for this sample of design students, the BSRI instruments did not capture the information and distinctions they were designed for. In the case of British participants, the pattern of correlations does not lend itself to a simple picture, with a gender-specific entangling of gender and personality scales. Bivariate correlations are indicated in Table 1.

3.4.2 | Correlation between color preferences and IPIP and BSRI scores

Inspection of Table 2 indicates that among the British sample, the correlates of females' color preferences are limited to BSRI scores. Specifically, across British women, **Masculinity** correlated positively with liking for brown and coral (5Y and 7.5R) and negatively with light blue (10B*), while **Femininity and Neuter** correlated negatively with preference for olive green (5GY), **Neuter** correlated negatively with preference for green (10G) and positively for tan (2.5YR). Conversely, apart from **Neuter** correlating negatively with light pink (2.5 R) and olive green (5GY), the correlates of British males' preferences were limited to IPIP scores.

For the "color-opponent" Indian sample, correlations are sparser. **O** is negatively correlated with blue (5B) for females and **A** is positively correlated with green (10G) for males. This group showed no gender-specific correlations with BSRI scales, in contrast to the British sample. In the "pastel"-like group, **Femininity** is (as in case for British females) negatively correlated with olive green (5GY) and **Masculinity** is positively correlated with beige (10YR*).

3.5 | Supporting information data for Indian participants only

3.5.1 | Importance of color in different artifacts

Mean ratings for 'importance of color' for the nine classes of artifact varied widely in their involvement of color in choices, from 'household' and 'gadgets' (rated as 'very important' by 17 and 22% of subjects) up to 'interior paint' and 'clothing' (rated 'very important' by 68 and 70%). This was borne out by MANOVA with Artifact Classes as dependent variables, and Gender and Color-Ed as factors which revealed a significant effect of Gender ($F_{(9,71)} = 2.29$, $P = 0.026$, $\eta_p^2 = 0.225$). The largest contribution to this was a marginally significant gender difference for the Furnishing class ($X_M = 3.97$, $X_F = 4.40$, $F_{(1,79)} = 4.16$, $P = 0.045$,[#] $\eta_p^2 = 0.05$). There was no significant interaction.

3.5.2 | Principal component analysis

A PCA was conducted to explore the structure in artifact data based on the importance of color in decision-making, over 81 subjects and 9 artifacts. Two principal components (PCs) were retained with eigenvalues $\lambda = 3.28$ and 1.45 (a third PC was marginal, with $\lambda = 1.04$). After rotation with the Varimax criterion, both PCs were unipolar, explaining 52.5% of the total variance. The classes 'Interior Paint', 'Exterior Paint', 'Furniture' and 'Furnishing' clustered on PC1, 'Clothing' and 'Accessories' on PC2. Alternatively, in the unrotated version, the first component is a '*g*-factor' on which all artifacts load equally, while the subjects' values indicate their individual ratings of color as an attribute bearing on consumer choices,

[#]with Bonferonni's correction for multiple comparisons.

TABLE 2 Spearman Rho (and p values) coefficient of correlation between color rankings and IPIP and BSRI scores

	British		Indian			
	F(43)	**M(37)**	**F(29)**	**M(28)**	**P-like(8)**	**P-dislike(16)**
*10B**	−0.345 (.023) **M**	–0.389 (.017) **C** –0.377 (.021) **A**			–0.726 (.042) **C**	0.638 (.008) **O**
5B			–0.399 (.032) **O**		0.752 (.032) **ES**	
10G	–0.32 (.037) **NEU**	–0.377 (.022) **C**		0.42 (.026) **A**		
5G		0.389 (.017) **E** –0.407 (.012) **A**				
*10GY**						–0.553 (.026) **A**
5GY	–0.351 (.021) **NEU** –0.344 (.024) **F**	–0.353 (.032) **NEU** 0.498 (.002) **E**			–0.913 (.002) **F**	
5Y	0.376 (.013) **M**					
*10YR**					0.788 (.02) **M**	–0.546 (.029) **O**
2.5YR	0.459 (.002) **NEU**					
7.5R	0.355 (.02) **M**	0.345 (.037) **C** 0.377 (.021) **A**				
*2.5R**		–0.432 (.008) **NEU** 0.366 (.026) **A**				
5RP		–0.59(<.001) **E** 0.424 (.009) **C** 0.519 (.001) **A**				
10P		–0.55(<.001) **E** 0.43 (.008) **A**			0.727 (.041) **F**	–0.688 (.003) **F**
*5P**						0.51 (.044) **M**

while the second component is a bipolar distinction between 'living space' and 'proximal possession'. The small gender difference for some artifact classes was not captured by PCA, with no group difference on subjects' scores on PC1 or PC2, in either the original or the rotated versions.

3.5.3 | Demographic data

Chi-square computations indicated an absence of significant relation between the categorical variables Gender, Color Preference Style ("color-opponent", "pastel"), Geographical Location (North, East, West, South, Center), and Color-Ed (educated or not).

Among the three 'Color-Interest' scales, Col-Int was negatively correlated with Col-Neut ($r = -0.56$) and Non-Col ($r = -0.70$). This argues for the divergent validity of the scales, ruling out the possibility that they merely reflect response style such as amenability bias (which would produce *positive* correlations). MANOVA with Color-Interest as the dependent variables and Gender and Color-Ed as factors reveals a marginally-significant Gender effect ($F_{(2,78)} = 3.95$, $P = 0.023$); this could be narrowed down to Non-Col interests, of which males checked significantly more than females ($X_F = 0.031$, $X_M = 0.037$; $F_{(1,79)} = 0.799$, $P = 0.006$). There was no significant interaction.

Using the five PC scores previously computed from applying PCA to all participants, of which PC2 is a 'Saturation' component that distinguishes the "color-opponent" from the "pastel" pattern of preference, none of these preference scores was significantly dependent on Color-Ed or Geographical Location. There is, however, an association between the Col-Int and preference pattern for the 14 "color-opponent" individuals with the highest Col-Int scores (i.e., the highest quartile). Numerous color-themed interests, for this group, were accompanied by a preference for the complementary combination of blue-greens (10BG, 5BG*) *and* reds (5RP), *and* a rejection of the combination of yellows (5Y, 10YR*) and purple-blues (5P*, 10B*). In terms of the Principal-Component summaries, this manifests as a correlation $r = 0.45$ ($P < 0.001$) between Col-Int and loading on the quadrapole PC4 (Figure 4).

4 | DISCUSSION

4.1 | Color preferences

4.1.1 | Cultural differences

The first difference observed between British and Indian participants relates to the criteria used in the color preference task. Written instructions were the same in the two countries. Participants were asked to indicate their preferred 'color' out of three presented on a card. Hue was not the only independent variable in the color set; variation in Chroma and Value also offered a distinction between "pastel" and "non-pastel" and these combined attributes were as legitimate as hue for choosing. Interestingly none of the British participants based their response solely on this distinction, whereas one in four Indian participants did.

With cross-cultural comparisons limited to the "color-opponent" sample, a second difference concerned the absence of consensus among Indians and more specifically among Indian males. Compared to Indian, British participants constituted a more stereotyped group, which is consistent with the larger variance reported for Arabic participants relative to British[7]. In our experiment, the origin of these differences cannot be pinned down to a single factor as the two samples differed in both culture and education. Indian participants were students in Design while the British were Psychology students. Color has an important role in designers' creative and professional activities; the interpretation of instructions and the manner of performing the task might involve a larger diversity of strategies among Designers who are less prone to reproduce a culturally stereotyped pattern of color preference. Indeed, Ou et al.,[19] asking for evaluation of two-color combinations on color emotion scales, reported an effect of Design training; designers show a preference for lower Chroma and for combinations of more-similar hues than did observers with a nondesign background. Although it is difficult to quantify the influence of education (Designer vs. Psychologists) on the color preference task, from demographic data one can only observe that, within the Indian sample, the exposure or otherwise to color courses did not significantly interact with color preference pattern. On the other hand, the lack of Indian consensus could reflect the cultural diversity that characterizes Indian population. Cultural diversity advocates assert that some cultural attribute (e.g., religion, language, caste) changes every 100 km. This diversity was difficult to control in our experiment, and information about cultural background was limited to the record of geographical location of formative experience, which transpired to have no significant effect on color choice. In fact, besides the cultural diversity, it is noted that our sample of National Institute of Design (NID) students are by-and-large representative of a young Indian professional profile educated at post-graduate level who will be working in the corporate sector of the Indian economy and, from that respect, constituted a very homogeneous sample. It is also noted that today NID students have considerable exposure and exchange with global and western cultures through mass media which is wholly integrated to their own culture.

Despite the wider variations in the Indian sample, the mean color preference curves did not differ greatly between the two cultures. The overall pattern of preference as described by the four PCs was comparable between the two groups, although at the level of individual color samples, Indians preferred olive and light green more than the British, who in turn preferred lavender and light blue.

In particular, limiting the comparison to males, Indians and British behaved remarkably similarly, with no group difference in their PC scores: male preferences consistently divide the hue circle into cool and warm semicircles, from light green to blue and from lavender to brown, respectively more- and less-preferred colors. Olive green is the only color for which a cultural difference was apparent. Olive green is a common color in Indian natural environment with Henna and Tulsi (holy basil) leaves both used for dyeing purposes. It is also a color used in men's clothes using natural dyes. This color is less popular in western men's clothing trends.

The comparison within the sub-group of females reveals a cultural difference (Figure 2c): British females show a preference for purple and lavender and light blue and a dislike for tan and coral, relative to Indian females. One possible explanation is that women's choice criteria might be related to the color that they like to wear, that is the colors flattering their skin tone or the color corresponding to dress code. Indian females' choice for orange palette is arguably considered as flattering for their skin tones while cool pastel colors are more flattering for North European skin tones, while the Indian women dislike of pastel samples—expressed by the very small number of "pastel"-like women ($N = 3$)—can be attributed to the color code used in India in which white or very pale color signifies widowhood. It is also expected that older women should avoid wearing bright colors. This conjecture has the corollary that for color preference choices abstracted from context, women would be mainly influenced by their color knowledge for their personal wardrobe, this influence being less clear in the color choices of men.

Natural environment is also very different between the two cultures. This difference could have influenced preference in hue and saturation if, for instance, specific surface reflectances and illuminants are biasing observers' perception through long-lasting adaptation thus moving the average natural environment color, or through color-contrast of the scenes that would selectively reduce sensitivity to a given color axis. However, Webster et al.[20] who investigated the role of physiological, environmental, and cultural factors on the perception of focal colors and unique hues between US and Indian observers, reported that the observed population differences could not be explained by adaption processes to their specific environment. In the present study, group difference being gender-specific, it would also be necessary to explain why adaptation to specific natural environment would only be expressed in females' color preference.

4.1.2 | Gender difference

Gender differences in color preference, previously observed among British subjects, were replicated as a similar expression in Indian subjects. First, the maxima and minima of color preference curves are more pronounced in females than in males, consistent with the British sample of Ref. 6 (though less so with the Chinese participants in that study). A similar female enhancement of expression of color preference has been illustrated in the Coloroid color circle, with data collected from over 70,000 participants of all ages in a comprehensive decade-spanning study.[21]

A gender-specific shift in preference profiles was also replicated, with women showing a higher preference for pink, manifesting in PCA as higher scores on the second principal component. A study of Japanese color preferences reported a liking for pink hues specific to women (although that study used a very different task in which subjects chose three liked and three disliked hue samples out of a 65-hue palette).[22]

The gender-specific cultural difference discussed above can also be approached as a cultural modulation of the present gender difference. This becomes apparent when PCA is applied to the culture groups separately. In the British sample, the gender-sensitive component opposes pink-purple-lavender and light blue [5RP, 10P, 5P*, and 10B*] to greens and brown [5G, 10GY*, 5GY and 5Y] and can be loosely assimilated to red-green opponency. In the Indian sample, the gender-sensitive component is less congruent with a canonical color opponency, opposing pinks, and dull green [5G, 2.5R*, and 5RP] to blues-olive green and brown [10B*, 5B, 5GY, and 5Y]. This result is compatible with Hurlbert and Ling's report[6] that the cone-opponent contrast component [L-M, 'red-green'] account for 72% of the British females' variance and only 64% of the Chinese females' variance. It suggests that the amount of variance remaining to be accounted for varies with culture and are determined by others than biological influences.

Our results are also consistent with Refs. (8, 9) but not with Ou et al.[23] who report a cultural difference but no gender difference. Their study tested 14 British and 17 Chinese subjects who evaluated 20 colors along a set of bipolar scales. Although color preference curves cannot be determined from the published results, results on the like–dislike scale are comparable with preference ranking data: Pearson correlation between mean British and Chinese like-dislike profiles was 0.46, rising to 0.68 between males and females, contrary to the present study.

4.2 | Correlations between BSRI, IPIP, and color rankings

Based on the pattern of correlation observed in the British sample—distinguishing males (whose rankings were mainly associated with IPIP scores) from females (whose rankings were exclusively associated with BSRI scores)—our study also addressed the possibility of an association between color ranking, personality traits and gender schemata. Saito[22] reported associations between personality/life-style self-assessed variables and membership of eight color preference–pattern groups (obtained by factor analysis of preference data), but no details or tests of significance were provided.

In the present study, British female color choices were correlated to BSRI scores and British male preferences mainly to IPIP scores, suggesting that color preferences act for British males as a personality identity marker, with colors designated as expressions of Extraversion or Agreeableness, while for females they express Femininity and Masculinity. Such a gender distinction was not replicated in the Indian sample. Correlations were considered within the three sub-samples of Indian participants—"color-opponent" and two "pastel" subgroups—and no correlation pattern could be identified either in function of gender or color preference criteria. The failure to replicate with Indian participants the British participants' dissociation between personality (IPIP) and gender schemata (BSRI) scores suggests that these associations might reflect cultural stereotypes. However, issues associated with the validity of BSRI measures are well known despite their widespread use.[24] Gender role stereotypes vary with culture and the absence of gender difference in Masculinity and Femininity items obtained in our Indian sample has already been observed among South Indian and Malaysian respondents.[25] It was noted at the time of testing that some items made little sense to the participants. These observations tend to cast doubt on the BSRI construct validity for Asian populations so the absence of any association between gender schemata scores and females' color preference in the Indian sample should be taken with caution if the BSRI was not accurately measuring gender schemata. Future research addressing possible association between gender schemata and color preference should adopt more appropriate tools to gender role in Asian population, such as the Indian Gender Role Identity Scale developed by Basu.[26]

The question of cross-cultural validity is less of an issue with the IPIP five-factor structure which has been shown to be robust across major regions in the world,[27] so the IPIP is considered as appropriate for cross-cultural personality assessment (although international norms are not available for the particular subsets of IPIP items used here). The absence of any general pattern between color ranking and personality traits across the two culture groups is suggesting that associations between a given color and a personality trait are flexible and based on cultural stereotypes rather than universally shared.

4.3 | Evaluation of the importance of color in different artifacts

While the majority of Indian males and females considered color as very important in clothes and interior painting, a gender difference was noted with a consensus among females that furnishing artifacts were of next-most importance while males considered automobiles as the next category. Patterns of correlations across individual variations indicated two clusters (principal components) that could be identified as 1—*living space* (comprising Interior Paint, Exterior Paint, Furniture, and Furnishing); and 2—*proximal possessions* (comprising Clothing and Accessories). A third component, if retained, enlisted Gadgets and Automobiles (also loading on Interior Paint), and could be glossed as 3—*remote possessions*. Although not significant, females' scores on this last component are lower than males' scores.

5 | CONCLUSION

Preference for cool over warm colors was replicated among Indian subjects. This overall pattern of color preference is also consistent with the color preference for blue-cyan-green over chartreuse-orange-yellow averaged over 48 US participants.[28] The specifically female preference for pink colors in British women [43 in the present study, 92 in Refs. (6) and (31) in Ref. (7)] and also reported in 18 Chinese[6] and 36 Arabic women[7] was observed among our 29 Indian female participants, although their preference did not extend to purple and lavender, leaving a warm bias to the preferred Indian pink.

The present data bring additional support to previous experimental results on the existence of a gender difference in color preferences (elicited in the absence of a specific application).[6,7,9] The generalization to other cultures points to pan-cultural factors driving gender differences in color preference, featuring pink colors, but with exact undertone and range varying with culture. A putative gender-specific pattern of association between color and personality traits or gender schemata failed to replicate with Indian participants, ruling out these factors as a universal explanation for the color gender difference. Although the evolution of a gender-specific behavioral use of trichromacy that would shape the opponent-color mechanisms would be consistent with a pan-cultural expression of gender difference in color preference, recent results obtained from color similarity judgments with participants stemming from the same Indian population and tested in the same laboratory conditions, call for prudence as the gender difference observed in British was not replicated in Indian participants.[29]

Indian subjects were also questioned about their education, interests and hobbies, as other potential correlates or predictors of color preference. Gender differences would have been informative, but the results were negative.

Our results thus confirm the classical observation of an overall preference for cool over warm colors and highlight the males' conformity to this archetypical color preference pattern. It is in the deviation from this archetypal color preference pattern that females express cultural differences, which suggests that their color preference is more malleable and prone to cultural influence whose driving force is still open to speculation.

ORCID

Valérie Bonnardel http://orcid.org/0000-0002-4787-1167

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AUTHOR BIOGRAPHIES

Valérie Bonnardel received a PhD in Visual Neuroscience from Pierre et Marie Curie University, Paris, working under the supervision of Francisco Varela. Then she pursued her research on the study of the human colour system in the comb-frequency domain at the University of Cambridge where she worked with John Mollon and Horace Barlow. She was awarded the National Institute of Design Asian Paints Research Chair in Ahmedabad (India) where she conducted research on cross-cultural aspects of human color vision. She was the Chair of the Color Group (Great Britain) and today she is the Treasurer of the Centre Français de la Couleur. She is Reader in Experimental Psychology at the University of Winchester (UK).

Sucharita Beniwal holds a M.Des. in Social Design from Ambedkar University, Delhi (AUD) and a Textile Design Diploma from NID-Ahmedabad (India). She has an extended experience as a Design Consultant in Textile Design and Community-Design spaces. She worked as a Research Assistant at the National Institute of Design Asian Paints Color Research Laboratory. She is currently a Faculty member in Textile Design at NID-Ahmedabad.

Nijoo Dubey is an architect and interior designer and was the coordinator of the National Institute of Design Asian Paints Color Research Laboratory-Ahmedabad. She is a Faculty member in the Design for Retail Experience at the National Institute of Design (NID)-Bengaluru (India).

Mayukhini Pande has a Postgraduate Diploma in Strategic Design Management from the National Institute of Design-Ahmedabad and is a Bachelor of Technology in Mechanical Engineering from the National Institute of Technology-Bhopal (India). She worked as a Research Assistant at the National Institute of Design Asian Paints Color Research Laboratory.

David Bimler is a research affiliate with Massey University in New Zealand. While specializing on multivariate procedures and multidimensional scaling as applied to psychophysics, his research focuses on vision, such as perception of color and facial expressions of emotion.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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