Title: Similarities in color preferences between women and men: the case of Hadza, the hunter gatherers from Tanzania

Abstract

Evidence for cross-cultural patterns of sexual differences in color preferences raised the question of whether these preferences are determined by universal principles. To address this question, we investigated most- and least-favorite color choices in a non-industrialized community, the Hadza that has an egalitarian hunter-gatherer culture fundamentally different from those previously investigated. We also compared color preference patterns in the Hadza with published data from Poland and Papua. Our results show that Hadza have very different color preferences than Polish and Papuan Yali respondents. Unlike many industrialized and non-industrialized cultures, Hadza color preferences are practically the same for women and men. These observations question the idea of universal differences of color preferences between sexes and raise important questions about the determinants of color preferences.

Introduction

Although single individuals may have quite specific preferences for colors, there are also general patterns across individuals. In particular, there is evidence for an overall tendency to like blue, at least in many industrialized societies (Crozier & Crozier, 2006; Saito, 1996; Sorokowski, Sorokowska, & Witzel, 2014; Yokosawa, Schloss, Asano, & Palmer, 2016). In addition, several studies reported differences between men and women (Al-Rasheed, 2015; Bonnardel, Beniwal, Dubey, Pande, & Bimler, 2017; Ellis & Malamuth, 2000; Fortmann-Roe, 2013; Jonauskaite et al., 2018; Palmer & Schloss, 2010; Sorokowski et al., 2014; Taylor & Franklin, 2012; Witzel, 2015), and it has been suggested that these sexual differences are stable across cultures (Sorokowski et al. 2014; Witzel, 2015; Hurlbert & Ling, 2007). However, earlier studies did not find sexual differences (Eysenck, 1941; Granger, 1955; Tate & Allen, 1985), and there is also evidence against cross-cultural similarities in sex differences (Taylor, Clifford, & Franklin, 2013).

Different theories are debated to account for systematic patterns in color preferences (Giudice, 2017). One proposes that color preferences are related to biological characteristics of color vision that are assumed to be determined through evolution (Hurlbert & Ling, 2007). Others have argued that color preferences are ecologically determined through learned associations between colors and objects (Palmer & Schloss, 2010; Taylor & Franklin, 2012;

Yokosawa et al., 2016).

Cross-cultural comparisons make a key contribution to clarify whether color preferences are universal or whether they are learned and depend on culture and ecology. This is particularly true for non-industrialized cultures that are not exposed to globalized discourses in the media patterns, such as the idea that blue is suitable for men, and pink is suitable for women. To our knowledge there have been only two studies published regarding differences between male and female color preferences conducted in non-industrialized, traditional, and isolated from western culture societies. To date, these studies provide mixed results. Sorokowski et al., (2014), found that although the color preferences of the Yali from Papua and from Polish respondents are different, the way that men and women differ were very similar. Opposed to that, Taylor, Clifford and Franklin (2013) published a study among the Himba tribe from Namibia and compared these data with British respondents finding the sex differences from these two samples not corresponding at all. The reason for these contradictory results remains unclear. It is possible that Taylor and colleagues did not find a cross-cultural pattern because they presented their participants with colors using computer screen. Non-industrialized observers who live without running water and electricity are not used to computer screens and this display mode might have affected their color choices in a way that deviates from their genuine/natural color preferences and covers cross-cultural patterns.

We investigated color preferences in a third culture, the Hadza, to clarify whether there are stable patterns in sex differences across non-industrialized cultures. The Hadza are an indigenous people from Tanzania and one of the few remaining societies who live by hunting and gathering (Blurton-Jones, 2016; Marlowe, 2010). Therefore, although Himba, Yali and Hadza are all non-industrialized cultures with minor contact with Western cultures, Hadza differ substantially from pastoral-nomadic Himba (Rank & Ollig, 2007) and cultivating Yali (Sorokowski, Sorokowska, & Danel, 2013) in the way they gain food. At the same time, social organization of hunter-gatherers is described as a most primeval and unchanged way of living (Marlowe, 2010) which brings them into interest of anthropologists and psychologists trying to examine our ancestors. The aim of our study was to determine whether there are sex differences in color preferences that are similar to those of Yali from Papua in another traditional culture. The Hadza use color vision in everyday life for the same reasons as did our ancestors (i.e. Hadza women collect baobab fruits or gather berries while men collect wild honey and hunt birds and mammals; see: Blurton-Jones, 2016; Marlowe, 2003; Regan, 2001). We used the same method as in Sorokowski et al (2014) study. Therefore, we had a possibility to compare our results with data from Poland and Papua.

Methods

Participants

Our study comprised 94 observers (44 women). The age of women was between 15 and 75 years (M=35.05, SD=15.11) and men were between 16 and 70 years of age (M=38.84, SD=14.86). The Hadza population of roughly 1000-1500 inhabits northern Tanzania near Lake Eyasi. They live in small camps that change their location from time to time. Their culture is described as egalitarian (Apicella, Marlowe, Fowler, & Christakis, 2012; Blurton-Jones, 2016; Marlowe, 2010). The observers examined by Sorokowski and colleagues (2014) were Yali (N=108) and Poles (N=200), half men, half women. Age of Yali women ranged between 25-59, (M = 38.4, SD = 8.7), Yali men ranged between 19 and 50 years (M = 35.6, SD = 7.6), Polish women were between 19 and 55 years old (M = 31.4, SD = 9.8) and men between 19 and 56 years (M = 34.4, SD = 10.0). For detailed description of both samples see Sorokowski and colleagues (2014).

Materials

We used the exact same printed color wheel as Sorokowski et al. (2014) so as to guarantee that stimuli were the same as in that study. It consisted of six colors that roughly corresponded to the prototypes of red, orange, yellow, green, blue and purple, and six colors with hues in between those typical colors. See supplementary material for the chromaticity coordinates of

the stimuli.

Procedure

The current study was conducted following the rules stated in the declaration of Helsinki. The study protocol has been approved by the appropriate Institutional Review Board (IRB) and by the Tanzania Commission for Science and Technology (COSTECH). Participants provided informed consent prior to participation. They received a small financial compensation for their participation. Participants were asked to point the color they like most (their favorite color) and then the color they like least (least favorite color). The study was conducted with the help of a local assistant from the Datoga tribe who communicated with the participants in Swahili, a language that most Hadza are familiar with. The questions asked were: “which color do you like most?” and “which color do you like least?”.

Results

Eleven women and five men refused to pick a least preferred color because they either liked all colors (2 participants) or disliked all remaining colors (14 participants). We calculated the relative frequencies of most and least preference choices to estimate the likelihood with which a color would be chosen as most (least) favorite across the members of each culture. Figure 1.a-b shows most and least preferred choices of Hadza observers, separately for women (solid red curve) and men (dotted blue curve). According to most preferred choices, Hadza observers liked green (G) most and orange (O) least. In contrast to what might be expected, the least preferred choices did not seem to correspond to the inverse of the most preferred choices. Least preferred choices indicated that the Hadza disliked red (R) most, which was mainly the case in men. Correlations between relative frequencies of color choices were calculated across the 12 stimulus colors in order to test for similarities of color choices across colors. Since relative frequencies depend on the variance of color choices across observers, the correlations depend on both, the variance across observes and the variance across stimuli. To account for both kinds of variance we recalculated probabilities (sim p) based on Monte-Carlo simulations of uniformly random color choices (see supplementary material for details). There was no negative correlation between most and least preferred choices ($r(10= 0.16$, $p = 0.63$, sim $p = 0.62$).

Hadza most and least preferred color choices significantly differed from both Yali (chi^2 = 36.4, $p < 0.001$; chi^2 = 20.0, $p = 0.04$) and Polish (chi^2 = 36.7, $p < 0.001$; chi^2 = 32.6, $p < 0.001$) observers. These cross-cultural differences are in line with previous observations of cross-cultural differences in remote cultures (Sorokowski et al., 2014; Taylor et al., 2013).

In contrast to our previous results with Polish and Papuan observers, Hadza choices of most preferred colors were very similar between women and men (cf. Figure 1.a). The preferred color choices of Hadza women and men were strongly correlated ($r(10) = 0.91$, $p = 0.001$, sim $p < 0.001$), explaining more than 80% of the total variance (cf. Figure 1.a). This correlation between Hadza women and men contrasts the absence of such correlations between women and men in Polish ($r(10) = 0.19$, $p = 0.56$, sim $p = 0.55$) and Yali observers ($r(10) = -0.10$, $p = 0.75$; sim $p = 0.76$).

We then compared sexual contrasts across cultures in the way Sorokowski et al. (2014) did it for Yali and Polish. Sexual contrasts were calculated as the difference between relative frequencies of color choices by women and by men for each stimulus color. Figure 1.c allows for comparing sexual contrasts of preferred choices in Hadza (red) with those of Polish (black) and Yali (green) observers. Hadza sexual contrasts for preferred colors varied much less across colors than for Yali and Polish observers (i.e. red curve is flatter than green and black curves in Figure 2). Sexual contrasts for favorite colors had been highly correlated

between Yali and Polish observers ($r(10) = 0.93$, $p < 0.001$; cf. Sorokowski et al., 2014). However, correlations between Hadza and Polish ($r(10) = -0.01$, $p = 0.98$) and between Hadza and Yali ($r(10) = -0.02$, $p = 0.94$) were not significant, and the respective correlation coefficients were significantly lower than those for Yali and Polish observers (both $z = 3.4$, $p < 0.001$).

For least favorite color choices, the correlation between the relative frequencies of Hadza women and men (Figure 1.b) was not significant ($r(10) = 0.35$, $p = 0.26$). Hadza sexual contrasts for least preferred colors (red curve in Figure 1.d) showed a tendency of a correlation with Polish sexual contrasts (black curve in Figure 1.d), which almost reached significance ($r(10) = 0.58$, $p = 0.0501$). The correlation between Hadza and Yali sexual contrasts (green curve in Figure 1.d) was far from significance ($r(10) = 0.42$, $p = 0.18$).

We used Monte Carlo simulations to estimate the statistical power for showing significant correlations between sexual contrasts (Details are provided in the supplementary material). The statistical power for finding a significant correlation ($p < 0.05$) between the sexual contrasts of most preferred choices in Yali and Polish observers was 0.87. For the Hadza, we tested for the hypothetical sexual contrasts that correspond to the average between Yali and Polish sexual contrasts. The statistical power for detecting correlations between Hadza and Yali, and between Hadza and Polish was 0.79 and 0.86. So, the likelihood of detecting a

similarity of sexual contrasts was >0.80, if we assume sexual contrasts of the magnitude observed in Yali and Polish observers (see further explanations in supplementary material). In contrast, power is much lower for detecting correlations between sexual contrasts of least preferred choices because we had slightly smaller sample sizes in the Hadza and because the magnitude of sexual difference estimated based on Yali and Polish least preferred choices was much smaller than for most preferred choices. Estimated power was only 0.35 for correlations of sexual contrasts between Hadza and Yali, and 0.27 between Hadza and Polish. The absence of significant results may be due to a lack of statistical power.

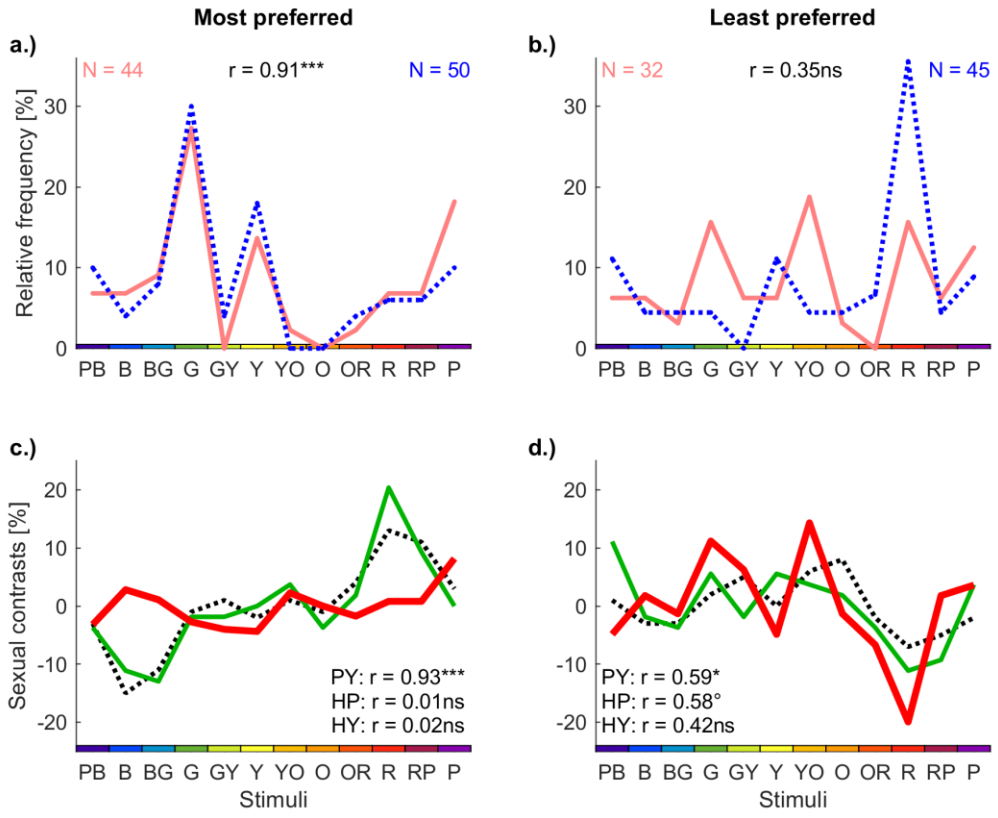

Figure 1. Choices of most (F1a) and least (F1b) preferred colors in Hadza women (solid red curve) and men (dotted blue curve). On the top of the diagrams, sample sizes for women (left) and men (right), as well as the correlation between the curves (center) are provided. Sexual contrasts for Polish (black dotted curve), Yali (green) and Hadza (fat red) observers for most (F1c) and least (F1d) preferred colors. Statistics in the right corner report correlations between Yali and Polish (top), Hadza and Polish (middle) and Hadza an Yali (bottom).

Discussion

Most and least preferred color choices differed between Hadza, Yali and Polish observers. In addition, Hadza sexual contrasts of most preferred choices did not show similarities with those of Yali and Polish observers. In contrast to Yali and Polish observers, most preferred choices were almost the same for Hadza women and men. However, results for the sexual contrasts of least preferred choices were not conclusive.

Limitations

The absence of clear patterns for least preferred choices is in line with previous observations of unsystematic variation in least preferred choices in the Yali (Sorokowski et al., 2014). If least preferred choices reflect the lower end of a continuum of preference rankings, the probability for least preferred choices should be the inverse of the probability for most preferred choices, as suggested by the negative correlation between least and most preferred choices in Polish observers (Sorokowski et al., 2014). However, like with the Yali, Hadza least preferred choices were not the inverse of most preferred choices. It may be speculated that the concept of "least preferred color" is more difficult to communicate across cultures, or it is possible that the Hadza do not have a clear idea of least preferred colors. This latter idea is further supported by the 17 observers who refused to pick a least preferred color because all colors appeared to have the same valence to them. A high conceptual uncertainty

about least preferred colors together with a comparatively low sample of observers may explain the lack of significant results for least preferred color choices.

More generally, our simple procedure of asking for most and least preferred colors differs to continuous measurements of color preferences, such as pairwise comparisons (e.g. Al-Rascheed, 2015; Hurlbert & Ling, 2007) or continuous ratings (e.g. Palmer & Schloss, 2010). Our approach considers the relative frequency of most and least preferred color choices as a continuous measure of preferences, but these frequencies are not necessarily be the same as different levels of preference across colors. We used that simplified procedure to facilitate and adapt the task for the purpose of measuring non-industrialized observers, and also to allow for comparisons with the Yali and Polish. Our results with this method for Polish (black curve in Figure 2 in Sorokowski et al., 2014) pretty much reproduced the blue preference observed in other industrialized societies when using more thorough continuous measures of color preference (e.g. Figure 1.C in Palmer & Schloss, 2010). However, it remains an open question whether results are fully comparable across methods.

Implications and outlook

In any case, our thorough analyses (including Monte Carlo simulations) indicate that Hadza most preferred color choices were very systematic and unlikely to occur by chance. The Hadza provide an example of a culture in which men and women share their preferences

almost entirely**.** This finding contrasts the presence of sex differences in many industrialized (e.g Al-Rasheed, 2015; Hurlbert and Ling, 2007; Taylor & Franklin, 2012; Witzel, 2015) and non-industrialized cultures (e.g Sorokowski et al., 2014; Taylor et al., 2013; Witzel, 2015). It also undermines the idea that sex differences show stable patterns across cultures (Hurlbert & Ling, 2007; Sorokowski et al., 2014; Witzel, 2015).

Taken together, these observations suggest that although there might be patterns across fundamentally different cultures, these patterns may not necessarily exist in all cultures. There may be cross-cultural constraints, e.g. in the natural environment, that stimulate cross-cultural tendencies in some cultures, such as the Yali and the Polish. However, these constraints seem not to be deterministic, hence allowing for the expression of culture-specific factors in some other cultures. In the case of the Hadza, and maybe the Himba (Taylor et al., 2013), the cultural determinants seem to be so strong that they cover cross-cultural patterns, at least to a large extent that they cannot be detected with the statistical power of our study. Our findings challenge future research to identify and test the biological, ecological and cultural determinants that produce variation as well as those that constrain color preferences across cultures.

These findings contradict a simple dichotomy between either inherited universal patterns (nature) or acquired cultural specificities (nurture). Instead, they call for more

elaborate theories about the determinants of color preferences. Ecological approaches, based for example on object-color associations (Palmer & Schloss, 2010), may account for differences across cultures (Yokosawa et al., 2016) as well as for cross-cultural similarities, e.g. because some objects, such as water or plants, play similar roles in many cultures. These object-color associations may also be modulated by cultural symbolism, i.e. culture-specific meanings attached to objects and colors (Palmer, Schloss, & Sammartino, 2013). However, while object-color associations successfully explain color preferences in general, they only partially account for sex differences (Taylor & Franklin, 2012).

Evolutionary determinants are not limited to explain fixed universal patterns, but may also lead to cultural variability (Del Giudice, 2017). Affordances in the environment may modulate the expression of different evolutionarily shaped responses (Chapais, 2017; Gangestad & Grebe, 2016; Schmitt, 2015). Sex differences may exist for biological reasons and be modulated and moderated by social and cultural factors to different degrees. For example, a propensity of men to dislike red might be counteracted by a more general cultural symbolism that associates red with positive emotions or objects.

It also occurs to us that the Hadza and Yali differ in their hierarchical relationship between women and men. Hadza are an egalitarian culture, which is also related to high status of women within this society (Marlowe, 2010; Marlowe, 2003). Although there are several

activities dedicated solely to men or women (Marlowe, 2010; Marlowe, 2003), there are many examples that highlight their egalitarian culture, such as they equally share food between camp members and they do not possess many goods (Marlowe, 2010). In contrast, there is high inequality of wealth across the population in Yali and Yali men have higher status than women (Sorokowski, Sorokowska, Danel, 2012). A link between egalitarianism and color preferences could be explained by the role of color as a marker of social status and gender identity (e.g. Koller, 2008). There may be cross-cultural predispositions (be it inherited or ecological) that encourage the use of certain colors as a marker of social status and gender identity. These determinants might be muted in cultures, in which social status and roles are similar between the sexes. This idea is in line with the observation that sex differences in color preferences correlate with sex roles (Hurlbert & Ling, 2007; Bonnardel, Beniwal, Dubey, Pande, & Bimler, 2017). The relationship between color preferences and sex roles might be addressed through developmental studies that compare the development of color preferences with children's identification with sex roles (see discussion in LoBue & DeLoache, 2011).

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