Supplementary Material

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

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1. STIMULI

1.1 Illustration (Figure S1)

Figure S1. Photograph of stimuli. Superimposed number indicate ordering of stimuli in responses (data) and results (Figure in main article).

1.2 Color specifications (Table S1)

Table S1. Color specifications of stimuli. White point corresponds to the illumination measured on a reflectance standard, background to the white background of the color wheel. Chromaticity coordinates are based on the CIE1931 color matching functions for a 2° standard observer. Reproduced from Table S1 in Sorokowski et al. (2014).

Color	ID	Nr	x	y	Y	L*	a*	b*
White point	WP		0.3289	0.3489	380	100	0	0
Background	BG		0.3285	0.3465	284	89.3	0.8	-1.4
Blue-purple	BP	1	0.2315	0.1528	13	21.8	26.8	-40.6
Blue	B	2	0.1886	0.1444	22	29.2	22.3	-55.6
Green-Blue	GB	3	0.1864	0.2371	43	40.0	-14.2	-37.1
Green	G	4	0.3589	0.5027	77	52.1	-25.8	38.5
Yellow-green	YG	5	0.4578	0.4793	178	74.0	1.7	73.2
Yellow	Y	6	0.4573	0.4736	188	75.7	3.1	72.4
Orange-yellow	OY	7	0.5061	0.4393	115	61.8	23.3	65.8
Orange	O	8	0.5219	0.4195	88	55.3	29.8	57.4
Red-orange	RO	9	0.5626	0.3744	58	46.2	45.0	46.1
Red	R	10	0.5831	0.3412	46	41.3	54.1	37.2
Red-purple	RP	11	0.4912	0.3073	32	34.8	41.7	8.8
Purple	P	12	0.3141	0.1890	24	30.2	40.7	-33.5

2. DATA

2.1 Hadza data (Table S2)

Table S2. Hadza data. Sex: 1 = female. Age in years; age ranges where precise age was unknown and had to be estimated. Most = most preferred color choices; Least = Least preferred choices; stimulus coding as in column Nr in Table S1. Missing values in "Least preferred": NONE = "likes all the colors" (2 cases); ALL = "dislikes all colors except for most preferred color" (14); MISSING = No response at all (1).

Sex	Age	Most	Least
1	70	3	4
1	25	2	7
1	50	2	7
1	18	4	10
1	60	4	10
1	75	6	4
1	45-47	12	**NONE**
1	23	1	4
1	19-20	11	8
1	30-32	12	4
1	37	4	12
1	30	3	7
1	25	1	11
1	18	4	1
1	50	3	**ALL**
1	40	12	**ALL**
1	17-18	6	**MISSING**
1	41	12	7
1	34	3	12
1	53	4	7
1	36	4	10
1	40	6	**ALL**
1	23	9	**ALL**
1	40	6	11
1	43	2	4
1	40	4	10
1	32	6	2
1	35	4	1
1	33	4	10
1	25	12	**ALL**
1	20	10	2
1	53	4	5
1	20	12	6
1	19	11	**ALL**
1	60	12	6
1	34	7	3
1	31	1	5
1	18	12	7
1	24	10	**ALL**
1	18	4	12
1	21	6	12
1	40	10	**ALL**
1	14	4	**ALL**
1	55	11	**ALL**
2	40	9	7
2	49	12	7
2	65	3	10
2	47	10	**ALL**
2	70	12	4
2	47	3	10
2	50	12	6
2	35	2	6
2	22	6	11
2	25	10	12
2	60	1	8
2	22-23	1	**ALL**
2	40	3	12
2	24	12	6
2	57	4	1
2	57	4	8
2	33	4	1
2	25	4	9
2	47	4	10
2	19	5	3
2	19	1	9
2	21	6	2
2	18	6	3
2	50	4	10
2	25	4	10
2	20	4	10
2	37	4	10
2	31	4	10
2	50	4	10
2	25	12	4
2	49	6	10
2	56	4	10
2	45	3	**ALL**
2	42	9	**NONE**
2	50	6	10
2	55	1	10
2	40	6	10
2	25	4	10
2	63	11	6
2	18	6	1
2	57	1	12
2	47	10	2
2	48	11	**ALL**
2	35	6	1
2	18	11	9
2	16	4	10
2	52	2	6
2	36	5	12
2	29	4	1
2	30	6	11

2.2 Yali data (Table S3)

Table S3. Yali data from Sorokowski et al. (2014). Format as Table S2.

Sex	Age	Most	Least
1	48	1	4
1	42	1	6
1	38	2	4
1	50	3	7
1	30	4	1
1	28	4	6
1	40	5	1
1	43	5	1
1	33	5	6
1	30	5	7
1	50	6	1
1	59	6	1
1	35	6	4
1	30	6	5
1	28	6	7
1	37	6	10
1	28	6	11
1	44	6	12
1	40	7	1
1	33	7	9
1	46	7	12
1	37	8	11
1	53	8	12
1	25	9	1
1	45	9	6
1	50	9	7
1	26	10	1
1	30	10	1
1	30	10	1
1	38	10	1
1	35	10	2
1	33	10	3
1	40	10	3
1	35	10	4
1	40	10	4
1	35	10	6
1	40	10	6
1	25	10	7
1	38	10	11
1	28	10	12
1	46	11	1
1	50	11	1
1	55	11	1
1	30	11	2
1	33	11	4
1	50	11	4
1	27	11	5
1	40	11	7
1	49	11	8
1	38	12	2
1	47	12	5
1	32	12	7
1	42	12	8
1	40	12	9
2	50	1	9
2	40	1	10
2	40	1	10
2	28	1	11
2	35	2	4
2	27	2	7
2	37	2	7
2	30	2	10
2	30	2	11
2	45	2	11
2	45	2	12
2	30	3	4
2	40	3	4
2	30	3	7
2	38	3	7
2	38	3	9
2	35	3	10
2	41	3	10
2	42	3	11
2	45	4	1
2	40	4	10
2	40	4	11
2	26	5	1
2	36	5	6
2	40	5	9
2	29	5	10
2	37	5	12
2	36	6	1
2	45	6	1
2	26	6	2
2	32	6	2
2	40	6	2
2	30	6	3
2	26	6	5
2	34	6	11
2	26	7	1
2	39	8	1
2	25	8	3
2	25	8	9
2	49	8	11
2	40	9	3
2	26	9	5
2	45	10	1
2	30	10	4
2	45	10	5
2	35	11	1
2	19	11	3
2	47	11	5
2	27	11	6
2	40	12	2
2	30	12	6
2	47	12	7
2	48	12	8
2	30	12	11

2.3 Polish data (Table S4)

Table S4. Polish data from Sorokowski et al. (2014). Format as Table S2.

Sex	Age	Most	Least
1	19	1	4
1	39	1	5
1	42	1	5
1	25	1	6
1	32	1	6
1	19	1	7
1	38	1	7
1	40	1	7
1	22	1	8
1	25	1	8
1	33	1	8
1	41	1	8
1	39	2	4
1	35	2	5
1	19	2	6
1	22	2	7
1	26	2	7
1	19	2	8
1	25	2	8
1	37	2	8
1	45	2	8
1	24	2	9
1	30	3	5
1	41	3	5
1	40	3	7
1	44	3	8
1	36	3	9
1	33	4	1
1	21	4	3
1	19	4	6
1	21	4	7
1	34	4	7
1	19	4	9
1	42	4	9
1	42	4	9
1	39	4	10
1	37	4	12
1	33	5	1
1	40	5	3
1	23	5	7
1	48	5	8
1	55	5	8
1	41	6	3
1	35	6	5
1	38	6	7
1	39	6	7
1	28	7	4
1	19	7	9
1	19	7	9
1	32	8	1
1	20	8	11
1	22	9	5
1	35	9	6
1	45	9	12
1	47	9	12
1	51	9	12
1	54	9	12
1	28	10	1
1	39	10	1
1	26	10	2
1	19	10	4
1	19	10	4
1	38	10	4
1	22	10	5
1	35	10	6
1	36	10	7
1	19	10	11
1	22	10	11
1	25	10	11
1	40	10	11
1	49	10	11
1	22	10	12
1	23	10	12
1	31	11	1
1	43	11	1
1	21	11	2
1	21	11	4
1	23	11	5
1	43	11	5
1	24	11	6
1	21	11	7
1	34	11	7
1	35	11	7
1	35	11	7
1	22	11	8
1	37	11	8
1	41	11	8
1	43	11	8
1	19	12	1
1	25	12	1
1	19	12	2
1	21	12	5
1	19	12	7
1	24	12	7
1	19	12	8
1	23	12	8
1	42	12	8
1	39	12	9
1	30	12	10
1	32	12	10
2	19	1	4
2	22	1	7
2	54	1	7
2	35	1	8
2	56	1	8
2	28	1	9
2	30	1	9
2	38	1	9
2	39	1	9
2	39	1	9
2	42	1	9
2	48	1	9
2	45	1	10
2	24	1	12
2	35	1	12
2	20	2	4
2	39	2	4
2	19	2	5
2	38	2	5
2	41	2	5
2	30	2	6
2	19	2	7
2	40	2	7
2	28	2	8
2	35	2	8
2	36	2	8
2	42	2	8
2	43	2	8
2	20	2	10
2	21	2	10
2	32	2	10
2	33	2	10
2	39	2	10
2	41	2	10
2	47	2	10
2	25	2	11
2	34	2	11
2	35	2	11
2	37	2	12
2	38	2	12
2	37	3	1
2	19	3	4
2	24	3	5
2	41	3	5
2	30	3	7
2	40	3	7
2	44	3	7
2	19	3	9
2	19	3	11
2	35	3	11
2	39	3	11
2	41	3	11
2	45	3	11
2	45	3	11
2	37	3	12
2	40	3	12
2	30	4	1
2	33	4	2
2	45	4	2
2	30	4	3
2	23	4	6
2	30	4	7
2	19	4	8
2	19	4	10
2	20	4	11
2	51	4	11
2	35	4	12
2	40	5	1
2	51	5	3
2	32	5	7
2	48	5	12
2	45	6	1
2	37	6	2
2	49	6	2
2	47	6	6
2	30	6	7
2	39	6	8
2	45	7	1
2	19	7	8
2	54	8	3
2	33	8	4
2	47	8	5
2	20	9	2
2	19	9	6
2	41	10	1
2	21	10	6
2	36	10	12
2	42	11	3
2	38	11	7
2	35	11	9
2	39	11	9
2	19	12	1
2	38	12	1
2	38	12	2
2	20	12	3
2	41	12	3
2	19	12	6
2	19	12	6
2	23	12	7
2	41	12	10

3. Results

3.1 Exact estimations of significance (Figure S2)

We estimated the likelihood for the observed correlations through Monte-Carlo simulations. For this, we produced (uniformly) random datasets for Hadza women and men, and determined the relative frequencies of correlations equal or higher than those we had observed. For each simulated observer one of the 12 colors was randomly drawn with equal probability across colors (1/12). The number of simulated observers was determined by the number of Hadza women and men in our study, i.e. 44 women and 50 men for most preferred color choices and 33 and 45 for least preferred color choices. Such a simulation produced a random frequency distribution across colors. We did 1000 of these simulations for each group. We then determined the distribution of correlations between women and men in each culture. For this, we calculated correlations between each combination of the 1000 simulated random data, resulting in 1 million correlation coefficients (cf. Figure S2). We determined the probability of obtaining the observed correlation by the relative frequency of simulated correlations that were equal or higher than the observed one. We applied two-tailed tests because we could not exclude negative correlations a priori. The simulated p-value of a two-tailed test is the relative frequency of the absolute value of simulated correlation coefficients that are equal or larger than the absolute value of the observed correlation coefficient. The resulting p-values were sim $p < 0.001$ for most, and sim $p = 0.27$ for least preferred colors in Hadza observers (Figure 2.a). These more exact estimations of p-values confirm the significances obtained with Student distributions for correlation coefficients (for most preferred: $r(10) = 0.91$, $p = 0.001$; for least preferred: $r(10) = 0.35$, $p = 0.26$). Analogously, such simulations were done to estimate significances of other correlations, such as between most and least preferred color choices (cf. main text).

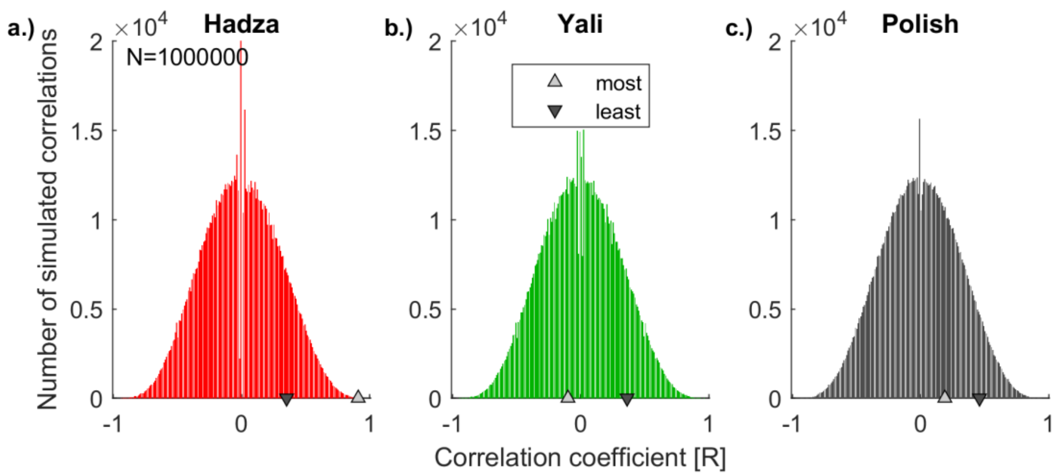

Figure S2. Correlation coefficients in random data. The x-axis lists correlation coefficients. The y-axis indicates the number of simulated correlations that yielded a specific correlation coefficient (in 0.01 bins). Panels only differ by the number of observers assumed for the random samples, i.e. 44 and 50 for the Hadza in panel a (least preferred not shown), both 54 for Yali (b) and both 100 for Polish (c). Upper and lower tip triangles indicate the empirically observed correlation coefficients for most and least preferred colors, respectively. Simulated p is calculated as the relative frequency of (the absolute value of) correlation coefficients larger or equal to the (absolute value of) observed ones.

3.2 Power (Figure S3)

We simulated random color choices in women and men using multinomial distributions with k=12 categories (aka categorical distributions). For Yali and Polish observers, we estimated the probabilities of women and men choosing each color based on the relative frequencies of color choices observed by Sorkowski et al. (2014). The number of "trials" was determined by the number of women and men in each sample, i.e. 54 in the Yali and 100 in the Polish sample. Such a simulation produced a random frequency distribution across colors. We did 1000 of these simulations for each of the four subsamples, i.e. for Yali women, Yali men, Polish women, and Polish men. We then determined the distribution of correlations between women and men in each culture. For this, we calculated correlations between each combination of the 1000 simulated random data, resulting in 1 million correlation coefficients (cf. Figure S3.a) and corresponding p-values (cf. Figure S3.d). The relative frequency of p-values below the significance level (alpha = 0.05) indicates the power of finding a significant correlation under the assumption that expected effects are exactly those observed by Sorokowski et al. (2014). According to this estimate, power was 0.88 (Figure S3.a).

We then calculated the power for detecting a correlation in the Hadza if they had exactly the same sexual contrasts as those observed in the Yali and Polish. For this, we averaged sexual contrasts between Yali and Polish (which were very similar anyway). The challenge with the unknown choice probabilities of the Hadza was that there are multiple theoretically possible choice probabilities that would produce those assumed sexual contrasts. An optimal approach to estimate the probabilities of Hadza color choices would start with the average relative frequencies of color choices observed in the Hadza. From this average, half of the sexual contrasts can be added to obtain female choices, and subtracted to produce male choices. However, it is impossible to produce the sexual differences observed with the Yali and Polish assuming the observed Hadza color choices. Negative probabilities would result because some colors (yellow-green, orange) are not chosen at all by Hadza women and men. This already speaks somehow against the idea that the Hadza could possibly produce the pattern observed in the Yali and Polish. Nevertheless, we wanted to get some idea about the role of statistical power. So, we started with equal probabilities across colors, and added only positive sexual contrasts to obtain female probabilities, and subtracted only negative sexual contrasts to obtain male probabilities. The Monte-Carlo simulations were then done as with the Yali and Polish. One million correlation coefficients and corresponding p-values were obtained for the correlations between simulated Hadza and Yali (Figure S3.b and e) and between simulated Hadza and Polish (Figure S3.c and f) color choices. This approach produced an estimated power of 0.81 and 0.87, respectively.

Of course, these estimations depend on the assumed effect sizes in the Hadza. In particular, the power drops if we assume that sexual contrasts are smaller in magnitude in the Hadza than in the Yali and Polish; for example, the statistical power for detecting a correlation between Hadza and Yali, and Hadza and Polish drops to 0.38 and 0.40, if we assume that sexual contrasts are only half the magnitude of the ones observed in the Yali and Polish.

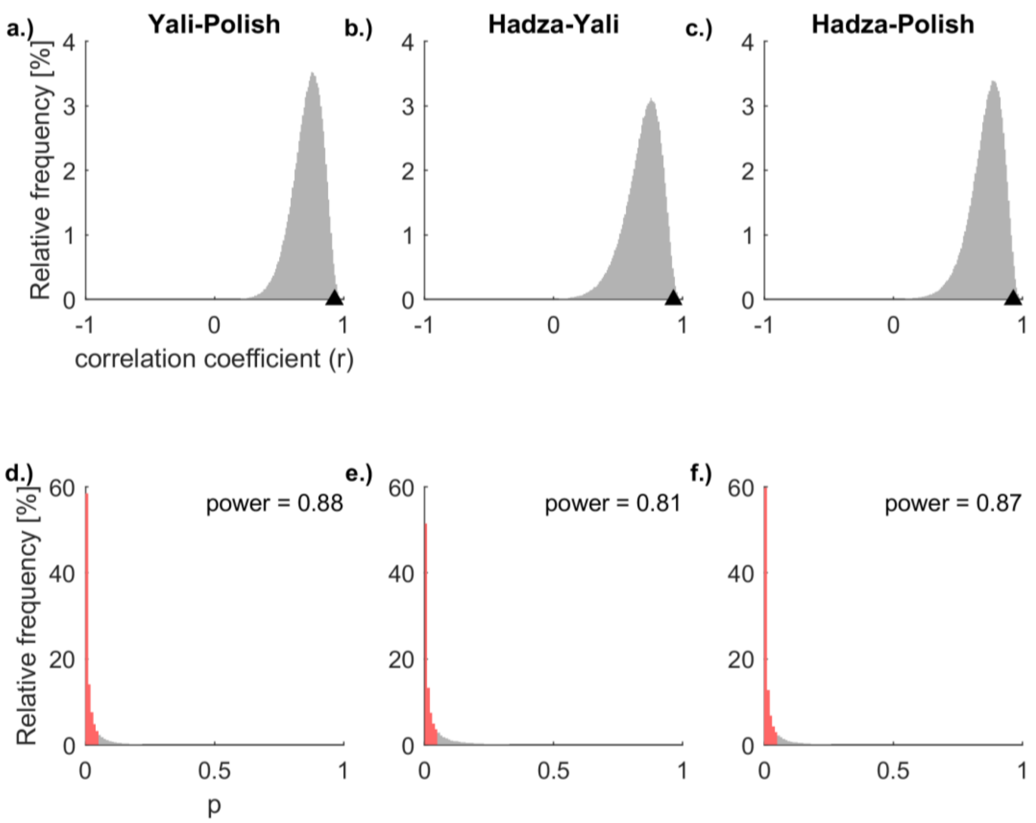

Figure S3. Power estimations. The graphics show the result of correlations between random multinomial distributions with probabilities that assume the sexual contrasts observed in Yali and Polish observers. The upper row shows the relative frequencies of correlation coefficients, the lower row those for the corresponding p-values. The black triangle in the upper row indicates the correlation coefficient observed in between the sexual contrasts of Yali and Polish observers ($r = 0.93$). The red part of the histogram in the lower row indicates significant p-values (i.e. $p < 0.025$ for two-tailed alpha of 0.05) and corresponds to the power, which is reported in the upper right corner.