Variance & Homogeneity of Facial Trait Space Across World Regions

PSA001 Secondary Data Analysis Challenge

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This report is part of the Psychological Science Accelerator (PSA) secondary analysis challenge. We investigated how the facial ‘trait space’ shifts across countries and world regions, using PSA_001 data [osf.io/f7v3n]. The face-trait space is conceptualized as a correlation matrix of weighted relationships (i.e., correlations) between traits that are commonly spontaneously inferred from faces (Over & Cook, 2018; Stolier, Hehman, & Freeman, 2018; Stolier, Hehman, Keller, et al., 2018). For example, if the traits ‘caring’ and ‘friendly’ are more strongly associated than ‘caring’ and ‘strong’, then the former trait-pair has more weight.

Different cultures give rise to different psychological contexts that may influence the impression formation process. As a consequence of cultural learning, perceivers’ conceptual representations of faces may become associated with particular traits due to correlated face-trait experiences. For example, to the extent that facial features associated with ‘caring’ are also associated with ‘strong’ in a particular culture, these associations may serve as templates in guiding trait impressions of various targets.

Given that cultural experiences vary across countries, here we examine how the face-trait space shifts (i.e., becoming more or less ‘intercorrelated’) across various countries. Additionally, we examine whether these shifts can be systematically explained by perceiver and target characteristics (e.g., race, gender). Our analyses and R code are preregistered at [osf.io/3tz7x].

Corrections to R code since preregistration

April 26, 2020 – Fixed critical coding error on lines 122, 163, and 197:

- Changed every instance of `unlist(attachme)` to `as.matrix(attachme)`
- Critical error because the `unlist()` function does not produce anova results (no way to distinguish between different levels of a factor) (!!)

April 26, 2020 – Changed line 157 to update the # of countries in the dataset (`0:28` to `0:42`)

- countries were only included if ratings were collected on all 13 traits, so many countries were excluded from this analysis in the exploratory segment

Unfortunately, the R code published prior to the release of the confirmatory dataset contained errors. To ensure reproducibility, both the original version of the R file and the fixed versions are available on OSF. Results tables from R will be reported with both original and fixed versions for the purposes of this data analysis challenge.

Analysis 1: Does the face-trait space vary across world regions?

In this preliminary analysis, we statistically compared face-trait matrices across world regions. To structure the data, we created a 13 x 13 trait correlation matrix for each of the 11 world regions, aggregating across participants and targets (i.e., stimuli). See Figure 1. After removing repeated trait-pair correlations (i.e., from the upper diagonal), we converted each matrix to a single column vector, producing 78 unique trait-pair correlations x 11 regions. Values were Fisher-z transformed to allow for comparison across world regions. A one-way repeated measures anova was conducted to examine whether the average trait-pair correlation differed significantly across world regions.

Figure 1. Pearson correlation matrices for trait impressions of faces per world region (full dataset). “X” denotes a non-significant relationship at $\alpha = .05$. Matrices are sorted using hierarchical clustering order.

Exploratory results. In the exploratory dataset, results from the one-way repeated measures anova indicated that the inter-correlations between trait-pairs were not equal across world regions, $F(2.70, 207.78) = 4.30, p = .008$. Greenhouse-Geisser corrected ($\epsilon = .270$).

Confirmatory results. This difference replicated in the full dataset, $F(4.31, 332.04) = 3.53, p = .002$ ($\epsilon = .431$), indicating that face-trait spaces differ across world regions.

Exploratory results, fixed R code:

```
> summary(blargh)
```

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	11.5701	1	324.48	77	2.7457	0.1016
v1	1.5331	10	27.47	770	4.2967	7.417e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.26984	0.007627 **

Exploratory results, original preregistered R code (with errors):

```
> blargh <- Anova(regmodel, idata=factorcodes, idesign =~ v1, type="III")
```

```
> blargh  
Anova Table (Type III tests)
```

Response: cbind(unlist(attachme))

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	11.57	1	28.051	1.503e-07 ***
Residuals	353.48	857		

Confirmatory results, fixed R code:

```
> blargh
```

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	18.7640	1	492.92	77	2.9311	0.09091 .
v1	1.0079	10	18.37	770	4.2250	9.807e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.43122	0.001797 **

Confirmatory results, original preregistered R code (with errors):

```
> blargh  
Anova Table (Type III tests)
```

Response: cbind(unlist(attachme))

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	36.44	1	99.409	< 2.2e-16 ***
Residuals	1229.03	3353		

Analysis 2: Does the face-trait space vary across *countries*?

The same analysis is applied at the country level. Due to the data structure, countries were excluded from analysis if ratings were missing on any of the 13 traits collected. Many countries were excluded from the exploratory analysis, because stratification of the exploratory and confirmatory datasets was not initially designed to satisfy this requirement. Thus, analyses were conducted on 29 countries in the exploratory dataset and 43 in the full dataset.

Again, a one-way repeated measures anova was conducted on Fisher-z transformed trait-pair correlations to examine whether the face-trait space differed significantly across countries.

Exploratory results. As expected, results from the one-way repeated measures anova indicated that the inter-correlations between trait-pairs were not equal across countries, $F(3.91, 301.02) = 3.20, p = .014$. Greenhouse-Geisser corrected ($\epsilon = .140$).

Confirmatory results. This difference replicated in the full dataset, $F(3.34, 257.11) = 2.65, p = .04$ ($\epsilon = .0795$), indicating that face-trait spaces differ across world regions. However, given that the G-G corrected p-value is close to .05 given such a large dataset, we suspect that the effect of the overall difference in face-trait space across countries is small.

Exploratory results, fixed R code (29 countries):

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	13.962	1	435.17	77	2.4705	0.1201
v1	4.288	28	103.12	2156	3.2018	3.563e-08 ***

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.13962	0.01419 *

Confirmatory results, fixed R code (43 countries):

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	36.438	1	1055.29	77	2.6587	0.1071
v1	5.785	42	167.95	3234	2.6521	4.991e-08 ***

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.079503	0.04322 *

Analysis 3: Does the face-trait space vary across target race and gender (ignoring regional differences)?

Replication of previous work (Xie, Flake, Stolier, Freeman, & Hehman, under review) examining whether the face-trait space generalizes across targets of different race and gender. Here, a two-way repeated measures ANOVA was conducted on 8 different trait matrices, in a 2 (Target Gender: Female, Male) $\times$ 4 (Target Race: White, Black, East Asian, Latinx) design.

Figure 2. Pearson correlation matrices for trait impressions of faces across race and gender (full dataset). “X” denotes a non-significant relationship at $\alpha = .05$. Matrices are sorted using hierarchical clustering order based on the ‘white male’ matrix.

Exploratory results. Results from the two-way repeated measures anova indicated that the inter-correlations between trait-pairs were not equal across race and gender. There was a main effect of gender, $F(1,77) = 7.24, p = .009$ but no significant main effect of race, $F(1.95, 149.98) = 1.84, p = .163$, qualified by a significant interaction between race and gender $F(2.52, 194.09) = 4.10, p = .011$.

Confirmatory results. These findings replicated in the full dataset. There was a main effect of gender, $F(1,77) = 7.93, p = .006$, but no main effect of race, $F(1.94, 149.06) = 1.56, p = .215$, qualified by a significant race–gender interaction $F(2.37, 182.22) = 4.14, p = .013$. Results indicated that, on average, the associations between different pairs of trait ratings (e.g., competent, attractive) differ across groups as a function of race and gender.

Exploratory results (fixed R code)

V1 = race, V2 = gender

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	25.6941	1	538.22	77	3.6759	0.058915 .
v1	0.6866	3	28.71	231	1.8413	0.140399
v2	0.9341	1	9.94	77	7.2382	0.008748 **
v1:v2	1.1035	3	20.70	231	4.1039	0.007313 **

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.64927	0.16321
v1:v2	0.84021	0.01134 *

Confirmatory results (fixed R code)

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	29.7094	1	577.08	77	3.9641	0.050027 .
v1	0.5859	3	29.00	231	1.5555	0.200985
v2	1.0270	1	9.97	77	7.9348	0.006158 **
v1:v2	1.1600	3	21.59	231	4.1366	0.007003 **

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v1	0.64527	0.21506
v1:v2	0.78885	0.01262 *

Analysis 4: Does the face-trait space vary across target and perceiver race and gender (ignoring regional differences)?

Similar to Analysis 3, here we additionally incorporated perceiver gender in the model (ignoring regional differences). Perceiver race was excluded because ethnicity was collected as an open-ended response in the demographic survey. A three-way repeated measures ANOVA was conducted on 16 different trait matrices, in a 2 (Target Gender: Female, Male) $\times$ 2 (Perceiver Gender: Female, Male) $\times$ 4 (Target Race: White, Black, East Asian, Latinx) design.

Exploratory results. Similar to Analysis 3, we found a main effect of target gender, $F(1,77) = 8.43$, $p = .005$, qualified by a significant two-way interaction between target and perceiver gender, $F(2.37,182.14) = 3.21$, $p = .035$, and a significant three-way interaction between target gender, perceiver gender, and target race, $F(2.65,204.03) = 11.73$, $p < .001$. However, the main effects of perceiver gender and target race were not significant ($ps > .12$).

Confirmatory results. These findings replicated in the full dataset. The face-trait space differed significantly as a function of target gender, $F(1,77) = 10.00$, $p = .002$, qualified by a two-

way interaction between target and perceiver gender, $F(2.28, 175.82) = 3.21$, $p = .024$, as well as a three-way interaction between target gender $\times$ perceiver gender $\times$ target race, $F(2.65, 204.03) = 11.73$, $p < .001$.

Exploratory results (fixed R code)

V1 = perceiver gender

V2 = target gender

V3 = target race

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	48.791	1	968.00	77	3.8811	0.052429 .
v1	0.005	1	8.11	77	0.0463	0.830190 .
v2	1.779	1	16.25	77	8.4298	0.004814 **
v3	1.554	3	55.62	231	2.1515	0.094534 .
v1:v2	0.001	1	2.28	77	0.0462	0.830357 .
v1:v3	0.143	3	4.19	231	2.6229	0.051369 .
v2:v3	1.558	3	37.39	231	3.2080	0.023878 *
v1:v2:v3	0.512	3	3.36	231	11.7325	3.497e-07 ***

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v3	0.65757	0.12055
v1:v3	0.86972	0.05981 .
v2:v3	0.78850	0.03473 *
v1:v2:v3	0.88324	1.387e-06 ***

Confirmatory results (fixed R code)

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	58.721	1	1104.38	77	4.0942	0.046502 *
v1	0.063	1	3.84	77	1.2557	0.265943
v2	2.349	1	18.08	77	10.0020	0.002238 **
v3	1.230	3	58.54	231	1.6173	0.186087
v1:v2	0.029	1	1.18	77	1.9144	0.170474
v1:v3	0.061	3	3.30	231	1.4132	0.239627
v2:v3	2.121	3	42.53	231	3.8409	0.010358 *
v1:v2:v3	0.109	3	1.57	231	5.3793	0.001349 **

Greenhouse-Geisser and Huynh-Feldt Corrections
for Departure from Sphericity

	GG eps	Pr(>F[GG])
v3	0.63709	0.202968
v1:v3	0.82737	0.243941
v2:v3	0.76112	0.018641 *
v1:v2:v3	0.88823	0.002157 **

Analysis 5: Does the face-trait space vary across own- vs. other-race and target gender (ignoring world regions)?

The goal of this analysis was to dig deeper into the interaction between race and gender, and explore any own- vs. other-race patterns in the data that may be interacting with gender. We took a stab at coding open-ended responses to the ethnicity demographic question to build a variable for perceiver race. We examined responses (in the exploratory segment only) with a frequency greater than 1, and only retained responses that could be categorized as White, Black, East Asian, or Latinx (to match the target race codes), resulting in 65 unique responses to the ethnicity question that met this criteria. The coding scheme is available on osf [osf.io/3tz7x].

After building a target race variable, we conducted a two-way repeated measures anova, in a 2 (Target Gender: Female, Male) $\times$ 2 (Perceiver $\times$ Target race: Own- vs. Other-race) design.

Figure 3. Pearson correlation matrices for female and male own- vs. other-race targets.

Exploratory results. We found no significant main effect for own- vs. other-race ($p = .095$), nor any significant interaction ($p = .488$) between target gender and own- vs. other-race perceptions. Target gender was significant as expected, $F(1,77) = 8.42$, $p = .005$.

Confirmatory results. Again, we found no significant main effect for own- vs. other-race ($p > .056$), nor any significant interaction ($p = .616$). As expected, target gender had a significant effect on the intercorrelatedness of the face-trait space, $F(1,77) = 6.81$, $p = .011$.

Exploratory analysis

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	3.8020	1	117.055	77	2.5010	0.117873
v1	0.3924	1	10.556	77	2.8620	0.094741 .
v2	0.2702	1	2.472	77	8.4181	0.004842 **
v1:v2	0.0080	1	1.265	77	0.4852	0.488192

Confirmatory analysis

Univariate Type III Repeated-Measures ANOVA Assuming Sphericity

	Sum Sq	num Df	Error SS	den Df	F value	Pr(>F)
(Intercept)	6.4523	1	173.001	77	2.8718	0.09418 .
v1	0.2245	1	4.609	77	3.7508	0.05645 .
v2	0.2549	1	2.883	77	6.8083	0.01090 *
v1:v2	0.0027	1	0.803	77	0.2543	0.61550

Analysis 6: Does the face-trait space vary across target race and gender across world regions?

In this final analysis, we incorporate analyses 1-4 into a multilevel/mixed-effects model, examining to what extent the face-trait space differs across target race and gender, while estimating variance in the face-trait space across world regions. This model can be expressed as follows:

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}\text{TarRace}_{ij} + \beta_{2j}\text{TarGen}_{ij} + \beta_{3j}\text{TarRace}_{ij}\text{TarGen}_{ij} + R_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + U_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

$$\beta_{2j} = \gamma_{20}$$

$$\beta_{3j} = \gamma_{30}$$

The level-1 unit of analysis (Y_{ij}) is a Fisher- z transformed trait-pair correlation between any two traits (e.g., warm, caring), aggregated across perceivers and targets. The average trait-pair correlation, γ_{00} , is estimated, as well as the random variance around this average across world regions. Target race and gender and their interaction are entered as level-1 predictors, where γ_{10} is the fixed effect of target race on the face-trait space, γ_{20} is the fixed effect of target gender, and γ_{30} is the fixed effect of their interaction.

Exploratory results. First, the average trait-pair correlation between any two given traits did not vary much across world regions (*region-ICC* = .004). East Asian female was arbitrarily selected as the reference group based on factor names. Among female targets, we found a significant but small difference in the intercorrelatedness of the face-trait space between East Asian, Latinx, and White targets. Facial trait impressions of Latinx women were slightly more unidimensional (i.e., intercorrelated) than impressions of East Asian women ($b = .04$, $t(6846) = 2.28$, $p = .023$). In contrast, impressions of White women were slightly less unidimensional (i.e., more differentiated) than impressions of East Asian women ($b = -.03$, $p = .034$). There were no significant differences in the intercorrelatedness of the face-trait space between East Asian and Black women.

Between East Asian women and men, the face-trait space was slightly more unidimensional for East Asian men ($b = .03$, $p = .002$). Among male targets, the face-trait space was more unidimensional for Black men than East Asian men ($b = .05$, $p = .009$), less unidimensional for Latinx men than East Asian men ($b = -.04$, $p = .018$). There were no significant differences in the intercorrelatedness of the face-trait space between East Asian and White men. Standard errors for all regression coefficients were $< .02$.

Confirmatory results. Again, the average trait-pair correlation between any two given traits did not vary much across world regions (*region-ICC* = .001). East Asian female was the

reference group. Among female targets, the difference between East Asian and Latinx women was no longer significant ($b = 2.71, p = .14$). However, the difference between East Asian and White women replicated ($b = -.04, p = .022$), indicating that impressions of White women are less unidimensional and more differentiated than those of East Asian women.

Differences between East Asian women and men replicated ($b = .03, p = .001$), as did results among male targets only. Specifically, the face-trait space was more unidimensional for Black men than for East Asian men ($b = .06, p = .002$), and more differentiated for Latinx men than for East Asian men ($b = -.04, p = .020$).

Exploratory analysis

```
> summary(mlmTargetdemos)
Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']
Formula: correlation ~ 1 + stim_ethnicity * stim_gender + (1 | region)
Data: mlmTar_matrix
REML criterion at convergence: 15467.9
Scaled residuals:
    Min       1Q   Median       3Q      Max
-2.89739 -0.82156  0.08354  0.79305  2.87680

Random effects:
Groups   Name              Variance Std.Dev.
region   (Intercept)  0.002109 0.04592
Residual                    0.552645 0.74340
Number of obs: 6864, groups: region, 11

Fixed effects:
              Estimate Std. Error      df t value Pr(>|t|)
(Intercept)   1.335e-01  1.650e-02 1.000e+01  8.092 1.07e-05 ***
stim_ethnicity1 -1.865e-02  1.554e-02  6.846e+03 -1.200  0.23015
stim_ethnicity2  3.542e-02  1.554e-02  6.846e+03  2.279  0.02267 *
stim_ethnicity3 -3.281e-02  1.554e-02  6.846e+03 -2.111  0.03480 *
stim_gender1    2.764e-02  8.973e-03  6.846e+03  3.080  0.00207 **
stim_ethnicity1:stim_gender1  4.045e-02  1.554e-02  6.846e+03  2.603  0.00927 **
stim_ethnicity2:stim_gender1 -3.663e-02  1.554e-02  6.846e+03 -2.357  0.01844 *
stim_ethnicity3:stim_gender1 -5.060e-03  1.554e-02  6.846e+03 -0.326  0.74473
```

Confirmatory analysis

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']
Formula: correlation ~ 1 + stim_ethnicity * stim_gender + (1 | region)
Data: mlmTar_matrix
REML criterion at convergence: 17774.7
Scaled residuals:
    Min       1Q   Median       3Q      Max
-2.7676 -0.8639  0.1159  0.8174  2.6686

Random effects:
Groups   Name              Variance Std.Dev.
region   (Intercept)  0.0006907 0.02628
Residual                    0.7745748 0.88010
Number of obs: 6864, groups: region, 11

Fixed effects:
              Estimate Std. Error      df t value Pr(>|t|)
(Intercept)   1.713e-01  1.325e-02 1.000e+01 12.924 1.45e-07 ***
stim_ethnicity1 -1.339e-02  1.840e-02  6.846e+03 -0.728  0.46667
stim_ethnicity2  2.707e-02  1.840e-02  6.846e+03  1.471  0.14122
stim_ethnicity3 -4.231e-02  1.840e-02  6.846e+03 -2.300  0.02150 *
stim_gender1    3.379e-02  1.062e-02  6.846e+03  3.181  0.00148 **
stim_ethnicity1:stim_gender1  5.799e-02  1.840e-02  6.846e+03  3.151  0.00163 **
stim_ethnicity2:stim_gender1 -4.269e-02  1.840e-02  6.846e+03 -2.320  0.02038 *
stim_ethnicity3:stim_gender1 -8.802e-03  1.840e-02  6.846e+03 -0.478  0.63240
```