Nature and evoked culture: sex differences in personality are uniquely correlated with ecological stress.

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Abstract

Sex differences in personality were found to be larger in more developed and more gender-equal societies. However, the studies that report this effect either have methodological shortcomings or do not take into account possible underlying effects of ecological variables. Here, a large, multinational (N = 867,782) dataset of personality profiles was used to examine sex differences in Big Five facet scores for 50 countries. Gender differences were related to estimates of ecological stress as well as socio-cultural variables. Using a regularized partial-correlation approach, the unique associations of those correlates with sex differences were isolated.

Sex differences were large (median Mahalanobis' D = 1.97) and varied substantially across countries (range 1.49 to 2.48). Global sex differences are larger in more developed countries with higher food availability, less pathogen prevalence, higher gender equality and an individualistic culture. However, after controlling for confounds, only historic pathogen prevalence, food availability and cultural individualism remained. Sex differences in personality are uniquely correlated to ecological stress. Previously reported correlations between greater sex differences and outcomes of gender equality could be due to confounding by influences of ecological stress.

Keywords: personality; sex differences; measurement; pathogens; culture; ecological stress

Introduction

Since the beginning of psychometric personality assessment, sex differences in personality inventories have been reported. Meta-analytic findings on these differences on normative data sets and the empirical literature reported by Feingold in 1994 (Feingold, 1994) suggested that these differences are robust and constant across age, year of data collection, education and nations. A large multinational study later challenged these findings (Costa, Terracciano, & McCrae, 2001). While essentially replicating the magnitude and robustness of sex differences in personality, the authors found larger sex differences in western cultures with higher gender equality. The authors concluded that these findings contradict sociological, gender role-based explanations for sex differences, calling for more multifactorial explanations. Other predictors of larger sex differences in personality were proposed by Schmitt, Realo, Voracek and Allik (2009). In a sample of subjects from 55 nations, the authors reported larger sex differences in more developed countries. It was hypothesized that these findings can be explained by the fact that there is a general biological trend to stronger sexual dimorphism in environments that are rich in resources. As time progressed, the samples of studies adding to these finding became larger. Lippa (2010) reported a negative correlation between UN gender development indices and sex differences in the personality trait “Agreeableness”. This places personality variables in line with other, more biological measures like systolic blood pressure, which also shows greater sex differences in more developed countries (Hottenga et al., 2005). Most recently Mac Giolla and Kajonius (2018) reported a strong, positive correlation between overall sex differences in

personality and the Global Gender Gap Index, providing even further evidence. These findings add to the general pattern known as the “Gender Equality Paradox”: despite societal and political interventions to increase gender equality in many western countries, it is exactly these countries that show the strongest underrepresentation of girls and women in scientific, technological, engineering and mathematics (STEM) professions. Recently, it was shown that more women are represented in STEM fields in countries with less gender egalitarian policies (Stoet, 2018). Another recent study reported that sex differences in physically aggressive behavior are larger in societies with greater gender equality (Nivette, Sutherland, Eisner, & Murray, 2018). According to these results, the surprising link between gender equality and greater differences in several variables can be regarded as being well investigated and replicated.

While the robustness of sex differences in personality was demonstrated clearly, studies attempting to explain the correlation of the magnitude of differences with gender equality have suffered from various methodological shortcomings. First, they either did not differentiate between measures for gender equality and overall development or used measures that confound development and gender equality. While indices for both variables correlate to some degree, this relation is by no means perfect. There are highly developed and wealthy countries with low levels of gender equality, like Saudi-Arabia or South Korea. Conversely, countries with relatively low development can surpass Western countries in terms of gender equality, like Uganda.

Second, many studies have used the five factors model of personality ("Big Five", Goldberg, 1993) to study sex differences. Those five broad domains can be divided into facets or aspects that can in turn show divergent sex differences. For example, the personality domain of “Openness” can be divided into six aspects. Women score higher for

the aspects “Openness to feelings” and “Aesthetic interests”, while men score higher for “Openness to ideas” (Weisberg, DeYoung, & Hirsh, 2011). If studied on the broad domain level, these differences would balance each other out.

Thirdly, most studies do not adequately address psychometric challenges in the measurement of personality. It has been argued by individual differences researchers (Del Giudice, 2009; Del Giudice & Booth, 2012) that personality scores should be studied as latent variables that are estimated under the assumption of measurement invariance. This should ensure that the same constructs are measured in the compared groups. Sex differences are best represented by comparison along multiple variables. For example, differences between men and women in facial morphology are represented by many aspects like facial width, eye size or eyebrow thickness. Human personality is a multidimensional construct as well. While sex differences in personality measures tend to be rather small when considering one facet at a time, these differences can add up to a remarkably large overall difference when taking into account differences among many variables.

Apart from these methodological issues, the exact mechanism behind the association of gender equality with greater sex differences remains unclear. Some authors seem to assume a direct link between gender equality and sex differences. For example, Mac Giolla and Kajonius (2018) speculated that “as gender equality increases both men and women gravitate towards their traditional gender roles“. However, in the last ten years many studies have stressed the role of ecological influences in the emergence of sex differences. For example, variation in gender equality was preceded by changes in the prevalence of infectious disease in a longitudinal study in the USA and the United Kingdom (Varnum & Grossmann, 2016). This was also found cross-culturally for individualism-collectivism

(Fincher, Thornhill, Murray, & Schaller, 2008), as well as the Big Five personality factors "Extraversion" and "Openness" (Thornhill, Fincher, Murray, & Schaller, 2010).

In his comprehensive discussion of the empirical literature, Schmitt (2015) proposed that despite their universality, the full expression of psychological sex differences is mediated by environmental stress like hunger and disease, as well as by restrictive socio-cultural practices. This is supported by more recent studies that that found to influence outcomes of gender equality that need to be taken into account to properly address possible confounding.

In this study, a large, multi-national dataset of 30 personality facet scores based on the Big Five will be used to study sex differences. Latent scores with measurement invariance constraints will be estimated to get a more accurate representation of these differences. A multivariate effect size measure, Mahalanobis' *D*, will be used to estimate overall sex differences in personality for every country. *D* can be interpreted like Cohen's *d*, as both metrics represent standardized differences between two points of central tendency. However, *D* takes into account differences in several variables and their intercorrelations and provides a measure of distance between two centroids in a multi-dimensional space.

To determine the contribution of well-known correlates of sex differences in personality, countries' *D* scores will then be associated with indicators of environmental stress, cultural individualism, gender equality and economic development. Based on the existing literature, high correlations between these variables are assumed. It can be hypothesized that sex differences in personality are also greater in countries with low environmental impact, greater gender equality and more cultural individualism. However, little is known about the unique influences of these variables. By estimating regularized

partial correlations (Epskamp & Fried, 2016), the unique contributions of these different, highly correlated variables to the emergence of sex differences in personality will be isolated.

Methods

Dataset and Operationalization

Measures of personality facets. The IPIP-NEO is a personality inventory based on the Five Factor Model of personality (FFM). It was constructed from the International Personality Item Pool (IPIP) to match the scales of the NEO Personality Inventory (Costa & McCrae, 1992). It is available as a 120-item and a 300-item version. Both versions were found that to correlate highly with those of the NEO-PI, while their reliabilities and validities were shown to be superior to the original (Johnson, 2014). Each of the five broad factor scales comprise six "facet" scales. The five factor scales are Neuroticism (facet scales: Anxiety, Anger, Depression, Self-consciousness, Immoderation and Vulnerability), Extraversion (Friendliness, Gregariousness, Assertiveness, Activity level, Excitement seeking, Cheerfulness), Openness (Artistic interests, Emotionality, Adventurousness, Intellect, Liberalism), Agreeableness (Trust, Morality, Altruism, Cooperation, Modesty, Sympathy) and Conscientiousness (Self-efficacy, Orderliness, Dutifulness, Achievement-striving, Self-discipline and Cautiousness).

Personality Data. Two large datasets were acquired from a public repository (Johnson, 2015) that were used for the development of the IPIP-120 (Ns = 307,313 and 619,150). Both samples were collected in an online survey (Johnson, 2014). According to Johnson (2014) these datasets were placed "in the public domain for analyses by interested members of the personality research community". These datasets contain cases of item responses to the 120 and 300 items version of the IPIP-NEO that were collected in the years 2001 to 2011. Both datasets were combined into one set (N = 867,782), retaining only the

items of the 120-item version and subjects from countries with at least 500 participants. Additionally, the dataset contains demographic information on age, sex, country of residence and the date of assessment. Only subjects who specified an age between 16 and 90 were included.

Ecological stress. The two most prominent sources of ecological stress are lack of nutrition and disease. Since the effect of ecological stress unfolds only after one generation (Nettle, 2009; Varnum & Grossmann, 2016), both historical estimates, preceding the collection of personality data by several decades, and contemporary estimates were included in the analysis. As a measure for the availability of nutrition, the per-capita calorie consumption for the included countries was obtained (Food and Agriculture Organization of the United Nations, 2018). Data represent the estimated amount of food energy available for human consumption measured in calories based on a country's domestic food supply available for utilization. A historic per capita calorie consumption estimate was calculated by averaging the estimates for the years 1961 to 1973 and a contemporary estimate by averaging years 2001 to 2011. Disease prevalence was measured by data provided by Fincher, Thornhill, Murray and Schaller (2008). In this dataset, the historical pathogen prevalence was estimated on the basis of historical infectious disease atlases published between 1944 and 1961 and other historical information. Contemporary prevalence was obtained from the GIDEON database on infectious diseases. The measure consists of prevalence scores for seven classes pathogens (leishmanias, trypanosomes, malaria, schistosomes, filariae, spirochetes and leprosy) that were summed to a composite score of global pathogen stress.

Gender Inequality. Since 2006, the World Economic Forum publishes annual reports called *Global Gender Gap Report*. These reports report on 14 key indicators (e.g. salaries,

enrollment in higher education, life expectancy, public office positions) in which men and women differ. Data on these key indicators are aggregated to an overall value of gender inequality: The Global Gender Gap Index (GGGI). This index can theoretically reach from 0 to 1, where 0 would indicate total inequality and 1 total parity. GGGI scores for the years 2006 to 2011 were obtained from publicly available reports at weforum.org. To account for possible changes in GGGI during the assessment period, an average GGGI was calculated from individual years' indices.

Individualism-collectivism. Estimates for cultural individualism were taken from Hofstede's multinational IBM study (Hofstede, 2001). They are based on factor analyses of surveys from 110,000 employees from 76 countries that were first conducted in the 60s and 70s and continuously replicated by other researchers (Hofstede, Hofstede, & Minkov, 2010). Countries that are high in individualism expect people to only care of themselves and their families, while low individualism is found in countries with tightly-knit social frameworks and strong group orientation. Individual countries' values can be retrieved from an online database available at www.hofstede-insights.com/product/compare-countries/.

General Human Development. As an indicator for general economic development of a country, the Human Development Index (HDI) was obtained from the World Development Indicators database (United Nations, 2018). The HDI is a composite index of life expectancy, education, and per capita income indicators. In theory, it can range from 0 (lowest human development) to 1 (highest human development). Values from 2001 to 2011 were obtained and averaged.

Missing data. Single missing values in any of these variables were imputed by averaging the values of neighbor countries. This was done for 18 out of 350 values.

Data Analysis

Latent Personality Variable Estimation. Following the guidelines for studying sex differences in psychological constructs proposed by Del Giudice et al. (2012), latent mean scores were used instead of observed scale scores. These latent scores were estimated using a procedure called multi-group covariance and mean structure analysis (MG-CMSA). In this procedure, several structural equation models with a series of invariance constraints are estimated for scales. The invariance constraints include an equal pattern of factor loadings (configural invariance), the degree of factor loadings (metric invariance) and the intercepts of indicators (scalar invariance). When comparing sex differences, invariance between male and female participants is tested. If the model fit does not decrease significantly while placing additional constraints on the model, measurement invariance is assumed. When testing measurement invariance, cut-offs were chosen as proposed by Booth and Irwing (2011), who tested invariance for the 16-PF personality inventory. Changes of less than 0.01 for CFI, 0.013 for RMSEA and -.008 for NNFI were considered indicators for invariance.

A random sample (N=15000) was drawn from the data set to conduct confirmatory factor analysis. Models with increased equality constraints were fit as described above. Maximum likelihood estimators with robust (Huber-White) standard errors (MLR) were used due to substantial non-normality of the data. Scores for the 30 latent constructs were then estimated for the whole sample from the model with scalar invariance. Missing answers to individual items were rare (less than 0.01%) and were replaced by the item mean prior to latent variable estimation. This step was necessary because latent variable estimation was only possible for complete cases. No cross-loadings or correlated errors were estimated.

The latent variable means of the first group (male subjects) were fixed to zero, so that the means of the second sample (female subjects) represent standardized mean difference

scores (Cohen's *d*). The focus of this study was an accurate assessment of overall sex differences along the big five facets. For reasons discussed before, the multivariate generalization of Cohen's *d*, Mahalanobis' *D*, was calculated for mean differences along all 30 facets measured by the IPIP-120. 95% confidence intervals were calculated using Reiser's exact method. Both Cohen's *d* and Mahalanobis' *D* scores were bias-corrected.

In addition, two heterogeneity coefficients for *D* scores were calculated: the revised heterogeneity coefficient (H_2) and the revised "Equal Proportion of Variables" (EPV_2) value (Del Giudice, 2017, 2018). These coefficients indicate whether only a small set of variables contributes to the overall *D* score, or if contributions are evenly distributed among all variables. For the EPV, a cutoff of less than .20 has been proposed to indicate high heterogeneity while for H, values above .80 are to be interpreted similarly. To ensure reproducibility, datasets and code to perform all steps of analysis is provided in the online supplement available at: https://osf.io/9kpc5/

Ecological and socio-cultural correlates. In this study, multiple possible explanatory variables are tested for their association with sex differences in personality. A weighted bivariate correlation matrix was calculated for all eight variables. The square root of the sample size for every country was used as a weight. This way, unequal sample sizes were accounted for while not giving excess weight to very large subsamples. To isolate unique associations between these variables, this matrix was then converted to a regularized partial correlation matrix using EBICglasso regularization (Epskamp & Fried, 2016; Friedman, Hastie, & Tibshirani, 2008). This approach controls every correlation for every other variable in the correlation matrix. Next, the number of correlations is reduced to such an extent that the entire covariance can be explained as sparingly as possible.

Results

Fit statistics for all estimated CFA models are summarized in Table 1. The model was tested for measurement invariance. Scalar measurement invariance was achieved with only minimal loss of model fit. Constraining latent covariances did not significantly decrease model fit either, so pooling of male and female latent correlation matrices while performing Mahalanobis' *D* calculation can be justified.

Table 1. Model fit statistics for measurement invariance analysis.

Model	x^2	**df**	**RMSEA**	**SRMR**	**CFI**	**NNFI**
M1: Configural	138309.90	13170	0.035	0.056	0.847	0.835
M2: Metric	139418.30	13212	0.035	0.058	0.846	0.835
Delta M1b-M2	*1108.40*	*120*	*0.00*	*0.002*	*-0.001*	*0.00*
M3: Scalar	144454.60	13380	0.036	0.059	0.840	0.829
Delta M2-M3		*168*	*0.001*	*0.001*	*-0.006*	*-0.006*
M4: Latent covariances	145983.50	13815	0.035	0.059	0.839	0.833
Delta M3-M4	*1528,90*	*435*	*0.00*	*0.00*	*0.001*	*0.002*

Note. M1: invariance constraints on factor structure. M2: invariance constraints on factor loadings. M3: invariance constraints on loadings and intercepts. M4: invariance constraints on loadings, intercepts and latent covariances.

By convention, the CFI and NNFI should be larger than .90 to indicate "good fit", while the SRMR should be below .08 and the RMSEA below .05. Although the absolute model fit indices (RMSEA and SRMR) indicated a very good fit, the comparative indices (CFI and NNFI) did not achieve acceptable values. One explanation for this can be an RMSEA below .158 for the null model (Kenny, 2015; Kenny, Kaniskan, & McCoach, 2015). Thus, the null model was estimated. The RMSEA of this model was .09, suggesting that CFI and NNFI should be

interpreted with caution. Because the other fit measures showed good fit, the models were still accepted.

Descriptive Results

Participants were 60.02% female and 39.98% male. The mean age of the sample was 25.90 years (SD = 10.00, Median = 22 years). The mean age of female participants was 25.9 years (SD = 10.1, Median = 22 years). For male participants, the mean age was 26.0 years (SD = 9.92, Median = 22 years).

Countries' overall sex difference scores, represented as Mahalanobis' *D*, are summarized in figure 1. *D* scores ranged from 1.49 (Pakistan) to 2.48 (Russia). The global, sample-size weighted average *D* was 2.11. This corresponds to a 17.19% overlap in distributions between male and female personality scores. Heterogeneity was moderate for most countries: the weighted average H coefficient was 0.713 and the EPV was 0.310. This warranted an investigation of differences in univariate effect sizes for better interpretation of *D* scores, as high heterogeneity indicates that only a part of variables contributes to overall sex differences in personality. Univariate sex differences in personality facets were medium to small, with an averaged absolute Cohen's d of 0.250.

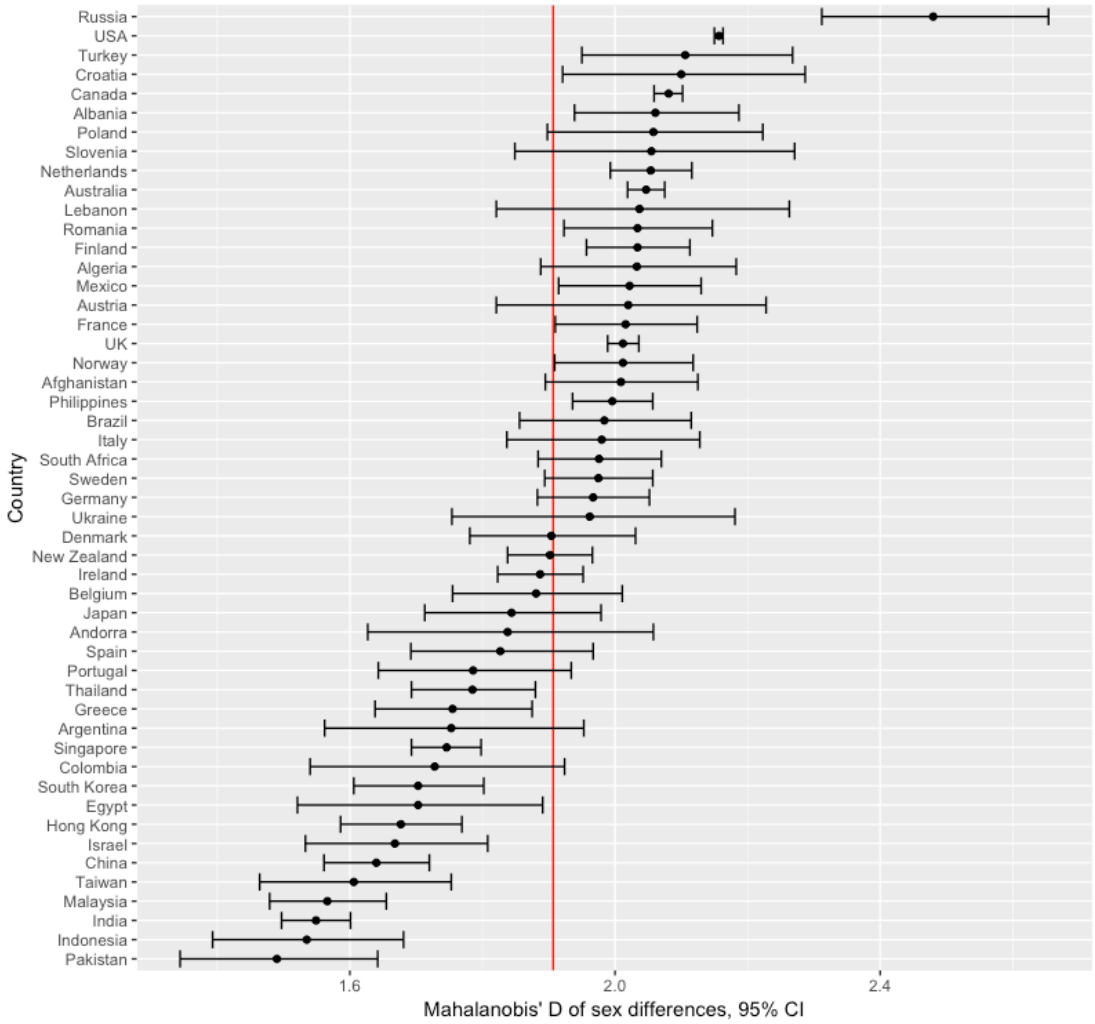

Figure 1. Multivariate sex differences in personality by country and 95% confidence intervals. The red line indicates the overall mean weighted by the square root of the sample size.

Environmental and socio-cultural contributions to sex differences.

Countries' Mahalanobis' *D* of sex differences in personality were correlated with ecological stress and socio-cultural measures. Sex differences were greater in countries with higher historic food consumption and lower in countries with historic pathogen prevalence. The findings are summarized in table 2. Significance levels were corrected for multiple comparisons using the Holm-Bonferroni method. After regularization, only four correlates were correlated with sex differences: historic and contemporary food consumption, historic pathogen prevalence and cultural individualism.

Table 2. Correlations of sex differences in personality, measures of ecological stress and socio-cultural variables.

	1	2	3	4	5	6	7	8
(1) Sex differences in personality	-		.21	-.33		.21		
(2) Historic food consumption	.54	-	.29		-.31			
(3) Contemporary food consumption	.61	.69	-		.33			.56
(4) Historic pathogen prevalence	-.69	-.71	-.68	-	.36	-.31		
(5) Contemporary pathogen prevalence	-.39	-.65	-.46	.69	-	.22		-.51
(6) Cultural individualism	.65	.65	.70	-.74	-.46	-		.18
(7) Global Gender Gap Index	.44	.50	.47	-.60	-.57	.55	-	.30
(8) HDI	.50	.68	.78	-.71	-.74	.68	.56	-

Note. N=50. Values below the diagonal are Pearson correlations. All correlations except for one marked with brackets are statistically significant, corrected $p < .05$. Values above the diagonal are regularized partial correlations. Correlations that were reduced to zero in the regularization process are omitted.

Replication of previous findings.

To check whether the results of this study replicate previous existing findings, Mahalanobis' D was correlated with the "Global Sex Difference Index" (GSDI) reported by a widely cited cross-cultural study (Schmitt et al., 2009). The GSDI is defined as the mean average sex difference of Neuroticism, Extraversion, Agreeableness and Conscientiousness and was supposed to give "an overall index of the extent to which sex differences were emphasized in a particular culture", similar to Mahalanobis' D in this study. The GSDI was available for 33

countries in the present sample. Overall sex difference scores from the two studies were significantly and moderately correlated ($r(31) = .52$, $p = .002$; Spearman's $\rho = .41$, $p = .017$).

Discussion

In a large, multinational sample of personality data, the universal nature of gender differences in personality was demonstrated again. Effect sizes of differences were large and comparable to previous studies using different personality inventories (T. Booth & Irwing, 2011; Del Giudice, 2009; Del Giudice & Booth, 2012). The national average sex differences in this study replicate previous findings fairly well, although the GSDI reported by Schmitt et al. (2009) is merely an average of univariate sex differences. Mahalanobis' D could not be calculated for these results because factor intercorrelations were not available for the subsamples.

Sex differences in personality were larger in more individualistic countries with higher food availability and lower pathogen prevalence. Effect sizes of the unregularized correlations were medium to large. After regularization, the unique correlations still represent medium to slightly above-average effects when following empirically derived guidelines for effect size interpretation in individual differences research (Gignac & Szodorai, 2016). Gender equality and cultural individualism were positively correlated with larger sex differences, thus replicating existing findings. However, the specific correlation between gender equality and sex differences was reduced to zero after regularization. This indicates that previously reported findings reporting this effect could be attributed to confounding variables and may be better explained by ecological influences. In this study, sex differences in personality showed the strongest unique associations with ecological variables, namely historic pathogen prevalence and historic food consumption. A possible explanation for this

could be that ecological influences on the development of human cultures unfold over one or more generations. For example, changes in pathogen prevalence precede shifts in gender equality by up to three decades (Varnum & Grossmann, 2017). Still, longitudinal studies are needed to validate this speculation.

The findings on correlations of sex differences with ecological variables generally provide empirical support for the theory of "facultatively-mediated sex differences" (Schmitt, 2015, p. 5) which states that sex differences develop more strongly under favorable environmental conditions because human psychology facultatively adapts to local environmental conditions. It could be that the different correlates studied here influence different aspects of human personality. For example, Kupfer and Tybur (2017) showed that high levels of agreeableness correlate with lower disgust when reacting to pathogen cues, which could be less adaptive in environments with higher pathogen prevalence. Because women score higher in agreeableness, it could be that pathogen prevalence has a stronger effect on female psychology. This speculation is supported by findings by Terrizzi, Clay and Shook (2014) who reported that females are more sensitive than men to pathogen cues and that this difference also explains sex differences in collectivism and social conservatism. On a similar note, sex differences in romantic attachment are smaller in countries with higher pathogen prevalence (Schmitt, 2011). Pathogen prevalence is also related to the formation of local rather than global cooperative networks and lower levels of openness (Brown, Fincher, & Walasek, 2016). Less is known about the effects of food availability. These differential effects could not be studied in this sample due to limitations in statistical power, but future work should examine these effects.

Individualism as a cause of psychometric sex differences in personality have been discussed in the literature (Guimond et al., 2007). The explanation for this association is

based on differences in social comparison processes. The authors concluded that in individualistic cultures, subjects tend to "self-stereotype" their personalities by making cross-gender comparisons. In more collectivistic societies, comparisons are made with members of the same sex. While the findings of this study support this hypothesis, the unique influence of ecological variables needs to be discussed.

It could be worthwhile for future studies on cross-cultural variation of sex differences to take into account ecological influences. Existing data sets could also be re-evaluated by taking ecological variables into account. Regularized partial correlations can be a suitable method for this undertaking.

Limitations

Some limitations apply to this study. First of all, personality data was obtained from a convenience sample of online questionnaires possibly causing a selection bias towards English language subjects with Internet access. This leads to an over-representation of subjects from English-speaking and more developed countries. In less developed countries, subjects with a higher level of education are likely to be over-represented. Countries with a low level of development are not represented at all because there was not data available or the sample sizes were too small. The risk of calculating distorted difference measurements was too high for them to be included in the analysis.

While personality data was collected from 2001 to 2011, the GGGI was only available for the years 2006 to 2011. Nevertheless, some personality data from previous years were included in the analysis. This incomplete overlap between data sets could have led to an underestimation of the correlation between GGGI and *D*. Future studies should fill this gap by carrying out larger personality data surveys in less developed countries. It is also

important to note that these data cannot be used to draw causal inferences about the relationship between gender equality and personality differences. Because of the purely cross-sectional, correlational approach of this study, causality cannot be established. One way to enable causal inference are large studies on personality carried out in regular intervals so that sufficient data is generated to estimate time-lagged models. This way, future studies could investigate whether changes in personality predict changes in gender equality or vice versa.

Finally, because of the limited number of countries available for analysis, this study focused on correlates known from the existing literature. Other variables that were not included in this study could contribute to the emergence of sex differences.

Conclusion

Global gender differences in personality are large and can be observed in many different cultures. The results support the hypothesis of ecologically moderated development of sex differences. Future studies should attempt to replicate these results using different data sets and measures, following the general guidelines of using multivariate effect sizes and, if necessary, using latent variable models to estimate psychological variables.

Conflicts of Interest

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References

Booth, T., & Irwing, P. (2011). Sex differences in the 16PF5, test of measurement invariance and mean differences in the US standardisation sample. *Personality and Individual*

Differences, *50*(5), 553–558. https://doi.org/10.1016/j.paid.2010.11.026

Brown, G. D. A., Fincher, C. L., & Walasek, L. (2016). Personality, Parasites, Political Attitudes, and Cooperation: A Model of How Infection Prevalence Influences Openness and Social Group Formation. *Topics in Cognitive Science*, *8*(1), 98–117. https://doi.org/10.1111/tops.12175

Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment*, *4*(1), 5–13. https://doi.org/10.1037/1040-3590.4.1.5

Costa, P. T., Terracciano, A., & McCrae, R. R. (2001). Gender differences in personality traits across cultures: Robust and surprising findings. *Journal of Personality and Social Psychology*, *81*(2), 322–331. https://doi.org/10.1037//0022-3514.81.2.322

Del Giudice, M. (2009). On the Real Magnitude of Psychological Sex Differences. *Evolutionary Psychology*, *7*(2), 147470490900700220. https://doi.org/10.1177/147470490900700209

Del Giudice, M. (2017). Heterogeneity Coefficients for Mahalanobis' D as a Multivariate Effect Size. *Multivariate Behavioral Research*, *52*(2), 216–221. https://doi.org/10.1080/00273171.2016.1262237

Del Giudice, M. (2018). Addendum to: Heterogeneity Coefficients for Mahalanobis' D as a Multivariate Effect Size. *Multivariate Behavioral Research*, 1–3. https://doi.org/10.1080/00273171.2018.1462138

Del Giudice, M., & Booth, T. (2012). The Distance Between Mars and Venus: Measuring Global Sex Differences in Personality. *PLOS ONE*, *7*(1), e29265. https://doi.org/10.1371/journal.pone.0029265

Epskamp, S., & Fried, E. I. (2016). A Tutorial on Regularized Partial Correlation

Networks. *ArXiv:1607.01367 [Stat]*. Retrieved from http://arxiv.org/abs/1607.01367

Feingold, A. (1994). Gender differences in personality: A meta-analysis. *Psychological Bulletin*, *116*(3), 429.

Fincher, C. L., Thornhill, R., Murray, D. R., & Schaller, M. (2008). Pathogen prevalence predicts human cross-cultural variability in individualism/collectivism. *Proceedings of the Royal Society B: Biological Sciences*, *275*(1640), 1279–1285. https://doi.org/10.1098/rspb.2008.0094

Food and Agriculture Organization of the United Nations. (2018). FAOSTAT Food Balance Sheets. Retrieved October 23, 2018, from http://www.fao.org/faostat/en/#data/FBS

Friedman, J., Hastie, T., & Tibshirani, R. (2008). Sparse inverse covariance estimation with the graphical lasso. *Biostatistics (Oxford, England)*, *9*(3), 432–441. https://doi.org/10.1093/biostatistics/kxm045

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences*, *102*, 74–78. https://doi.org/10.1016/j.paid.2016.06.069

Goldberg, L. R. (1993). The Structure of Phenotypic Personality Traits. *American Psychologist*, 9.

Guimond, S., Branscombe, N. R., Brunot, S., Buunk, A. P., Chatard, A., Désert, M., … Yzerbyt, V. (2007). Culture, gender, and the self: Variations and impact of social comparison processes. *Journal of Personality and Social Psychology*, *92*(6), 1118–1134. https://doi.org/10.1037/0022-3514.92.6.1118

Hofstede, G. (2001). Culture's consequences. In *Comparing values, behaviors, institutions, and organizations across nations* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). *Cultures and organizations: software of the mind ; intercultural cooperation and its importance for survival* (Rev. and expanded 3. ed). New York: McGraw-Hill.

Hottenga, J.-J., Boomsma, D. I., Kupper, N., Posthuma, D., Snieder, H., & Willemsen, G. (2005). *Heritability and Stability of Resting Blood Pressure*. 10.

Johnson, J. A. (2014). Measuring thirty facets of the Five Factor Model with a 120-item public domain inventory: Development of the IPIP-NEO-120. *Journal of Research in Personality*, *51*, 78–89. https://doi.org/10.1016/j.jrp.2014.05.003

Johnson, J. A. (2015, September 22). Johnson's IPIP-NEO data repository. Retrieved February 26, 2018, from Open Science Framework website: https://osf.io/tbmh5/

Kenny, D. A. (2015). Measuring Model Fit. Retrieved March 14, 2019, from http://www.davidakenny.net/cm/fit.htm

Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The Performance of RMSEA in Models With Small Degrees of Freedom. *Sociological Methods & Research*, *44*(3), 486–507. https://doi.org/10.1177/0049124114543236

Kupfer, T. R., & Tybur, J. M. (2017). Pathogen disgust and interpersonal personality. *Personality and Individual Differences*, *116*, 379–384. https://doi.org/10.1016/j.paid.2017.05.024

Lippa, R. A. (2010). Sex Differences in Personality Traits and Gender-Related Occupational Preferences across 53 Nations: Testing Evolutionary and Social-Environmental Theories. *Archives of Sexual Behavior*, *39*(3), 619–636. https://doi.org/10.1007/s10508-008-9380-7

Mac Giolla, E., & Kajonius, P. J. (2018). Sex differences in personality are larger in gender equal countries: Replicating and extending a surprising finding. *International Journal*

of Psychology. https://doi.org/10.1002/ijop.12529

Nettle, D. (2009). Ecological influences on human behavioural diversity: a review of recent findings. *Trends in Ecology & Evolution*, *24*(11), 618–624. https://doi.org/10.1016/j.tree.2009.05.013

Nivette, A., Sutherland, A., Eisner, M., & Murray, J. (2018). Sex differences in adolescent physical aggression: Evidence from sixty-three low-and middle-income countries. *Aggressive Behavior*. https://doi.org/10.1002/ab.21799

Schmitt, D. P. (2011). Psychological Adaptation and Human Fertility Patterns: Some Evidence of Human Mating Strategies as Evoked Sexual Culture. In A. Booth, S. M. McHale, & N. S. Landale (Eds.), *Biosocial Foundations of Family Processes* (pp. 161–170). https://doi.org/10.1007/978-1-4419-7361-0_11

Schmitt, D. P. (2015). The Evolution of Culturally-Variable Sex Differences: Men and Women Are Not Always Different, but When They Are…It Appears Not to Result from Patriarchy or Sex Role Socialization. In T. K. Shackelford & R. D. Hansen (Eds.), *The Evolution of Sexuality* (pp. 221–256). https://doi.org/10.1007/978-3-319-09384-0_11

Schmitt, D. P., Realo, A., Voracek, M., & Allik, J. (2009). "Why can't a man be more like a woman? Sex differences in big five personality traits across 55 cultures": Correction to Schmitt et al. (2008). *Journal of Personality and Social Psychology*, *96*(1), 118–118. https://doi.org/10.1037/a0014651

Stoet, G. (2018). The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education. *Psychological Science*, 0956797617741719. https://doi.org/10.1177/0956797617741719

Terrizzi, J. A., Clay, R., & Shook, N. J. (2014). Does the Behavioral Immune System Prepare Females to Be Religiously Conservative and Collectivistic? *Personality and Social*

Psychology Bulletin, *40*(2), 189–202. https://doi.org/10.1177/0146167213508792

Thornhill, R., Fincher, C. L., Murray, D. R., & Schaller, M. (2010). Zoonotic and Non-Zoonotic Diseases in Relation to Human Personality and Societal Values: Support for the Parasite-Stress Model. *Evolutionary Psychology*, *8*(2), 147470491000800. https://doi.org/10.1177/147470491000800201

United Nations. (2018). Human Development Data (1990-2017). Retrieved June 30, 2018, from Human Development Data (1990-2017) website: http://hdr.undp.org/en/data

Varnum, M. E. W., & Grossmann, I. (2016). Pathogen prevalence is associated with cultural changes in gender equality. *Nature Human Behaviour*, *1*(1), 0003. https://doi.org/10.1038/s41562-016-0003

Varnum, M. E. W., & Grossmann, I. (2017). Pathogen prevalence is associated with cultural changes in gender equality. *Nature Human Behaviour*, *1*(1), 0003. https://doi.org/10.1038/s41562-016-0003

Weisberg, Y. J., DeYoung, C. G., & Hirsh, J. B. (2011). Gender Differences in Personality across the Ten Aspects of the Big Five. *Frontiers in Psychology*, *2*. https://doi.org/10.3389/fpsyg.2011.00178