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1) Data collection. Have any data been collected for this study already?

No, no data have been collected for this study yet (as of February 7, 2019).

2) Hypothesis. What's the main question being asked or hypothesis being tested in this study?

Prejudice is an unfavorable opinion or feeling toward members of other groups prior to, or not based, on actual experience. Different groups may be target of prejudices. However, a person who is anti-homosexual is likely to be anti-immigrant or anti-atheist, leading to the concept of generalized prejudice. Generalized prejudice is relatively stable in time (Akrami et al., 2009) and may be considered as disposition. Dispositional approach to prejudice situates individual differences in generalized prejudice into the frame of other dispositions, e.g. personality. If we use Five-factor model of personality as theoretical frame than, according to the meta-analysis (Sibley and Duckitt, 2008), dimensions of openness and agreeableness are likely to correlate with prejudice. These correlations may be mediated via ideological variables of right-wing authoritarianism (RWA) and social dominance orientation (SDO), as Duckitt's and Sibley's (2009) dual-process model predicts. In a study that we are planning to conduct, we will use the twin design in order to examine the etiology of generalized prejudice and its relations with personality and ideological variables. We will use HEXACO model as a theoretical framework for personality and the measures of right-wing authoritarianism and social dominance orientation as theoretical framework for ideological variables derived from the dual-process model. We are planning to collect all data in a form of self- and peer- reports and therefore all hypotheses will be tested through the both methods of data collection. Thus, the main topics of our study and our expectations are as follows:

1) The etiology of prejudices toward specific groups and generalized prejudice (gP)

We expect that additive genetic (A), shared environmental (C), and non-shared environmental (E) influences will contribute to the individual differences in prejudices to the five specific groups, namely to the prejudices toward overweight, mentally ill, atheists, gays, and immigrants. We don't expect a significant effect of the non-additive genetic (D) effect since it was not present in previous behavioral genetic studies of attitudes. We also expect these factors to contribute to the individual differences in generalized prejudice which will be define as a general factor (*gP*) derived from the above mentioned five individual prejudices. These hypotheses will be tested via model-fitting, by comparing the standard univariate

behavioral genetic models which include E, AE, AD, ACE and ADE models. Besides that, at the level of correlations, we expect higher intraclass correlations among monozygotic than dizygotic twin pairs, and we expect that dizygotic twin pair correlations will be higher than half of the monozygotic twin correlations, indicating shared environmental influence. We expect the same pattern of influences for the both methods of data collection – self- and peer-reports. The basis for those hypotheses comes from the previous research on the heritability of behavior, including the attitudes as a phenotype (Polderman et al. 2015), as well as from the general theories of learning, e.g. social learning theory, which may explain the process involved in shared environmental contribution to the individual differences in prejudices. Also, few available studies - e.g. Croatian preliminary twin data of the self- report prejudice toward immigrants, atheists and gay peoples (Bratko et al., in preparation) and Germany twin study of the self-reported measures of prejudice toward foreign nationals, namely toward EU and non-EU groups living in Germany (Kandler et al., 2015) – also suggest the expectation of A, C and E influences to the individual differences in generalized prejudice.

2) The phenotypic and genetic/environmental overlap between prejudices toward different groups

The central concept in a planned study is generalized prejudice – a general factor (*gP*) which emerges from the shared variance of the prejudices toward different groups. We expect, in a line with a previous research in a field, that a general factor of prejudice would account for the substantial amount of the variance of the prejudice toward specific groups, namely toward overweight, mentally ill, atheists, gays, and immigrants. However, since the planned study will use genetically informative design, we will have the possibility to go beyond the analysis of phenotypic structure and to examine the etiology of the covariation between individual prejudices and to test the hypothesis about the overlap of the genetic and environmental factors which contribute to the individual differences between different prejudices. Thus, we expect that substantial part of the additive genetic and shared environmental influences will be common for the different prejudices, while non-shared environmental influences will be specific for each particular prejudice.

3) Bivariate relations of the generalized prejudice with personality and ideological variables

Based on the previous research on relations between Five-factor model of personality and generalized prejudice, we expect the phenotypic correlations of generalized prejudice with Agreeableness and Openness to experience. However, the vast majority of behavioral genetic studies in the personality domain indicates that only genetic and non-shared environmental influences contribute to the individual differences in personality traits (Vukasović & Bratko, 2015). Therefore, we expect that primary sources of influence which would contribute to the covariation between personality and generalized prejudice will come from the overlap of the additive genetic influence on these variables. The same expectation we have for the bivariate relation between generalized prejudice and ideological variables - Right-wing authoritarianism and Social dominance orientation.

4) Multivariate relations of the personality, ideological variables and generalized prejudice

At the phenotypic level we expect, in a line with the dual-process model, that relations between Openness to experience and generalized prejudice will be mediated via Right-wing authoritarianism, while eventual covariation between Agreeableness and generalized prejudice would be mediated via Social dominance orientation. Regarding the overlap between genetic and environmental effects of these personality traits, ideological variables and generalized prejudice, we expect that substantial part of the gP genetic variance will be shared with O, A, RWA, and SDO.

2) Dependent variable. Describe the key dependent variable(s) specifying how they will be measured.

This is correlational study in which the key variables are measures of prejudice. Beside five prejudice measures, the measures of the six personality dimensions and measures of two ideological variables will be used. All of these variables will be measured through the self- and peer- reports. In self- report versions the twins will be asked to assess themselves, and in peer-report versions the twins will be asked to assess their twin siblings, using the “average” persons in their social networks as a reference frame.

Measures of prejudice

We will use the self- and peer measures of prejudice toward five different groups - overweight, mentally ill, atheists, gays, and immigrants.

These prejudices will be assessed both with the self- and peer- form of prejudice scales. Self-report versions of the scales were constructed and validated in the previous studies conducted in Croatia (Matić, 2018; Matić Bojić, Low and Bratko, 2018). Each of the prejudice scale consists of 12 balanced items (e.g. ‘I would gladly become friend with an immigrant’; reverse coded), accompanied by 5-point Likert-type scale (from ‘1 – strongly disagree’ to ‘5 – strongly agree’). The items depict different cognitive, emotional and behavioral responses towards a general category of the groups which are objects of the prejudices. These scales were translated to English and German language by the four experts (two for English and two for German language). The back translated version of the instruments were evaluated by the authors of this preregistration and adjusted where that was needed. All items from the Croatian version were then changed into the form which is suitable for the assessing the other persons (peer form) and translation/back translation procedure was repeated.

Personality measures

HEXACO scales will be used as a measure of personality. HEXACO model includes the 100 items which are accompanied by the 5-point Likert-type scales. These scales are validated measures for the six personality dimensions: Extraversion, Agreeableness, Conscientiousness, Emotionality and Honesty/humility. HEXACO instruments are validated and available in all three languages. Self- and peer- report forms are available for English and German version, while Croatian peer- report version was developed by the authors of this preregistration.

Ideological variables

Right-wing authoritarianism will be assessed using a RWA³D scale by Funke (2005), which is a German version of the original Altemeyer’s (1988) RWA scale. The scale consists of 12 items (e.g. ‘What our country really needs is a strong, determined leader who will crush evil,

and take us back to our true path’) with accompanying 5-point Likert-type scale (from ‘1 – strongly disagree’ to ‘5 – strongly agree’).

Social dominance orientation will be assessed via translated version of Pratto’s, Sidanius’s, Stallworth’s and Malle’s (1994) 16-Item Social Dominance Orientation Scale. The original scale consists of 16 items (e.g. ‘Some groups of people are simply inferior to other groups.’) with accompanying 7-point Likert-type scale (from ‘1 – strongly disagree’ to ‘7 – strongly agree’), but the format of the scale for this research was modified, from original 7-point to a 5-point scale.

3) Conditions. How many and which conditions will participants be assigned to?

The twin design is essentially quasi-experimental design in which participants are not randomly assigned into the groups of monozygotic and dizygotic pairs. However, the researchers may use the fact that twinning naturally occur in, roughly, one out of the 90 - 95 deliveries. One third of these twin pairs are monozygotic, one third dizygotic same-sex, and one third dizygotic opposite-sex pairs. In a planned study we will collect the data only on the groups of monozygotic and same-sex dizygotic twin pairs. Participant’s zygosity will be determined by the self-report questionnaire which was used in a previous twin studies conducted by the first author of this preregistration.

4) Analyses. Specify exactly which analyses you will conduct to examine the main question/hypothesis.

Before the genetic modeling, twin data will be corrected for the main effect of age and gender, as well as for the interaction of these factors using the regression approach developed by the Bouchard & McGue (1981). This is standard procedure in the behavioral genetic analysis because gender and age similarity within twin pairs may artificially inflate the twins’ correlations. Other hypotheses will be examined by the appropriate behavioral genetic analyses:

1) The etiology of prejudices toward specific groups and generalized prejudice (gP)

Hypotheses regarding the genetic and environmental sources of individual differences in prejudices will be tested via structural modeling of the variance/covariance matrices among monozygotic and dizygotic twin pairs. We will test the standard univariate genetic models – E, AE, DE, ACE, and ADE model. We will estimate the parameters from the full ACE or ADE model, and from the best-fitting model. As stated earlier, we expect that ACE model would fit data best and that additive genetic, shared environmental, and non-shared environmental latent variables will have significant parameter estimates for all of the five individual prejudices, as well for the composite score of the generalized prejudice which will be formed as a saved factor (component) score from the component analysis of the five individual prejudices. Besides that, intraclass correlations will be calculated for all individual prejudices, and for the generalized prejudice as well.

2) The phenotypic and genetic/environmental overlap between prejudices toward different groups

Firstly, the correlation between five measured prejudices will be calculated in order to estimate the plausibility of the generalized prejudice factor. Secondly, the structure of the phenotypic relations among five measures will be analyzed using the procedure suggested by Revelle & Wilt (2013): *R* software, package *psych*, Exploratory Factor Analysis for estimating general factor saturations with Schmid-Leiman transformation. We will report all available indicators: ω_g (the amount of variance explained by the general factor), ω_{total} (the total reliable variance of the test/questionnaire/scale), ECV (explained common variance of the general factor), RMSEA (The Root Mean Square Error of Approximation), and α (Cronbach alpha).

Genetic and environmental contribution to the phenotypic covariation between five individual prejudice measures will be tested by the multivariate behavioral genetic model fitting. We will compare standard multivariate models – common pathway, independent pathway and Cholesky decomposition model- in order to estimate the overlap between genetic and environmental sources of influence on the individual differences of different prejudices.

3) Bivariate relations of the generalized prejudice with personality and ideological variables

Several bivariate behavioral genetic models for the analysis of the genetic and environmental overlap between generalized prejudice and six personality scales and generalized prejudice and two ideological variables will be performed. This bivariate models will be based on the best-fitting models from the univariate behavioral genetic analyses of the each pair of the variables, using the Akaike information criteria as an index which will help us with the choice of the models.

4) Multivariate relations of the personality, ideological variables and generalized prejudice

Multivariate Cholesky decomposition will be performed in order to test the hypotheses about genetic and environmental overlap between personality, ideological variables and gP. The order of entering the variables in the analysis would be a) personality variables which has substantial correlations with gP; as stated before, we expect that this criteria would be fulfilled for A and O factors; b) ideological variables which has substantial correlations with gP; as stated earlier, we expect that for both RWA and SDO variables; c) gP.

6) Outliers and Exclusions. Describe exactly how outliers will be defined and handled, and your precise rule(s) for excluding observations.

The cases with more than 20 percent of the missing data would be excluded from the analysis. Other missing data will be handled via serial mean function. Regarding outlier cases exclusion, we will use the absolute deviation around the median method (Leys et al., 2013) since the method of +/- three standard deviations around the mean is sensitive to the assumption of the normal distribution of the variables, which may be violated due to the outliers which are excluding. The median absolute deviation (MAD) method is based on the a) determination of the median of the obtained variable; b) calculating the absolute differences between the individual score and the median; c) calculating the median value of the absolute differences of individual

score and median of the scale (MAD); d) multiplying the MAD by the constant based on the distributions; since we expect for our distributions to be normal, the multiplying constant is $b = 1.4826$; e) deciding the criteria for outliers exclusions based on the $MAD \times b \times 3$ criteria. We will use the conservative criteria 3. Thus the procedure for detecting and exclusion of the outliers would be $MAD \times b \times 3$ (see Leys et al., 2013 for details).

7) Sample Size. How many observations will be collected or what will determine sample size?

In behavioral genetic studies the large samples are needed in order to obtain relative precise estimates of the quantitative genetic parameters, i.e. heritability, environmentality, and genetic and environmental correlations of the target variables. In this study we are interested in the generalized prejudice and its' relations with personality and ideological variables. However, the twin sample is difficult to recruit for the individual study and large sample are not always available. Thus, for the planned data collection we used the following procedure in order to determine the minimal sample size. 1) The literature search for the previous studies of the variables of interest to reach the reasonable estimate of the effects sizes - additive genetic (A) and shared-environmental (C), and non-shared environmental effect - which might be expected. After obtaining the reasonable predictions (educated guess) for the expected effect sizes, we used the "effect size calculator" - the procedures developed by the Wisscher (2004), Wisscher, Gordon and Neale (2008), and the most recent Verhulst (2016) procedure for the power analysis.

Thus, in order to calculate statistical power for the planned classical twin study design, we first consulted power analyses simulations published by Verhulst (2016). Then we performed our own power analyses for the planned parameter estimates using an open-source *statistical software program R* and *OpenMx*, package that fits a variety of advanced multivariate statistical models.

Here we will only give a short overview of the steps taken to make the power analysis for the planned study as accurate as possible. First, we consulted the relevant literature regarding the expected effects sizes (parameter estimates in twin studies). Second, based on the literature and evidence-based data, we made an educated guess of the expected parameter estimates and included them in the first step of the power analysis by simulating data for MZ and DZ twin pairs. We started with the assumption of the additive genetic, shared environment, and non-shared environment effect sizes: $A = .40$, $C = .20$, $E = .40$. Third, we fit the model to the simulated data. Fourth, we obtained the weighted non-centrality parameter (W_{ncp} ; the mean of the non-central χ^2 distribution). Finally, we calculated the vector and plotted it to obtain a standard power graph or the sample size for a specific level of power that can be extracted. This procedure suggest as follows:

- 1) To calculate expected effect sizes of additive genetic (A), shared environmental (C), and non-shared environmental (E) influences contributing to individual differences in phenotypes of interest, with the statistical power of .80 and with MZ:DZ ratio of 1:1, we would need 420 same-sex twin pairs (210 MZ + 210 DZ).
- 2) To calculate expected effect sizes of multivariate relations between our variables of interest (personality, ideological variables and generalized prejudice), with the statistical power of

.80 and with MZ:DZ ratio of 1:1, we would need 500 same-sex twin pairs (250 MZ + 250 DZ) to estimate genetic correlations.

However, we think that initial target sample size for data collection should be larger due to the fact that zygosity diagnosis will be done after the data collection. Although the number of the same sex MZ and DZ twins in population should be similar, it is hard to expect exactly 1:1 MZ:DZ ratio and in that case the lower number is relevant. Thus, we think that target sample size for the data collection should be 600 twin pairs from Germany. The sample should be roughly balanced for gender and should include participants older than 18 years.

8) Other. Anything else you would like to pre-register?

(e.g., secondary analyses, variables collected for exploratory purposes, unusual analyses planned?)

9) Name. Give a title for this AsPredicted pre-registration

Suggestion: use the name of the project, followed by study description.

Twin study of the self- and peer- assessments of generalized prejudice: genetic and environmental overlap between prejudice, personality, and ideological variables