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ORIGINAL RESEARCH

The Genetic and Environmental Roots of Variance in Negativity toward Foreign Nationals

Christian Kandler · Gary J. Lewis · Lea Henrike Feldhaus · Rainer Riemann

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Abstract This study quantified genetic and environmental roots of variance in prejudice and discriminatory intent toward foreign nationals and examined potential mediators of these genetic influences: right-wing authoritarianism (RWA), social dominance orientation (SDO), and narrow-sense xenophobia (NSX). In line with the dual process motivational (DPM) model, we predicted that the two basic attitudinal and motivational orientations—RWA and SDO—would account for variance in out-group prejudice and discrimination. In line with other theories, we expected that NSX as an affective component would explain additional variance in out-group prejudice and discriminatory intent. Data from 1,397 individuals (incl. twins as well as their spouses) were analyzed. Univariate analyses of twins' and spouses' data yielded genetic (incl. contributions of assortative mating) and multiple environmental sources (i.e., social homogamy, spouse-specific, and individual-specific effects) of variance in negativity toward strangers. Multivariate analyses suggested an extension to the DPM model by including NSX in addition to RWA and SDO as predictor of prejudice and discrimination. RWA and NSX primarily mediated the genetic influences on the variance in prejudice and discriminatory intent toward foreign nationals. In sum, the findings provide the basis of a behavioral genetic framework integrating different scientific disciplines for the study of negativity toward out-groups.

Keywords Genetic · Environmental · Prejudice · Discrimination · RWA · SDO · Xenophobia

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C. Kandler (✉) · R. Riemann
Department of Psychology and Sport Sciences, Bielefeld University, Universitätsstr. 25, 33615 Bielefeld, Germany
e-mail: christian.kandler@uni-bielefeld.de

G. J. Lewis
Department of Psychology, University of York, Heslington, UK

L. H. Feldhaus
Department of Psychology and Ergonomics, Berlin Institute of Technology, Berlin, Germany

Negativity toward foreigners

Despite globalization and increased international communication and cooperation, intolerance, hostility, and discrimination toward foreign groups, ethnicities, and cultures persist. Given the resurgence of nationalism in contemporary Europe (Berezin 2006), alongside international forums on migration consistently highlighting the need to tackle out-group hostility and discrimination (Crush and Ramachandran 2009), the roots of negativity toward foreign nationals have received broad scientific attention (Yakushko 2009).

There are several ways to capture out-group negativity. Most frequently, studies have used measures of negative attitudes (i.e., prejudices) toward out-groups (e.g., Dovidio et al. 2002; Ekehammer and Akrami 2003; Turner et al. 2007). However, given the fact that only modest to moderate links exist between prejudice and discrimination ($r = .29$; Schütz and Six 1996), the investigation of prejudices is not the only and probably not even the best way to understand negativity toward out-group members. Even though discrimination is hard to operationalize, discriminatory intent toward out-group members appears to be a good indicator of out-group negativity and a valuable complement to prejudice. In their meta-analysis, Schütz and Six (1996) found moderate to substantial links between discriminatory intent and discrimination ($r = .49$). Thus, the current study focused on both prejudice and discriminatory intent toward foreign nationals as indices of out-group negativity.

Different disciplines provide different explanations for prejudice and discrimination. Social-cognitive theories highlight environmental sources (e.g., threat), whereas evolutionary and neuropsychological theories typically emphasize genetic and biological factors in interaction with the environment (e.g., threat management systems). Additional perspectives focus on the mediating role of individual characteristics such as basic ideological orientations (i.e., authoritarianism and social dominance orientation) and fear or avoidance of strangers (i.e., narrow-sense xenophobia). Those characteristics may mediate the influences of both extrinsic and intrinsic factors on prejudice and discrimination. While each of these perspectives provides important insights into the origins of prejudice and discrimination, a deeper understanding of the contributions of genetic and environmental factors on individual differences in negativity toward foreigners may help to understand the phenomenon of out-group negativity and may provide the basis of an integrative theory.

The current study sought to address two main agendas: First, we disentangled genetic and different environmental sources (i.e., social homogamy, specific influences shared by spouses or twins, and individual factors) of variance in prejudice and discriminatory intent toward foreign nationals taking phenotypic assortment into account. Second, we investigated whether these genetic and environmental sources of the variance in negativity toward foreign nationals were mediated by right-wing authoritarianism, social dominance orientation, and narrow-sense xenophobia.

Social-cognitive theories on negativity toward foreigners

Numerous theories suggest economic, social, and cultural explanations of out-group negativity. From the perspective of the Realistic Group Conflict Theory (Sherif et al. 1961), competition for limited economic resources or political power between several groups may result in negative feelings and attitudes toward the competing out-group.

Beyond competition for economic resources or political power challenged by out-groups (i.e., *realistic threat*), the Integrated Threat Theory of Prejudice (Stephan and Stephan 2000) suggests three additional types of threat: (1) *symbolic threat* that is based on conflicting values and beliefs between in- and out-group, (2) *intergroup anxiety* leading to feelings of threat and uncertainty experienced during social interaction with out-group members, and (3) *negative stereotypes* of out-groups (i.e., negative expectations concerning the out-group members). In line with these theories, several studies have demonstrated that out-group prejudices are associated with different types of threat (e.g., Esses et al. 2001; Gonzales et al. 2008; Riek et al. 2006; Stephan et al. 2002, 2000).

Experiences of threat and, thus, prejudice may be reduced due to *intergroup contact* (Allport 1954). Allport's Intergroup Contact Theory postulates that positive contact between groups can diminish intergroup prejudice under certain circumstances. In fact, it has been shown across a variety of natural and experimental settings that increasing intergroup contact reduces negative feelings and attitudes (e.g., Blair et al. 2003; Blascovich et al. 2001; Pettigrew and Tropp 2006).

Also, the sheer *majority-minority asymmetry* may influence negativity toward out-group members. In line with this position, national majorities and native groups hold more negative attitudes toward immigrants than minorities do (Staerkle et al. 2005).

Group-level and individual-level environmental influences

The aforementioned theories and empirical findings provide explanations for contextually affected variance in out-group negativity: threat, intergroup contact, and in-group status. However, from a behavioral genetic perspective, these influences may or may not be shared by family members raised and reared together, such as siblings. Shared environmental influences act to make siblings similar to each other and may reflect intra-familial influences (e.g., parental influences) or extra-familial effects (e.g., neighborhood). In their review, Hatemi et al. (2011) reported significant shared environmental effects on the variance in out-group attitudes and prejudice.

Shared environmental effects by siblings may also be shared to some degree by spouses, by siblings-in-law as well as by spouses of siblings reflecting a common macro-environmental group-level effect, such as shared social, economic, and cultural background (i.e., social homogamy; Morton 1973). Previous studies, however, provided less support for social homogamy as source of spouse similarity in attitudes (e.g., Alford et al. 2011).

Influences that are commonly conceived to be equal for siblings or spouses are, in fact, not necessarily shared. Individuals may differently experience or interpret the same objectively shared environmental influences. Those environmental influences are effectively not shared and act to make individuals different from one another. Environmental influences not shared by siblings raised and reared together may also reflect objectively nonshared effects from different friends, residences (after leaving their parental home), communities, and individual life events (e.g., assaults, lay-off by employer). Behavioral genetic studies have provided evidence for nonshared environmental influences on the variance in diverse attitudes even after controlling for error of measurement (e.g., Hatemi et al. 2010).

Environmental influences not shared by siblings may be shared to some degree by spouses due to mutual spouse interaction or if selection of spouses depends on factors which are unique to individual siblings (Eaves 1979). Those effects act to increase the similarity of spouses but not the similarity of siblings-in-law or of spouses of siblings.

Until now, no study (to our knowledge) has disentangled the contribution of these four different environmental sources of variance in prejudice and discrimination toward foreign nationals. However, the disentanglement of social homogamy, environmental effects shared by twins, spouse-specific homogamy, and individual-specific effects provide an interesting insight into where environments become manifest affecting variance in out-group negativity: (1) at group-level, (2) at a specific dyadic level, or (3) at individual level.

Genetic and biological sources of negativity toward foreigners

Individual reactions to perceived threats, such as prejudice toward out-group members and tendencies to discriminate against them, might also underlie biological mechanisms. In terms of evolutionary perspectives, humans likely evolved basic adaptive systems supporting cooperation and reciprocity (Brewer 1999; Cosmides and Tooby 1992). Cooperation may foster the inclusive fitness of involved interaction partners. The decision to cooperate (i.e., giving resources to others) is a dilemma of trust, because the benefit for the sender depends on the receiver's willingness to do the same. People may prefer to interact and cooperate with social partners who are genetically related (i.e., *kin selection*) or who will most likely cooperate (i.e., *reciprocity*), such as in-group members (Hamilton 1964; Dawkins 1976; Trivers 1971). Individual differences in in-group favoritism were found to be moderately heritable, ranging from 20 % to 50 % (Lewis and Bates 2010; Rushton and Bons 2005). The process of an increasing favoritism towards members of the in-group may accompany out-group derogation (Tajfel and Turner 1979) leading to the conclusion that variance in out-group negativity should be attributable to some degree to genetic influences.

In fact, behavioral genetic studies on negative attitudes toward specific groups, such as homosexuals (Verweij et al. 2008) or hippies (Martin et al. 1986), have reported that more than one-third of the variance was attributable to genetic sources. Moreover, individual differences in attitudes toward white superiority, apartheid, and immigration as well as racial prejudice have been shown to be substantially genetically influenced (e.g., Hatemi et al. 2010; Loehlin 1993; Martin et al. 1986; Truett et al. 1992). However, a recent twin study has shown that distinct heritable influences underpin in-group positivity and out-group negativity (Lewis et al. 2014). Thus, distinct genetic and biological mechanisms may underpin in-group favoritism and out-group derogation.

Boyer and Bergstrom (2011) suggest that humans possess precautionary adaptations designed to detect and respond to fitness-relevant threats. Different neurophysiological threat management systems, such as self-protection and disease-avoidance systems, appear to elicit specific affective (e.g., fear, disgust), cognitive (e.g., prejudice), and behavioral (avoidance or aggression) responses to perceived fitness-relevant threats, such as to physical safety and health (Neuberg et al. 2011; Smith et al. 2011). Threat management systems are sensitive and responsive to cues of threat that may be real, but also subjective, imagined, or irrational (Park et al. 2003). Individual differences in threat management systems predicted xenophobic reactions only to subjectively foreign people, but not to strangers who were perceived as subjectively familiar (Faulkner et al. 2004). In line with those findings, variance in threat management systems are considered to be not only attributable to individual differences in a learning history of confrontations with stimuli that are really threatening but also to genetic differences in thresholds for identifying events or strangers as threatening.

If threat management systems have a fitness-relevant function, it raises the question why genetic variance exists or persists in such systems. One plausible explanation is variation due to occasional spontaneous gene mutations leading to selection-mutation equilibrium. Another explanation is active mate assortment (Watson et al. 2014). If genetic differences affect the characteristics on which assortment occurs then the nonrandom spouse similarity in these characteristics may be due to genetic sources (Fisher 1918). Thus, positive phenotypic assortment has two implications. First, it acts to increase genetic similarity among relatives. Second, it increases the polarization of genetic differences in polygenic phenotypes in a population (Wright 1921).

Studies have found moderate positive spouse correlations for out-group attitudes and avoidance (e.g., Alford et al. 2011; Watson et al. 2004, 2014). However, spouse similarity can be due to both genetic and environmental contributions, such as shared social background and spouse-specific environmental effects (Heath and Eaves 1985). If studies do not take these potential sources of spouse similarity in attitudes into account then it remains largely unclear to what extent phenotypic assortment can explain positive spouse correlation reflecting a possible mechanism that acts to maintain genetic variance in out-group negativity or to what degree spouse similarity is purely environmentally driven.

The role of basic ideological attitudes and fear of strangers

Genetic (but also environmental) variance in prejudices and discriminatory intent may be mediated by broader values and attitudes concerning how society should be structured. The dual process motivational (DPM) model of ideology and prejudice (Duckitt and Sibley 2010; Duckitt et al. 2002; Sibley and Duckitt 2008, Van Hiel et al. 2004) outlines the proposition that individual differences in prejudice are attributable to specific motivational and cognitive antecedents. In this model, prejudice toward strangers is largely influenced by two relatively independent basic dimensions of social attitudes. One dimension is labeled as *right-wing authoritarianism* (RWA; Adorno et al. 1950; Altemeyer 1981), which is characterized by dominance, submission, and conventionalism. RWA reflects the primary uncertainty-driven orientation and value of establishing and maintaining collective security, societal stability, and cultural tradition. The other dimension is labeled as *social dominance orientation* (SDO; Pratto et al. 1994). SDO captures preferences for societal hierarchy, superiority of the in-group, and is linked to competitive-world beliefs. SDO reflects the competition-driven orientation and value of establishing and maintaining group dominance.

Several studies have shown that RWA and SDO account for variance in general prejudice toward out-groups (Duckitt and Sibley 2010). Of further importance, the two dimensions predict prejudices against different out-groups through distinct pathways (Asbrock et al. 2010; Duckitt 2006; Duckitt and Sibley 2007). Individuals who score high in RWA tend to believe that the world is dangerous. As such, they are more likely to show negative attitudes toward out-groups perceived as deviant and as threatening to collective security and tradition. In contrast, individuals who score high in SDO tend to show negative attitudes toward out-groups with lower and minority status or out-groups perceived as challenging the hierarchy and as competing for the resources of their own group.

The DPM model provides an integrative and well-established perspective of how out-group prejudices and discrimination are affected by attitudinal and motivational orientations (i.e., RWA and SDO). However, given the already mentioned widespread evidence of fear and affect (e.g., intergroup anxiety, perception and avoidance of irrational threat) influencing out-group prejudice, an affective component appears to be neglected in the DPM model. Several studies have shown that the relationship between intergroup contact and out-group prejudice appears to be mediated by intergroup anxiety (e.g., Stephan et al. 2000; Turner et al. 2007, 2008; Voci and Hewstone 2003). In addition, individuals who see the world as a dangerous place and especially those, who are chronically anxious, are more likely to perceive out-group members as threatening (Maner et al. 2005). Including such a basic affective variable into the DPM model would extend the primarily cognitive and motivational model by integrating an affective component as antecedent of prejudice and discrimination toward out-groups (Neuberg et al. 2011; Smith et al. 2011).

Though the term has been used ambiguously and often beyond the scope of affective components, *xenophobia* may reflect such an additional basic affective component (Yakushko 2009). In its narrow and original sense, xenophobia is considered to be a special form of anxiety (i.e., *narrow-sense xenophobia*; NSX) that is characterized by irrational fear (Greek: phobos) of strange objects (Greek: xenos; i.e., foreign individuals, groups, or things). Similar to the construct *intergroup anxiety* (Stephan and Stephan 2000), NSX includes discomfort or negative expectations when interacting with members of other groups or in anticipation of intergroup interaction. However, NSX goes beyond interaction with out-group members and includes strange and unfamiliar situations, circumstances, and things, and is, thus, more basic than *intergroup anxiety*. People who score high on NSX perceive the unknown and unfamiliar objects or situation as potential threats and try to avoid these (Bolaffi et al. 2002). Thus, NSX describes individual differences in thresholds for identifying or experiencing events as threats and strangers as threatening. In line with previous research on related constructs, such as intergroup anxiety (e.g., Paolini et al. 2004; Turner et al. 2007, 2008) or social fear disposition (Hatemi et al. 2013), NSX as a basic affective component should account for variance in prejudice and discriminatory intent toward foreigners over and above the primary attitudinal and motivational orientations RWA and SDO. In summary, NSX, RWA, and SDO are promising basic individual attributes that may mediate genetic but also environmental sources of variance in prejudice and discrimination toward foreigners. But what is known about the sources of variance in RWA, SDO, and NSX?

Previous studies have found a moderate-to-strong genetic contribution (about 40 to 60 %) to the variance in RWA (e.g., Bouchard and McGue 2003; Funk et al. 2013; Lewis and Bates, 2013; Ludeke and Krueger 2013;

McCourt et al. 1999) and also a large spouse correlation of about $r = .50$ (Bouchard 2009). Thus, the genetic variance in RWA can, in principle, account for the genetic variance in generalized prejudice and discrimination toward foreigners. Even though no study (to our knowledge) has investigated the genetic and environmental sources of variance in SDO, specific aspects or facets and related constructs have been found to be heritable to some degree, for example ethnocentrism (18 %; Orey and Park 2012), attitudes toward equality (27 %; Olson et al. 2001), and acceptance of inequality (20 %; Kandler et al. 2012). Heritability estimates tend to be lower compared to RWA. According to these behavior genetic results, previous phenotypic studies have shown that SDO scores depend on contextual and situational influences (e.g., competition) rather than RWA scores (Lehmiller and Schmitt 2007). Consequently, it might be expected that SDO is less influenced by genetic factors compared to RWA and less relevant regarding the genetic variance in prejudice and discriminatory intent toward foreigners.

Many studies found evidence of moderate-to-strong genetic effects on the variance (about 28 to 48 %) in anxiety, phobias, and social as well as general anxiety disorders, with less evidence of environmental effects shared by family members (Hettema et al. 2001). Therefore, genetic factors may partly explain variance in NSX that, in turn, may mediate genetic variance in prejudice and discriminatory intent. In line with this idea, a recent study reported associations between social fear disposition and attitudes toward out-groups that were primarily mediated by genetic sources (Hatemi et al. 2013).

Aims of the current study

Both genetic and environmental sources seem to affect individual differences in negativity toward foreigners. The current study's first major aim was to disentangle genetic from multiple environmental sources of variance in RWA, SDO, NSX, prejudice and discriminatory intent toward foreign nationals using data of twins and their spouses. More specifically, we analyzed to what degree individual differences in out-group negativity were due to genetic variance, environmental effects shared by twins and spouses (i.e., social homogamy), twin-specific shared environmental effects, spouse-specific shared environmental effects, and individual-specific environmental influences. The examination of those influences provides important implications on where environmental sources become manifest: At the in-group-level (i.e., social homogamy), at the specific dyadic level (i.e., specific for twins or spouses), or at the individual-specific level.

In line with the considerations and previous findings on related variables presented above (e.g., Bouchard 2004; Hatemi et al. 2011), we expected that genetic effects would significantly contribute to the variance in out-group negativity (*Hypothesis* 1). According to previous research (e.g., Bouchard and McGue 2003; Lehmiller and Schmidt, Lehmiller and Schmitt 2007), genetic effects on the variance in RWA scores should be larger than genetic influences on the variance in SDO scores (*Hypothesis* 2). We also expected a significant contribution of phenotypic assortment beyond social and spouse-specific environmental homogamy as a potential mechanism that acts to increase spouse similarity (*Hypothesis* 3) and, thus, to polarize genetic diversity preserving genetic variance in a population.

The second major aim of the study was to estimate to what extent (genetic and environmental influences on) the variance in prejudice and discriminatory intent toward foreign nationals were predicted (or mediated) by RWA, SDO, and NSX. In line with the DPM model (e.g., Duckitt and Sibley 2010), variance in RWA and SDO scores should account for variance in prejudice and discriminatory intent. Since RWA and SDO primarily reflect attitudinal and motivational dimensions, we expected that NSX (as primarily affective dimension) accounted for additional variance in prejudice and discriminatory intent beyond RWA and SDO (*Hypothesis* 4). Because of the role of RWA, SDO, and NSX as potential mediating individual core attributes, we finally expected that the entire genetic variance in prejudice and discriminatory intend toward foreign nationals should be mediated by RWA, SDO, and NSX (*Hypothesis* 5).

Methods

Participants

The sample consisted of data from 1,397 individuals. Data from complete twin pairs were available for, 48 monozygotic (MZ) male pairs, 178 MZ female pairs, 20 dizygotic (DZ) male pairs, 81 DZ female pairs, and 67 DZ opposite-sex DZ pairs. We also included data from 87 unmatched twins reared together. About 74 % were females and average age was 34 ($SD = 13.6$). All twins and spouses were German nationals. Detailed description of the sample was presented by Stößel, Kämpfe, and Riemann (Stößel et al. 2006). In addition to the twins' self-reports 522 spouses of twins (60 %) including 273 spouses of MZ twins, 197 spouses of DZ twins, and 52 spouses of unmatched twins provided self-ratings on RWA, SDO, NSX, prejudice and discriminatory intent toward foreign nationals.

Measures

Prejudice toward foreign nationals

Prejudice toward foreign nationals was captured by self-reports on seven prejudicial bipolar adjective pairs: (1) trustworthy–back-stabbing; (2) uninterested–interested; (3) likable–dislikable; (4) undisciplined–disciplined; (5) studious–lazy; (6) unfriendly–friendly; and (7) modest–arrogant.[1] Items 2, 4, and 6 were reverse coded. These adjective pairs were used to characterize other nationals (Turkish, Polish, Italian, and Swedish) on a five-point scale. Turks, Italians, and Poles are the three largest groups with foreign citizenship in Germany (Özcan 2007), whereas Swedes are a very small group of immigrants. After data collection, we ran principal components analyses (PCA) with promax rotation. The number of components was determined on the basis of scree tests (Cattell 1966) and minimum average partial (MAP) tests (O'Connor 2000). This procedure yielded four components clearly related to the four nationalities. The four components accounted for 53 % of variance.

Because of moderate up to substantial correlations between the components prejudice toward Poles and prejudice toward Turks ($r = .42$) as well as between the components prejudice toward Italians and prejudice toward Swedes ($r = .27$), we ran a second order PCA with promax rotation which yielded a clear two component structure. These components accounted for 68 % of variance and showed low links ($r = .17$). Based on the PCA results, we composed two scale scores. One score reflected prejudice toward Swedes and Italian, which were members of the European Union (EU) at time of data collection between 2002 and 2004 (i.e., EU state nationalities; $PREJ_{EU}$). A second score reflected prejudice toward Poles and Turks, which were not members of the EU (i.e., foreign non-EU member nationalities; $PREJ_{NEU}$) at time of data collection (today, Poland is a member of the EU). Internal consistency was $\alpha = .82$ for $PREJ_{EU}$ and $\alpha = .87$ for $PREJ_{NEU}$.[2]

Discriminatory intent toward foreign nationals

Discriminatory intent (DISC) was measured by self-reports on seven items for each foreign nationality capturing the tendency to deny positive resources to a group or to favor stronger sanctions against this group: (1) [Swedes] should be punished harder than Germans after violations of German law; (2) [Italians] should get jobs only in specific areas; (3) [Turks] should get the same rank like a German has in society; (4) [Poles] who are unemployed should get less support than unemployed Germans; (5) [Swedes] should be able to live out their culture just as Germans; (6) [Italians] should be more often controlled by the police than Germans; and (7) [Turks] should get the same social benefits as Germans (Footnote 1). These items were followed by a five-point scale from "Strongly Disagree" to "Strongly Agree". Items 3, 5, and 7 were reverse coded. PCAs with minimum average partial tests yielded only one component. This component accounted for 55 % of the variance. Based on the PCA results, we composed one score of discriminatory intent (across all nationals). Internal consistency was $\alpha = .97$ (Footnote 2).

RWA, SDO, and NSX

We used a German version of Altemeyer's (1996) RWA scale (see Funke 2005) and a German translation of Pratto et al.'s SDO scale (1994; see also Sidanius and Pratto 2001) including items with equal numbers of positive and negative formulations to measure RWA and SDO. The internal consistency was $\alpha = .73$ for RWA and $\alpha = .80$ for SDO. To assess NSX we developed a new questionnaire. This measure included eleven items. Internal consistency was $\alpha = .81$ (Foot note 1). RWA, SDO, and NSX items (Table 1 for the English item formulations) were followed by a five-point scale ranging from "Strongly Disagree" to "Strongly Agree".

Because of the questionable unidimensionality of the RWA (Funke 2005) and SDO items (Ho et al. 2012) as well as potential overlap in item content among RWA, SDO, and NSX measures, we first ran PCAs with promax rotation to confirm discriminant construct validity in terms of structural independence of the three constructs. PCAs were conducted for several subsamples (e.g., twin a, twin b, spouse a, spouse b, male, and female) that yielded highly similar results. In all cases, the screeplot suggested a three-component solution: Eigenvalues dropped off markedly after three large values (on average 5.94, 3.96, 2.92, 1.77,

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[1] The questionnaire in German and English item formulations is available on request from the first author.

[2] Rerunning the analyses for different subsamples (twin a, twin b, spouse a, spouse b, male, and females) did not lead to different results for both prejudice and discriminatory intent toward foreign nationals. Concerning prejudices, we also ran PCAs with promax rotation on the basis of the seven bipolar adjective items for each foreign nationality separately. These yielded one-factor solutions for prejudice toward three nationals (accounting for 55 %, 58 %, and 53 % of the variance) expect for prejudice toward Italians. For the latter, the scree and the MAP tests yielded two components which explained 60 % of the variance. A second-order PCA, however, yielded again two components which accounted for 60 % of the variance and could be clearly interpreted as $PREJ_{EU}$ and $PREJ_{NEU}$. Concerning discriminatory intent, we did the equivalent analyses. PCAs yielded one-factor solutions for discriminatory intent in all four cases of foreign

Footnote 2 continued
nationals (accounting for 59 %, 57 %, 58 %, and 61 % of the variance). A second-order PCA yielded only one component which accounted for 94 % of the variance.

Table 1 Promax rotated factor loadings of the 12 RWA, 16 SDO, and 11 NSX items for the combined sample of twins and spouses of twins

Items	Principal components					
	Twins ($N = 875$)			Spouses ($N = 522$)		
	I: RWA	II: SDO	III: NSX	I: RWA	II: SDO	III: NSX
Right-wing authoritarianism						
(1) People ought to develop their own moral standards of "Good and Bad" instead to put less attention to the Bible and other old traditional beliefs[a]	−.06	.17	.05	−.15	.02	.06
(2) Instead of more civil rights, we need an upholding of law and order	**.70**	−.05	.13	**.78**	.01	**.33**
(3) The days when women are submissive to their husbands and social conventions belong strictly in the past. A "woman's place" should be wherever she wants to be[a]	.18	.22	.17	.15	.25	.24
(4) Turning away from tradition will emerge as fatal error 1 day	**.28**	.13	.07	**.31**	.06	.21
(5) There is no crime that legitimates death penalty[a]	**.46**	.03	.16	**.50**	.19	.20
(6) Obedience and respect for authority are the most important virtues the children should learn	**.71**	−.10	.12	**.71**	.01	.27
(7) Homosexual cohabits should be putted on a par with marriages[a]	**.32**	**.27**	.14	**.32**	.25	**.31**
(8) What our country really needs is a strong, determined leader who will crush evil, and take us back to our true path	**.69**	−.10	.07	**.71**	.02	.21
(9) It is good that the youth has the right to do their own things and to protest against things they disagree with, nowadays[a]	**.26**	.17	.23	**.33**	**.26**	**.33**
(10) In the long run, virtuousness and law-abiding will bring us forward instead of the permanent challenge of our society's foundations	**.60**	−.04	.10	**.59**	.09	.22
(11) It is right to preserve the rights of radicals and deviators in every sense	**.27**	.07	.07	**.30**	.13	.10
(12) The true key to good life is obedience, discipline, and virtue	**.70**	−.07	.16	**.70**	.02	.19
Social dominance orientation						
(1) We should strive to make incomes as equal as possible[a]	−.24	**.58**	−.19	−.25	**.42**	−.21
(2) Group equality should be our ideal[a]	−.25	**.56**	−.10	**−.29**	**.49**	−.07
(3) It's OK if some groups have more of a chance in life than others	.20	**.57**	−.00	.05	**.54**	.08
(4) To get ahead in life, it is sometimes necessary to step on other groups	**.32**	**.30**	.02	.19	**.37**	.01
(5) We should do what we can to equalize conditions for different groups[a]	.12	**.62**	.12	.18	**.64**	.15
(6) It's probably a good thing that certain groups are at the top and other groups are at the bottom	.22	**.63**	−.00	.18	**.59**	.07
(7) Inferior groups should stay in their place.	**.41**	**.37**	.25	**.45**	**.41**	.31
(8) We would have fewer problems if we treated people more equally[a]	−.00	**.68**	−.06	.13	**.66**	.10
(9) It would be good if groups could be equal[a]	.13	**.69**	.04	.08	**.70**	.10
(10) In getting what you want, it is sometimes necessary to use force against other groups	**.37**	**.32**	.00	.20	**.38**	.02
(11) All groups should be given an equal chance in life[a]	.10	**.55**	.14	.19	**.64**	.20
(12) If certain groups stayed in their place, we would have fewer problems	**.51**	.22	.21	**.55**	**.26**	.33
(13) Social equality should increase[a]	−.01	**.66**	−.01	.02	**.67**	.02
(14) Sometimes other groups must be kept in their place	**.49**	.07	.05	**.48**	.13	.11
(15) Some people are simply inferior to others	**.41**	.22	.05	**.34**	.16	.10
(16) No group should dominate in society[a]	.10	**.33**	.07	.05	**.47**	.17
Narrow-sense xenophobia						
(1) The feeling I have when I meet somebody or something foreign feels pleasant[a]	.05	.02	**.61**	.09	.09	**.59**
(2) I would prefer things not to change that fast	**.34**	−.14	**.47**	**.39**	−.13	**.45**
(3) I enjoy it if there is constantly something new happening[a]	.10	−.07	**.59**	.20	−.01	**.59**
(4) Normally I do not have a good feeling when making contact with foreigners	−.01	.05	**.66**	.10	.10	**.66**
(5) An intensive exchange between different cultures of the world should be strongly encouraged[a]	**.37**	.19	**.39**	**.39**	.25	**.47**

Table 1 continued

Items	Principal components					
	Twins ($N = 875$)			Spouses ($N = 522$)		
	I: RWA	II: SDO	III: NSX	I: RWA	II: SDO	III: NSX
(6) With unfamiliar situations, I dislike that you never know what to expect	**.34**	−.10	**.57**	**.34**	−.09	**.56**
(7) When something is not clear it just annoys me[a]	.18	−.02	**.37**	.16	.11	**.47**
(8) Foreign persons or things put me off rather than they attract me	.20	.04	**.72**	**.33**	.07	**.68**
(9) In general I face foreigners with openness[a]	.09	.08	**.66**	**.27**	.11	**.67**
(10) Often, I have a distinct aversion to foreign persons or things	.23	.07	**.63**	.24	.06	**.62**
(11) Actually, I can adjust myself to new circumstances very well[a]	−.05	.04	**.66**	.07	.12	**.68**
Explained variance in %	13.91	10.44	8.10	16.53	9.88	6.85
Factor score correlations		.06	.24		.11	.39
			.03			.13

Factor loadings >.25 are shown in bold

[a] Items were reverse coded

1.50 …). In most cases, the MAP test also indicated a three-component solution (except for the male subsample for which a four-component solution was indicated). The three principal components explained about 33 % of the variance and could be interpreted in terms of three constructs RWA, SDO, and NSX (shown in Table 1 for twin and spouse samples). Since specific items did not show highest loadings on the initial scale (e.g., SDO items 7, 12, 14, and 15 showed highest loadings on the RWA component), we decided to use RWA, SDO, and NSX factor scores derived from the PCAs with promax rotation for the ongoing analyses.

Sex and age differences in the variables investigated were generally low or not significant. Men (male = 0; female = 1) scored higher on RWA ($\beta = -.08$; $p = .03$), SDO ($\beta = -.10$; $p = .01$), and prejudice toward non-EU nationals. Older people scored higher on RWA ($\beta = .07$; $p = .04$) and lower on prejudice toward non-EU nationals ($\beta = -.16$; $p = .00$). As sex and age effects can act to increase or decrease twin and spouse similarity, twins' and spouses' self-reports were corrected for linear and quadratic age effects, sex differences, as well as sex × age interaction effects using a multiple regression procedure (McGue and Bouchard 1984). Subsequent analyses were based on standardized residuals derived from these regressions.

Analyses

We estimated twin and spouse correlations, correlations between twins and siblings-in-law, and correlations between spouses of twins via pairwise deletion procedures for handling missing values. These correlations allowed a rough insight into the sources of genetic and environmental variance in out-group negativity. Contributions of genetic effects to the variance rely on larger MZ twin correlations compared to DZ twin correlations. This is due to the fact that MZ twins share 100 % of their segregating alleles, whereas DZ twins share on average only 50 %. As shared environmental factors are completely shared by MZ as well as DZ twins, they are indicated by DZ correlations exceeding half the MZ correlations. Low MZ twin correlations indicate strong contributions of environmental effects not shared by twins and random measurement error.

Significant spouse correlations indicate nonrandom mating. If spouse similarity is due to phenotypic assortment, the correlation between twins and their cotwins' spouse and the correlation between spouses of twins should be larger for MZ compared to DZ twins (Reynolds et al. 1996). Social homogamy acts to increase twin resemblance to the same degree as it contributes to spouse resemblance, the similarity between a twin and the cotwin's spouse, and the similarity between spouses of twins (Eaves 1979). It is indicated by twin–cotwin's spouse correlations which are equal to the correlations of twins' spouses regardless of zygosity. In addition, these correlations will be equal to the spouse correlation if spouse similarity is purely determined by social homogamy (Heath and Eaves 1985). Spouse-specific shared environmental effects (i.e., spouse-specific homogamy) contribute exclusively to spouse similarity. Thus, they are indicated by significant spouse correlations, whereas twins and cotwin's spouses or spouses of twins ought to be uncorrelated.

We also estimated variance–covariance matrices of twins' and spouses' data via expectation maximization (EM) procedures for handling missing values without loss of statistical power (Little and Rubin 2002). These variance–covariance matrices provided the basis of disentangling genetic from environmental variance components within

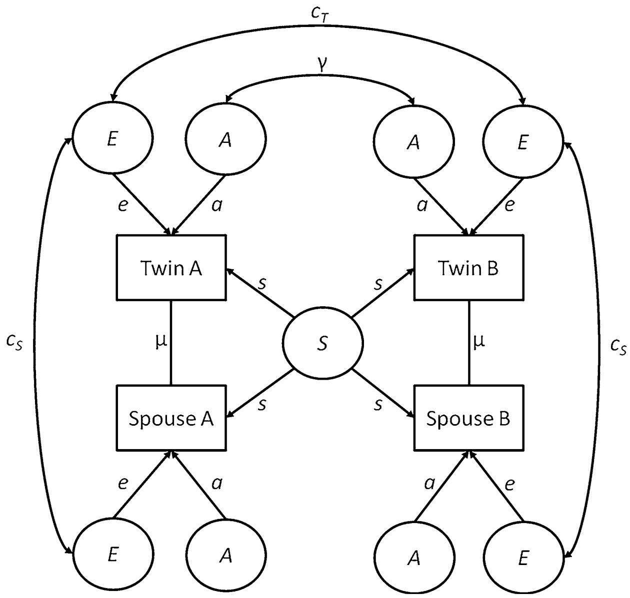

Fig. 1 Model of twins reared together and twins' spouses: *A* additive genetic factors; *S* influences due to social homogamy; *E* environmental factors beyond social homogamy; c_T correlations due to environmental factors shared by twins/siblings reared together; μ phenotypic assortment; c_S latent correlation due to spouse-specific influences; γ 1 for MZ twins and ½ × (1 + μ × a^2) for DZ twins; variances of all latent variables were fixed to one in order to obtain estimates for path coefficients

variables via structural equation model analyses. According to Heath and Eaves (1985) and Reynolds et al. (1996), we used a variance decomposition model for MZ and DZ twins reared together and twins' spouses (Fig. 1; Table 2). This model decomposes phenotypic variation into genetic variance (a^2), variance due to social homogamy (s^2), and environmental variance beyond social homogamy (e^2). The latter can be further decomposed into an environmental component due to twin-specific shared environmental effects ($c_T \times e^2$), spouse-specific shared environmental effects ($c_S \times e^2$), and individual-specific environmental effects including measurement error: $e^2 - (c_T \times e^2 + c_S \times e^2)$. These model analyses allowed for testing *Hypothesis* 1 and *Hypothesis* 2.

The model further allows an estimation of the contribution of phenotypic assortment (μ) beyond social homogamy (s^2) and spouse-specific homogamy ($c_S \times e^2$) to the spouse similarity testing *Hypothesis* 3. As it can be seen in Fig. 1 and Table 2, phenotypic assortment acts to increase genetic similarity of spouses and DZ twins but not of already genetically identical MZ twins. Consequently, if phenotypic assortment is present but not taken into account, then estimates of shared environmental effects would be overestimated. The other way round, if social or spouse-specific homogamy acts to increase spouse similarity, then the exclusive modeling of phenotypic assortment would lead to underestimations of true shared environmental effects (Reynolds et al. 1996).

Since nonadditive genetic effects cannot be estimated in the presence of environmental influences shared by twins, we tested models that only allow for additive genetic effects. Environmental effects are assumed to be equal for MZ and DZ twins as well as for spouses of twins. The causal mechanisms underlying the spouse similarity are assumed to be in equilibrium across generations. Additionally, the model assumes the absence of gene-environment interaction and gene-environment correlation (beyond mate selection). The model of twins reared together and twins' spouses were fitted to the EM variance–covariance matrices via maximum likelihood using the statistical software package Mx (Neale et al. 2003).

A further aim of our study was to test whether NSX accounted for additional variance in prejudice and discriminatory intent toward foreign nationals beyond RWA and SDO (*Hypothesis* 4). For that purpose we ran a hierarchical regression analyses to test in a first model whether both RWA and SDO can account for variance in out-group prejudice ($PREJ_{EU}$, $PREJ_{NEU}$) and discriminatory intent (DISC) and in a second model whether NSX can account for an additional variance component. These analyses were based on twins' and spouses' self-reports. Missing values were handled by pairwise deletion procedures.

Finally, we examined the overall magnitude of genetic and environmental variance in $PREJ_{EU}$, $PREJ_{NEU}$, and DISC that could be accounted for by genetic and environmental components in NSX, RWA, and SDO. For that purpose, we ran three Cholesky decomposition models (Posthuma 2009), one for each dependent variable ($PREJ_{EU}$, $PREJ_{NEU}$, and DISC) with RWA, SDO, and NSX as predictor/mediator variables. The classical Cholesky model is just based on the data of twins and so is not speaking to variance components beyond additive genetic, twins' shared environmental, and twins' nonshared environmental effects. We used the information regarding the estimations of c_T and μ for each variable from the spouses-of-twins model results allowing for twin-specific environmental correlations (c_T for MZ and DZ twins) and appropriate twin correlations between additive genetic factors (1 for MZ twins and ½ + ½ × μ × a^2 for DZ twins) to adapt the classical Cholesky model. The adapted model allowed for more accurate estimations of additive genetic effects (a^2) in the presence of phenotypic assortment, for estimations of social homogamy effects shared by twins and their spouses (s^2), and residual environmental effects (e^2) shared to some degree by twins ($c_T \times e^2$). It can test the non-significance of genetic and environmental components in $PREJ_{EU}$, $PREJ_{NEU}$, and DISC not accounted for by genetic and environmental influences on the variance in RWA, SDO, and NSX. Thus, this model allowed us to test whether genetic variance in RWA, SDO, and NSX can account for the genetic influences on

Table 2 Model of twins reared together and twins' spouses

Phenotypic statistics	Variance decomposition
Variance	$a^2 + s^2 + e^2$
MZ twin covariance	$a^2 + s^2 + c_T \times e^2$
DZ twin covariance	$½ \times a^2 \times (1 + \mu \times a^2) + s^2 + c_T \times e^2$
Spouse covariance	$\mu + s^2 + c_S \times e^2$
MZ twin-cotwin's spouse covariance	$\mu \times (a^2 + s^2 + c_T \times e^2) + s^2$
DZ twin-cotwin's spouse covariance	$\mu \times (½ \times a^2 \times (1 + \mu \times a^2) + s^2 + c_T \times e^2) + s^2$
MZ twins' spouses covariance	$\mu^2 \times (a^2 + s^2 + c_T \times e^2) + s^2 + 2 \times \mu \times s^2$
DZ twins' spouses covariance	$\mu^2 \times (½ \times a^2 \times (1 + \mu \times a^2) + s^2 + c_T \times e^2) + s^2 + 2 \times \mu \times s^2$

a^2: variance due to additive genetic effects; s^2: variance due to social homogamy; e^2: environmental variance beyond social homogamy; μ: phenotypic assortment; $c_T \times e^2$: environmental component due to twin-specific shared environmental effects; $c_S \times e^2$: spouse-specific shared environmental effects; $e^2 - (c_T \times e^2 + c_S \times e^2)$: individual-specific environmental effects (incl. measurement error)

$PREJ_{EU}$, $PREJ_{NEU}$, and DISC (*Hypothesis* 5) by fixing the genetic factor on $PREJ_{EU}$, $PREJ_{NEU}$, and DISC to zero and comparing the reduced models against the full models with χ^2-difference tests. The Cholesky decomposition models were fitted to the EM variance–covariance matrices via maximum likelihood.

Results

Univariate results

Phenotypic correlations among twins and spouses are shown in Table 3. These correlations provided a first insight into the genetic and environmental sources of variance. For each variable, MZ twin correlations were larger than DZ twin correlations indicating contributions of genetic influences.[3] For RWA and DISC, there tended to be larger MZ twin-cotwin's spouse correlations than DZ twin-cotwin's spouse correlations and correlations between spouses of twins suggesting an influence of phenotypic assortment. However, the differences between twin–cotwin's spouse correlations and correlations between spouses of twins for both MZ and DZ twins were relatively small indicating an additional contribution of social homogamy. There was a significant spouse correlation for NSX but non-significant twin-co-twin's spouse correlations and correlations between twins' spouses indicating spouse-specific homogamy.

Univariate biometric model fitting analyses yielded at least acceptable model fit indices for the saturated univariate models (i.e., RMSEA <.08; Steiger 1990): The RMSEA ranged between .000 and .056 (Table 4). In line with *Hypothesis* 1, we found evidence for genetic contributions to the variance (about 17 % to 32 %) in out-group negativity. However, estimates of genetic influences to the variance in $PREJ_{EU}$ were not statistically significant at $p < .05$. Substantial genetic influences contributed to the variance in RWA (50 %) and NSX (43 %), whereas the genetic effects to the variance in SDO (7 %) were not statistically significant. Thus, consistent with *Hypothesis* 2, the heritability estimate for RWA was considerably larger compared to the heritability of SDO. For parsimony, we next fixed all path coefficients to zero that were found to be not significant with estimations <.10. These model reductions did not lead to significant reductions in model fit (Table 5).

The model fitting results also provided significant influences shared by twins as well as by spouses of twins (i.e., effects due to shared social background) for RWA, SDO, $PREJ_{NEU}$, and DISC. They also yielded significant twin-specific shared environmental effects in case of SDO and $PREJ_{EU}$ and significant spouse-specific shared environmental effects for NSX. Individual-specific environmental effects (and error) were moderate for RWA and NSX (30 to 41 %), but substantial for SDO, prejudice, and discriminatory intent (49 to 71 %).

According to *Hypothesis* 3, we found evidence of phenotypic assortment for all variables except for NSX as a mechanism that acts to increase spouse similarity. Even though our analyses indicated that spouse similarity was primarily due to phenotypic assortment (except for NSX), the model analyses yielded a significant contribution of social homogamy for RWA, SDO, $PREJ_{NEU}$, and DISC as well as spouse-specific homogamy in case of NSX (see bottom of Table 5).[4]

[3] The twin correlations for the 101 same-sex DZ twin pairs (on average .30) did not differ significantly from those for the 67 opposite-sex twin pairs (on average .27). Therefore and because of statistical power, we did not exclude opposite-sex twin pairs from our analyses.

[4] According to a proposal of an anonymous reviewer, we also ran alternative model analyses to compare between models allowing for phenotypic assortment and models allowing for reciprocal spouse interaction (see Agrawal et al. 2006, for more details). These model analyses yielded comparable results: A model allowing for reciprocal spouse interaction best fitted the data in case of NSX, whereas models allowing for phenotypic assortment provided the best fit for all other variables.

Table 3 Family correlations

Family relations	N	Variables					
		RWA	SDO	NSX	$PREJ_{EU}$	$PREJ_{NEU}$	DISC
MZ twins	226	.70**	.36**	.48**	.29**	.48**	.51**
DZ twins	168	.47**	.32**	$.13^{+}$	.20*	.29**	.34**
Spouses	522	.48**	.25**	.14**	.16**	.36**	.43**
MZ twin-cotwin's spouse	269	.38**	.08	.06	.15**	.22**	.34**
DZ twin-cotwin's spouse	195	.34**	.22**	−.06	−.06	.33**	.20**
MZ twins' spouses	107	.34**	.12	.11	.04	.11	.37**
DZ twins' spouses	69	.29*	.17	.06	−.08	.24*	.32*

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice toward non-EU nationalities, *DISC* discriminatory intent toward foreign nationals

** $p < .01$; * $p < .05$; $^{+}$ $p < .10$

Table 4 Univariate biometric model fitting results: full models

Model statistics and parameters	Variables					
	RWA	SDO	NSX	$PREJ_{EU}$	$PREJ_{NEU}$	DISC
Model fit statistics						
$\chi^2(df = 14)$	15.78	7.13	8.90	16.12	22.73	13.50
P	.33	.93	.84	.31	.07	.49
RMSEA	.021	.000	.000	.027	.056	.021
Standardized variance components due to…						
…additive genetic factors (a^2)	**.50 (.32–.59)**	.07 (.00–.35)	**.43 (.29–.53)**	.17 (.00–.38)	**.32 (.08–.43)**	**.31 (.05–.41)**
…social homogamy (s^2)	**.20 (.13–.34)**	**.10 (.04–.21)**	.03 (.00–.08)	.00 (.00–.07)	**.15 (.08–.30)**	**.20 (.14–.28)**
…twin-specific shared environ. effects ($c_T \times e^2$)	.00 (.00–.16)	.19 (.00–.34)	.00 (.00–.11)	.11 (.00–.31)	.00 (.00–.17)	.00 (.00–.23)
…spouse-specific homogamy ($c_S \times e^2$)	.00 (.00–.10)	.00 (.00–.15)	.11 (.00–.17)	.00 (.00–.14)	.00 (.00–.17)	.00 (.00–.13)
…individual-specific environ. effects and error ($e^2 - (c_T \times e^2 + c_S \times e^2)$)	**.30 (.21–.35)**	**.64 (.46–.72)**	**.43 (.34–.60)**	**.72 (.58–.82)**	**.53 (.35–.62)**	**.49 (.36–.57)**
Latent correlations						
Phenotypic assortment (μ)	**.26 (.03–.37)**	.15 (.00–.24)	.00 (.00–.18)	.14 (.00–.20)	.20 (.00–.30)	**.26 (.04–.35)**
Twin-specific environ. correlation (c_T)	.00 (.00–.35)	.23 (.00–.36)	.00 (.00–.17)	.14 (.00–.31)	.00 (.00–.24)	.00 (.00–.31)
Spouse-specific environ. correlation (c_S)	.01 (.00–.32)	.00 (.00–.22)	.20 (.00–.32)	.00 (.00–.16)	.00 (.00–.31)	.00 (.00–.25)
Spouse correlation (r_S) due to…						
…phenotypic assortment (μ/r_S)	**.56 (.07–.72)**	.59 (.00–.85)	.00 (.00–1.0)	.97 (.00–1.0)	.58 (.00–.79)	**.57 (.09–.71)**
…social homogamy (s^2/r_S)	**.44 (.28–.74)**	**.41 (.15–.82)**	.20 (.00–.56)	.03 (.00–.55)	**.42 (.21–.82)**	**.43 (.29–.66)**
…spouse-specific homogamy ($c_S \times e^2/r_S$)	.00 (.00–.22)	.00 (.00–.57)	.80 (.00–1.0)	.00 (.00–.96)	.00 (.00–.47)	.00 (.00–.29)

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice toward non-EU nationalities, *DISC* discriminatory intent toward foreign nationals. Analyses were based on twins' and spouses' data (452 MZ and 336 DZ twins; 273 MZ and 197 DZ spouses); significant estimates are shown in bold (95 % confidence intervals)

Multivariate results

Phenotypic correlations between the variables on the basis of twins' and spouses' data are shown in Table 6. RWA, SDO, and NSX showed low to moderate associations. The correlations between $PREJ_{EU}$ and other variables were conspicuously low, whereas the links between $PREJ_{NEU}$ and DISC as well as their associations with potential

Table 5 Univariate biometric model fitting results: reduced models

Model statistics and parameters	Variables					
	RWA	SDO	NSX	$PREJ_{EU}$	$PREJ_{NEU}$	DISC
Model fit statistics						
$\Delta\chi^2$ vs. full model	0.00	0.18	0.78	0.01	0.00	0.00
df	2	2	3	2	2	2
p	1.0	.92	.85	.99	1.0	1.0
Standardized variance components due to…						
…additive genetic factors (a^2)	**.50 (.41–.59)**		**.46 (.38–.53)**	.17 (.00–.38)	**.32 (.21–.43)**	**.31 (.22–.41)**
…social homogamy (s^2)	**.20 (.13–.27)**	**.10 (.04–.17)**			**.15 (.08–.22)**	**.20 (.14–.26)**
…twin-specific shared environ. effects ($c_T \times e^2$)		**.25 (.15–.34)**		.12 (.00–.31)		
…spouse-specific homogamy ($c_S \times e^2$)			**.13 (.07–.18)**			
…individual-specific environ. effects and error ($e^2 - (c_T \times e^2 + c_S \times e^2)$)	**.30 (.26–.35)**	**.65 (.58–.73)**	**.41 (.33–.51)**	**.71 (.62–.82)**	**.53 (.46–.62)**	**.49 (.42–.57)**
Latent correlations						
Phenotypic assortment (μ)	**.26 (.17–.37)**	**.15 (.06–.24)**		**.14 (.08–.20)**	**.20 (.11–.30)**	**.26 (.18–.35)**
Twin-specific environ. correlation (c_T)		**.27 (.18–.36)**		.14 (.00–.31)		
Spouse-specific environ. correlation (c_S)			**.24 (.14–.34)**			
Spouse correlation (r_S) due to…						
…phenotypic assortment (μ/r_S)	**.57 (.40–.72)**	**.60 (.29–.86)**		**1.0 (1.0–1.0)**	**.58 (.35–.79)**	**.57 (.42–.71)**
…social homogamy (s^2/r_S)	**.43 (.28–.60)**	**.40 (.14–.71)**			**.42 (.21–.65)**	**.43 (.29–.58)**
…spouse-specific homogamy ($c_S \times e^2/r_S$)			**1.0 (1.0–1.0)**			

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice toward non-EU nationalities, *DISC* discriminatory intent toward foreign nationals. Analyses were based on twins' and spouses' data (452 MZ and 336 DZ twins; 273 MZ and 197 DZ spouses); significant estimates are shown in bold (95 % confidence intervals)

Table 6 Phenotypic correlations between RWA, SDO, NSX, prejudice, and discriminatory intent toward foreign nationals

Variables	RWA	SDO	NSX	$PREJ_{EU}$	$PREJ_{NEU}$
SDO	.08**				
NSX	.29**	.06*			
$PREJ_{EU}$	−.08**	.11**	.16**		
$PREJ_{NEU}$	.35**	.12**	.24**	.14**	
DISC	.60**	.17**	.35**	.06*	.48**

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice non-EU nationalities, *DISC* discriminatory intent toward foreign nationals. Analyses were based on twins' and spouses data ($N = 1,397$)

** $p < .01$; * $p < .05$

predictor variables RWA, SDO, and NSX were moderate to substantial.

Hierarchical regression analyses (Table 7) indicated that both RWA and SDO independently account for variance in out-group prejudice and discriminatory intent. In line with *Hypothesis* 4, NSX provided additional prediction for $PREJ_{EU}$, $PREJ_{NEU}$, and DISC indicating the incremental validity of NSX. The effects of SDO and NSX on $PREJ_{EU}$, $PREJ_{NEU}$, and DISC did not vary markedly ($\beta = .09$ to $\beta = .12$ and $\beta = .15$ to $\beta = .19$). However, the effects of RWA varied across $PREJ_{EU}$, $PREJ_{NEU}$, and DISC ($\beta = -.14$ to $\beta = .59$).

Finally, we ran multivariate biometric (Cholesky decomposition) models to examine the overall genetic and environmental variance components in out-group prejudice and discriminatory intent shared with RWA, SDO, and NSX. Model fitting analyses yielded good model fit indices (RMSEA < .05; see Table 8). For parsimony, we first fixed all path coefficients to zero that were found to be not significant on the basis of univariate biometric results (see Tables 4 and 5). This model reduction did not lead to significant reductions in model fit. Then, we fixed the residual genetic effects on $PREJ_{EU}$, $PREJ_{NEU}$, and DISC—that is the portion of genetic variance not common with RWA, SDO, and NSX—to zero. This model reduction did not lead to a significant decrease of model fit in case of $PREJ_{EU}$ and DISC, but there was a worsening of fit in the case of $PREJ_{NEU}$ (see Table 8). That is, consistent with *Hypothesis* 5, the genetic variance in $PREJ_{EU}$ and DISC was completely shared with the genetic variance in RWA and NSX. More specifically, model fitting analyses indicated that genetic variance in NSX primarily accounted for the genetic variance in $PREJ_{EU}$ (see Fig. 2a), whereas genetic variance in RWA primarily explained the genetic

Table 7 Hierarchical regressions from prejudice and discriminatory intent toward foreign nationals on RWA, SDO, NSX

Regression models	Dependent variables					
	$PREJ_{EU}$		$PREJ_{NEU}$		DISC	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Explained variance						
R^2_{corr}	.018**	.051**	.130**	.150**	.369**	.402**
ΔR^2_{corr}		.034**		.021**		.033**
Effects (standardized β weights)						
RWA	−.09**	−.14**	.34**	.30**	.59**	.53**
SDO	.12**	.11**	.09**	.09**	.12**	.11**
NSX		.19**		.15**		.19**

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice non-EU nationalities, *DISC* discriminatory intent toward foreign nationals. Analyses were based on twins' and spouses data ($N = 1,397$)

** $p < .01$; * $p < .05$

Table 8 Multivariate biometric model fitting results

Model fit statistics and parameter estimates	Variables		
	$PREJ_{EU}$	$PREJ_{NEU}$	DISC
Full ASE Cholesky model			
χ^2 (*df*)	39.50 (42)	39.84 (42)	43.50 (42)
P	.58	.57	.41
RMSEA	.000	.000	.010
Reduced ASE Cholesky model on the basis of univariate biometric results			
$\Delta\chi^2$ (*df*) vs. full ASE Cholesky model	2.10 (11)	**2.67 (8)**	1.85 (8)
Δp	.99	**.95**	.99
χ^2 (*df*)	41.60 (53)	**42.51 (50)**	45.35 (50)
P	.87	**.77**	.66
RMSEA	.000	**.000**	.000
Testing the genetic variance components specific for the variable			
$\Delta\chi^2$ (*df*) vs. reduced ASE Cholesky model	**2.15 (1)**	5.06 (1)	**2.73 (1)**
Δp	**.14**	.02	**.10**
χ^2 (*df*)	**43.75 (54)**	47.57 (51)	**48.08 (51)**
P	**.84**	.61	**.59**
RMSEA	**.000**	.000	**.000**

RWA right-wing authoritarianism, *SDO* social dominance orientation, *NSX* narrow-sense xenophobia, $PREJ_{EU}$ prejudice toward EU nationalities, $PREJ_{NEU}$ prejudice toward non-EU nationalities, *DISC* discriminatory intent toward foreign nationals; analyses were based on twins' data (MZ pairs: 226; DZ pairs: 168); the best fitting models are shown in bold

variance in DISC (see Fig. 2c). However, not in line with *Hypothesis* 5, the genetic variance in $PREJ_{NEU}$ was only partially (30 %) mediated by RWA and NSX (Fig. 2b): $(.33^2 + .08^2)/(.33^2 + .08^2 + .53^2)$.

Beyond genetic mediation, multivariate model fitting results also yielded significant environmental mediations between SDO and $PREJ_{EU}$, between RWA and DISC, and between NSX and DISC. The model analyses also indicated a common variance in RWA, SDO, $PREJ_{EU}$, and DISC due to social homogamy.

Discussion

The current study (1) disentangled genetic from several environmental sources of variance in negativity toward foreign nationals taking phenotypic assortment into account, (2) tested the incremental validity of narrow-sense xenophobia in addition to RWA and SDO as potential predictor of prejudice and discrimination, and (3) investigated the extent to which genetic and environmental variance in prejudice and discriminatory intent were mediated by RWA, SDO, and NSX. For the most part, the findings supported our hypotheses and yield several implications for theories on prejudice and discrimination.

Genetic and environmental sources of variance in negativity toward foreigners

In line with previous research on prejudice (e.g., Bouchard and McGue 2003; McCourt et al. 1999; Verweij et al. 2008), we expected genetic roots of the variance in outgroup negativity (*Hypothesis* 1). Consistent with this hypothesis, our analyses revealed that about 17 to 32 % of the variance in prejudice and discriminatory intent toward foreign nationals was due to genetic contributions.

We found evidence of low to substantial genetic contributions to the variance in potential predictors (RWA, SDO, and NSX) of negativity toward foreign nationals.

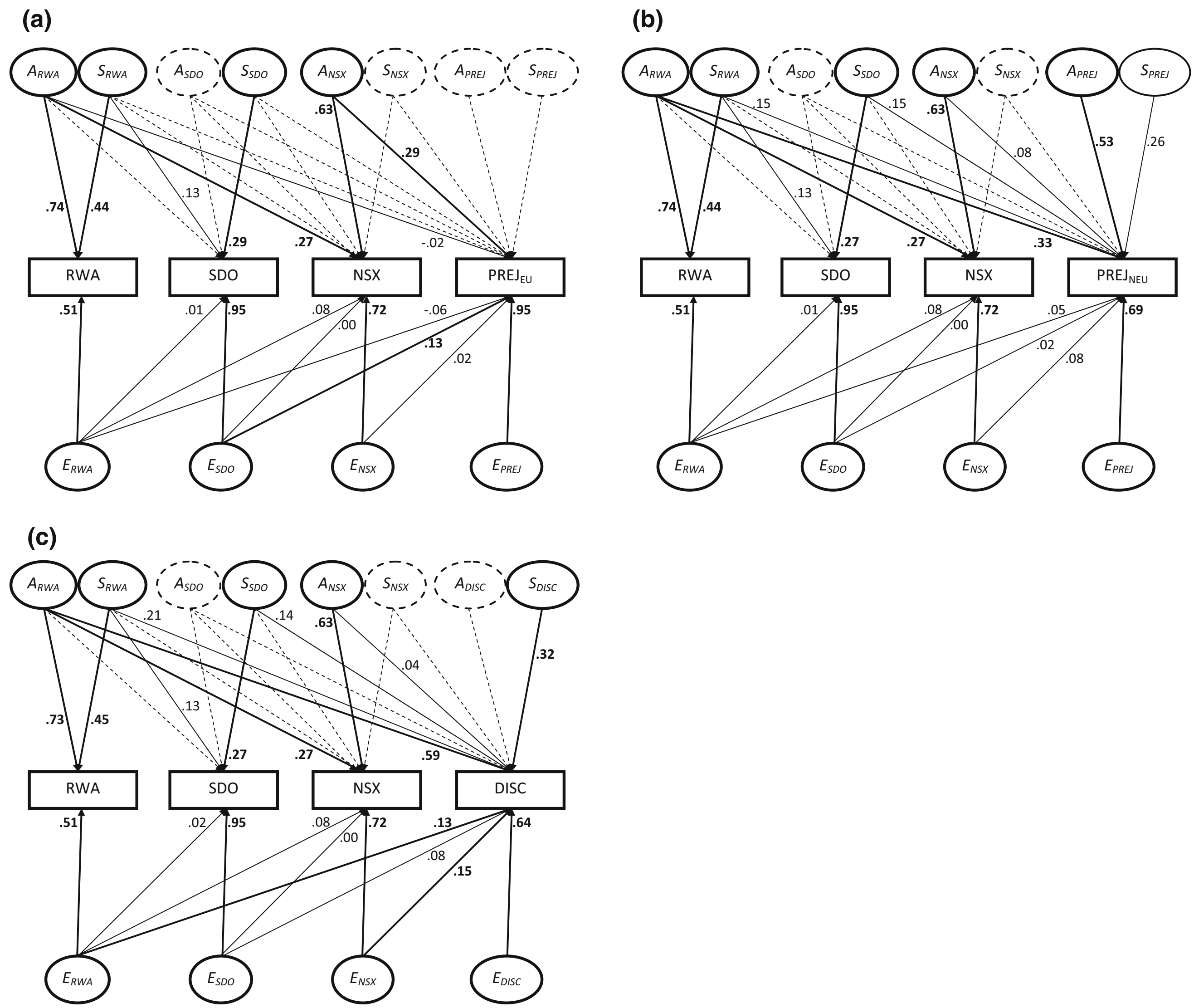

Fig. 2 Best fitting multivariate ASE Cholesky models with NSX, RWA, and SDO as potential predictor and **a** prejudice toward EU-nationalities ($PREJ_{EU}$), **b** prejudice toward non-EU nationalities ($PREJ_{EU}$), and **c** discriminatory intent toward foreign nationals (DISC) as potential dependent variables. *Dashed paths* are fixed to zero. *S*-effects are completely shared by twins and spouses of twins due to shared social background, *E*-effects are partly shared by twins due to twin-specific shared environmental effects $c_T \times e^2$, and *A*-effects are completely shared by MZ twins, but only partially by DZ twins: ½ × (1 + μ × a^2); standardized path coefficient estimates in *bold* were significant on $p < .05$. For simplicity, the model is shown for only one twin

Consistent with *Hypothesis* 2, RWA was substantially heritable, whereas SDO showed negligible heritability. This is in line with the finding that SDO is more context-sensitive than RWA (Lehmiller and Schmitt 2007). According to the DPM model (Duckitt and Sibley 2010), SDO is heated up in the face of conflict or competition between own and out-group.

Our study provides support for phenotypic assortment in the case of RWA, SDO, prejudice toward foreign nationals, and discriminatory intent (*Hypothesis* 3). Phenotypic assortment may reflect a mechanism that acts to maintain genetic variance in a population beyond other mechanisms potentially involved in preserving genetic variance in a population (e.g., mutation-selection balance). However, the results of our study also provided evidence for social homogamy as a driving force underlying spouse similarity in negativity toward foreigners. That is, for a substantial part spouse similarity and, thus, variance in negativity toward foreign nationals appears to be due to pure environmental origins.

In fact, a large proportion of variance in negativity toward foreigners was due to environmental effects. Whereas we found less support for twin-specific shared environmental effects for prejudice toward foreigners and discriminatory intent, there were significant environmental influences shared by twins that were completely shared with spouses and also between spouses of twins indicating a contribution of their shared social background. Similarly, shared environmental influences contributed to the variance as well as to the family similarity in RWA and SDO. These findings are in line with previous studies which have reported significant shared environmental influences for out-group attitudes (e.g., Hatemi et al. 2011) but negligible contributions of twin-specific shared environmental effects (e.g., Hatemi et al. 2010). That is, to some degree variance in negativity toward foreigners is attributable to variance among groups which twins and spouses of twins are members of. Those groups may represent religious and political groups, communes, associations, economic and educational milieu, or circles of friends which may communicate and mediate negative positions and discriminatory tendencies toward other groups. For example, negative stereotypes have been discussed as a form of fundamental psychological threat (Stephan and Stephan 2000) that may affect negativity toward foreign nationals. Negative stereotypes are mediated through social background and may thus reflect environmental influences shared by twins and spouses.

A small percentage of the environmental contribution to the variance in narrow-sense xenophobia was spouse-specific. That is, spouses may share important environmental influences (e.g., experiencing important events, traveling through different cultures, or having common friends with foreign nationality) that act to increase similarity in their fear toward foreigners. However, spouses themselves are important social interaction partners and reflect one of the most important social environments for an individual. Thus, spouse-dyads can be seen as important social microsystems which may act as protective or supportive factor that act to increase or decrease negativity toward out-group members. In line with this small spouse-specific effect, previous studies (e.g., Alford et al. 2011) found a modest upward trend for spouse similarity with the length of the relationship indicating that spouses may assimilate to a moderate degree across time with respect to their negative feelings and opinions toward foreigners.

Environmental influences became primarily manifest at the level of the individual that cannot be completely accounted for by error of measurement. On the one hand, individual-specific environmental influences may reflect individual perceptions or interpretations of environmental experiences which are objectively shared by in-group members (e.g., twins, spouses, friends); but on the other hand, they may also reflect objectively unique influences, such as individual life experiences. For example, an individual may have a job through which he or she is often communicating with foreigners through positive intergroup contact that may act to reduce negativity toward foreigners (Allport 1954).

Mediators of genetic and environmental effects on prejudice and discriminatory intent

Our study revealed that RWA and SDO showed significant links to prejudice and discriminatory intent against foreign nationals (although rather unexpected RWA tended to show a negative link to prejudice toward EU nationalities). According to the DPM model (Duckitt 2006; Duckitt and Sibley 2007, 2010), the links may be attributable to perceived competition (e.g., for jobs) in the case of SDO, or perceived threat to security and tradition, values, and norms in the case of RWA. Interestingly, RWA showed stronger links to prejudice toward non-EU nationalities and discriminatory intent. Turks and Poles reflect the largest groups of foreign non-EU nationals—at time of data collection—in Germany (Özcan 2007). People high on RWA may perceive large groups of immigrants with different customs and practices as more threatening with regard to societal certainty, culture, and values.

In line with *Hypothesis* 4, our study provides support for the incremental validity of narrow-sense xenophobia in addition to RWA and SDO as predictors of prejudice and discriminatory intent. RWA and SDO as cognitive-motivational orientations are related but conceptually and empirically distinct from NSX with its affective core (e.g., fear of strangers). Since NSX accounted for additional variance in prejudice and discriminatory intent beyond RWA and SDO, it poses questions regarding the DPM model (Duckitt and Sibley 2010). In the DPM model, RWA and SDO were the only variables considered so far to mediate between intrinsic (e.g., personality) and extrinsic sources (e.g., threat and competition) on the one hand and prejudice and discrimination on the other. Since RWA and SDO scores reflect attitudinal orientations rather than affect, the DPM model largely neglects the contribution of affective mediators. Consequently, we propose an extension of the DPM model by including at least narrow-sense xenophobia as a third core variable (i.e., intergroup anxiety, fear of strangers) extending the DPM model to a *Triadic Process Motivational* model.

Our study revealed that RWA, NSX, and SDO account for a moderate to substantial proportion of variance in prejudice and discriminatory intent against foreign nationals through both genetic and environmental effects. More specifically, genetic variance in RWA and NSX at least partly overlaps with the genetic variance in prejudice and discriminatory intent. Even though RWA, SDO, and NSX also mediate influences of environmental factors, our results indicate that the links between negativity toward foreigners and RWA and NSX appear to be largely genetically and, thus, intrinsically mediated. That is, people may differentially be sensitive to the experience of threat and competition which may not be actually experienced but subjective, imagined, or irrational (Park et al. 2003). These findings are largely consistent with *Hypothesis* 5: Core attitudinal and motivational orientations mediate all the genetic roots of prejudice and discriminatory intent toward foreign nationals.

Limitations and outlook

Although our study extends previous research on negativity toward foreigners, some limitations and perspectives for future research have to be mentioned. First, the sample size of our study was relatively small for twin studies and there was an overrepresentation of women relative to men and MZ relative to DZ twins. Accordingly, these results should be replicated in future studies with larger, more balanced, and more representative samples that may focus on possible differences between sexes.

Second, the model of twins reared together and their spouses presumes an equilibrium state across generations. Given changes over generations regarding the attitudes investigated (e.g., immigration politics), this assumption may not be tenable. Future studies using larger data sets across different generations (e.g., parents of twins, twins and spouses, and twins' offspring with their spouses) can provide an insight into the validity of this assumption.

Third, in keeping with the DPM model, in which RWA and SDO are assumed to represent antecedents of prejudice and discrimination, we assumed that NSX (as primarily an affective variable) reflects an additional basic antecedent of prejudice and discrimination. However, the design of our study was cross-sectional. Future longitudinal studies will be helpful to examine the causal relations between these variables.

Fourth, our study suggests that the level of discriminatory intent toward foreign nationals does not seem to depend on the specific nationality of foreigners. Principal component analyses of discriminatory intent toward Italian, Turks, Swedes, and Poles yielded only one component. However, we found larger links between discriminatory intent and prejudice toward non-EU nationals compared to the associations with prejudice toward EU nationals. This suggests that discriminatory intent is not associated with prejudice per se. Replication is needed and future research may focus on the issues (1) whether discriminatory intent is linked to prejudices moderated by the focused foreign nationality, or (2) whether discriminatory intent is a construct conceptually and empirically distinct from prejudice.

Fifth, we found that genetic influences accounted for variance in out-group negativity and that RWA and NSX mediate genetic influences on prejudice and discriminatory intent toward foreign nationals. But what are the origins of this genetic variance? To some degree phenotypic assortment can account for the genetic variance. It is possible that other more basic individual attributes which show strong genetic influences, such as personality traits, may share genetic variance with RWA, SDO, and NSX. Similar to the DPM model, in which Openness and Conscientiousness are proposed as predictors of RWA and in which Agreeableness is hypothesized as a predictor of SDO (Duckitt and Sibley 2010), specific individual personality traits may influence narrow-sense xenophobia. Meanwhile, several studies have shown that RWA is prospectively predicted by Openness (Perry and Sibley 2012; Sibley and Duckitt 2010) and that RWA mediates the effects of Openness on generalized prejudice (Ekehammer et al. 2004). The contribution of NSX suggests a possible involvement of the anxiety-related trait Neuroticism, which in turn is highly heritable (Keller et al. 2005; Pilia et al. 2006). Of interest, the difference between MZ and DZ twin similarity in our study also indicates both additive and nonadditive genetic factors on the variance in narrow-sense xenophobia, a finding also noted for Neuroticism (Hahn et al. 2012; Kandler et al. 2009). Until now, there have been inconsistent findings on the contributions of Neuroticism to out-group negativity. Some researchers have argued that Neuroticism is unrelated to prejudice (Sibley and Duckitt 2008; Ekehammer and Akrami 2003), whereas others have found significant positive links (McFarland 2010; Saucier and Goldberg 1998). Therefore, future research on the intrinsic roots of out-group prejudice and discrimination should include core personality traits to determine the association between such basic traits and prejudice/discrimination.

Finally, genetic variance in negativity toward foreigners may reflect genetic factors which trans- or interact with environmental influences (Johnson 2007). That is, genetically based differences in negativity toward foreigners may depend on environmental influences or may determine the kinds of environments that individuals avoid or choose to be in. Variance in self-selected environments, in turn, may affect individual differences in xenophobia. In line with this idea, Hatemi et al. (2010) reported significant genotype-environment correlations for attitudes toward immigration and segregation. Future studies including measured environmental factors (e.g., realistic threat or intergroup contact) are able to examine these mechanisms providing deeper insight into the gene-environment interplay accounting for the variance in negativity toward foreigners.

Conclusions

The current study demonstrates empirical support for negativity toward foreigners as a broad construct that includes attitudinal and behavioral components (prejudice and discriminatory intent) and basic ideological orientations (RWA and SDO) but also affect, such as the fear of strangers (narrow-sense xenophobia). Variance in out-group negativity was in part due to genetic factors and positive phenotypic assortment may reflect a driving force that acts to maintain this genetic variance in a population. Beyond genetic sources, multiple environmental factors (i.e., individual-specific, twin-specific, spouse-specific, and familial social background) become manifest in negativity toward foreigners.

RWA, SDO, and narrow-sense xenophobia account for incremental proportions of variance in prejudice toward foreign nationals and discriminatory intent. Thus, our study provides support for an affective component of out-group negativity in addition to RWA and SDO suggesting an extension of the DPM model (Duckitt and Sibley 2010). RWA and narrow-sense xenophobia primarily mediate genetic variance in prejudice and discriminatory intent. In sum, our findings suggest multiple genetic and environmental sources of variance in negativity toward foreigners.

Conflict of Interest Christian Kandler, Gary J. Lewis, Lea Henrike Feldhaus and Rainer Riemann declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent All ethical standard procedures were followed in accordance with standards declared by the Deutsche Gesellschaft für Psychologie (German Society for Psychology) and the American Psychological Association. All participants provided informed consent.

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