**The political animal: The roles of genetics, environments, evolution,
attachment, and personality in the formation of political attitudes**

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Individuals are not stable things, they are fleeting. Chromosomes too are shuffled into oblivion, like hands of cards soon after they are dealt. But the cards themselves survive the shuffling. The cards are the genes. The genes are not destroyed by crossing-over, they merely change partners and march on. Of course they march on. That is their business. They are the replicators and we are their survival machines. When we have served our purpose we are cast aside. But genes are denizens of geological time: genes are forever.

Richard Dawkins, *The Selfish Gene* (1976/2006, p. 35)

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Oslo, September 2020
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Summary

All of the four papers in this thesis concerns the evolution and underlying causes of individual differences in political attitudes and ideologies.

There are plenty of mysteries to unravel in the space of human individual differences, both generally and with political phenotypes. Why are almost all psychological traits heritable? Why is the unique environment an important source of variation, while shared environment generally is not? Does evolution maintain genetic differences between people? What causes genetic variation in political attitudes and prejudice, and why does the variation persist?

All these questions are big overarching questions. Even so, we will keep these questions in the back of our minds as we discuss our findings, as well as the broader range of relevant scientific literature.

In paper 1 we find that social dominance orientation (SDO)—the tendencies to prefer hierarchical or egalitarian relations between groups—correlate with several political attitudes for genetic reasons, suggesting the existence of genetically founded strategies regarding territory and resource control in human nature.

In paper 2 we find that attachment share very little variance with the socio-relational traits of right-wing authoritarianism and social dominance orientation, both at the phenotypic and etiological level. This is incompatible with several etiological conjectures where attachment is thought to influence the development of political and prejudicial attitudes. Nevertheless, we also find that both attachment and the socio-relational traits contribute (inversely) to interpersonal trust and altruism, both at the phenotypic and genetic level.

In paper 3 we investigate if right wing authoritarianism and social dominance orientation are best subsumed under big five personality variation, or if they are best viewed as separate genetic entities in human nature. We conclude that the socio-relational traits are indeed separate, but that they also work in conjunction with personality, especially openness to experience and agreeableness, in producing political and prejudicial attitudes.

In paper 4 we review the literature behind social dominance orientation (SDO), such as its psychometrics, predictive power, and construct validity. We also discuss its evolution, sex differences, and whether or not it can be said to be trait-like.

In the general introduction and discussion that follows, I will take the opportunity to discuss problems that are relevant for all of the papers in more depth. I discuss what politics is. I examine the theory behind the socio-relational traits of authoritarianism and social

dominance, as well as a discussion of the psychology involved in warfare and genocide. I go through the logic behind the heritability concept and multivariate twin methodology. I also take a closer look at interactions and correlations between genes and environments, especially the role active gene-environment correlation might play for personality and political phenotypes. I also discuss the notion of animal personality, its heritability, and the concept of adaptive as well as non-adaptive correlations of traits across situations (the concept a *behavioral syndrome*). I also discuss the role of inherent stochasticity during development. That is, to what extent can the well-documented effect of the non-shared environment, on political phenotypes as well as on other traits, be said to reflect the *external, idiosyncratic experiences* of individuals, or to *inherent stochastic processes* at the molecular level during the development of the brain?

Based on the findings embedded in this thesis, I conclude that political attitudes can be viewed as extensions from the general socio-relational traits of desiring in-group cooperation and submission to norms (as tapped by authoritarianism) and the desire for out-group domination (as tapped by social dominance orientation). My coauthors and I conjecture that the patterns revealed by our results suggests a genetically founded behavioral syndrome in human nature, designed to produce different adaptive strategies for navigating social hierarchies, and the divergent resource distributions triggered by such strategies.

List of papers

Paper I

Thomas Haarklau Kleppesø, Nikolai Olavi Czajkowski, Olav Vassend, Espen Røysamb, Nikolai Haahjem Eftedal, Jennifer Sheehy-Skeffington, Jonas R. Kunst, and Lotte Thomsen (2019). Correlations between social dominance orientation and political attitudes reflect common genetic underpinnings. *Proceedings of the National Academy of Sciences*, 116(36), 17741-17746.

Paper II

Thomas Haarklau Kleppesø, Nikolai Olavi Czajkowski, Olav Vassend, Espen Røysamb, Nikolai Haahjem Eftedal, Jennifer Sheehy-Skeffington, Eivind Ystrom, Jonas R. Kunst, Line C. Gjerde and Lotte Thomsen. Attachment and politics are two functionally distinct systems, but both share genetics with interpersonal trust and altruism

Paper III

Thomas Haarklau Kleppesø, Nikolai Olavi Czajkowski, Olav Vassend, Espen Røysamb, Nikolai Haahjem Eftedal, Jennifer Sheehy-Skeffington, Eivind Ystrom, Jonas R. Kunst, and Lotte Thomsen. The socio-relational personality: The genetic underpinnings of right-wing authoritarianism and social dominance orientation explains prejudice beyond big five personality.

Paper IV

Kleppesø, T. H*, Eftedal*, N. H., & Thomsen, L. (2020). Social Dominance Orientation (SDO). In T. K. Shackelford & V. A. Weekes-Shackelford (Eds.), *Encyclopedia of Evolutionary Psychological Science*. Cham: Springer International Publishing.

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Introduction: What is politics?

A key question in political science and psychology is if political attitudes have a deeper structure. That is, can political attitudes be reduced to one or a few coherent dimensions? The classical left-right structure originates from the 1789 French revolution where the supporters of the status quo sat on the right side of the French assembly hall, while the opposing side sat on the left. This old ideological conflict over change versus stability echoes age-old disputes regarding the roles played by hierarchy, authority and inequality (Burke, 1790; Haidt, 2012; Jost, Federico, & Napier, 2009).

If we think about social life as a game, politics can be considered as the set of rules that coordinates who is entitled to what resources, and how much. Inevitably, social interactions lead to conflict because the interest of individuals are usually not perfectly overlapping. Importantly, when modern individuals reason about social welfare, immigration and criminal justice, they do so with minds that evolved to deal with small-scale dilemmas in groups of 20-200 people (Petersen, 2015). In other words, human reasoning concerning politics are likely to have deep evolutionary origins partly because resource-distribution is an inevitable problem in a world of finite resources. Indeed, in many species the control of territory and resources is often due to the most formidable individuals forcefully taking control of them, which in turn generates dominance hierarchies (Goessmann, Hemelrijk, & Huber, 2000; J. M. Smith & Price, 1973; Van Vugt & Tybur, 2015).

Moral and political attitudes can change over time within individuals (e.g. due to education, see Eftedal et al., 2020), and they certainly change over generations, reflecting the zeitgeist of any historical period. Nevertheless, it is now clear that individual differences in political attitudes does not change willy-nilly, but are relatively stable and trait-like, very much like personality. These stable differences might reflect evolved political *strategies*.

Some individuals use strategies of deception and competitiveness to come out on top, combined with a winner-takes-all attitude. An example is Machiavelli's assertion that any worthy prince engaged in political games must "be a fox to spot the snares, and a lion to overwhelm the wolves" (2007, p. 68). Machiavelli goes on to suggest that this strategy would be pointless if "all men are good", but since he regards men as "wicked and not prepared to keep their word to you, you have no need to keep your word to them".

This attitude reflects the perception of many individuals as well as the basic gist of some ideological systems (i.e., economic isolationism and nationalism). Here, the world is a

zero-sum game: Resources and power are finite—abundance for us is scarcity to them, and vice versa—hence resources are best won, and kept, through forceful gatekeeping.

For others, cooperativeness, fairness, and equality are the desired rules of the political game. This point of view is well-encapsulated in John Rawls thought experiment on the *original position*. Here, imaginary representatives of real citizens come up with principles of justice under a *veil of ignorance*. That is, they do not know in advance what talents and abilities they will have in the society they construct. Hence, they are likely to be risk-averse and create conditions that will keep the suffering of the disadvantaged in check. Inevitably, some groups will have advantages, but the just society will consider the group memberships of real individuals—social status, ethnicity, gender, and so on—as irrelevant. Rawls (1971, p. 116) write:

After all, physical conflict and resort to arms result in an ordering; certain claims do win out over others. The main objection to this ordering is not that it may be intransitive. Rather, it is to avoid the appeal to force and cunning that the principles of right and justice are accepted. Thus I assume that to each according to his threat advantage is not a conception of justice. It fails to establish an ordering in the required sense, an ordering based on certain relevant aspects of persons and their situation which are independent from their social position, or their capacity to intimidate and coerce.

Note that for both Machiavelli and Rawls the basic problem under consideration is that some individuals and some groups, for whatever reason, are more formidable and powerful than others. And formidability is precisely what orders dominance rank across the phylogenetic tree (Goessmann et al., 2000; J. M. Smith & Price, 1973; Van Vugt & Tybur, 2015). But Machiavelli treats this as natural law and consequently that any individual or group interested in maintaining dominance and power, ought to be ruthless: To trust nobody. For Rawls, individuals and groups that take advantage of their above-average formidability and/or social position to keep their hierarchical position, is in itself the very problem to be solved.

Let's look more closely at dominance and egalitarianism as they can be found in nature.

Dominance and egalitarianism

Pogue Colonel: You write "Born to Kill" on your helmet and you wear a peace button.

What's that supposed to be, some kind of sick joke?

Private Joker: I think I was trying to suggest something about the duality of man, sir.

- Stanley Kubrick, Full Metal Jacket (1987)

Chimpanzees are extremely rivalrous. Here is Boehm (1999, p. 23) summing up his field observations of our evolutionary cousins:

Every young male, as he approaches or reaches adolescence, becomes driven by political aspirations. First, he displays at low-ranking adult females until they begin to pant-grunt submissively when they greet him. Then he moves on to the more formidable females. Sometimes he suffers reverses along the way, particularly if the females have allies to help them.

If these hierarchical pursuits work, the chimpanzee will move on to lower-ranking males, until eventually, Boehm continues, “he keeps working his way up the male hierarchy until he can go no further”. The reader will notice that such behavior patterns often mirror human behavior. Although chimpanzees, bonobos, and gorillas have many crucial social differences, they are all a lot more despotic than egalitarian—their social system depends on the ability to dominate. However, a key part of any hierarchical behavior is to submit when necessary. Boehm (1999) argues that human tendencies towards domination is innate, and that this tendency is the reason why all hunter-gatherer tribes that have been studied have developed levelling mechanisms that counter such domineering and keeps potential despots in check. Humans also naturally form hierarchies both within and *between* groups—a topic I return to, drawing on Social Dominance Theory (Sidanius & Pratto, 1999).

Despite evolved adaptations for status-seeking, several scholars have argued that hunter-gatherer societies are relatively egalitarian, and that egalitarianism and social levelling mechanisms are also key parts of human nature (Knauff, 1991; Sheehy-Skeffington & Thomsen, 2020; Woodburn, 1982). Although hunter-gatherer societies have sky-high homicide rates, partly due to continuous intergroup warfare (Chagnon, 1988), violent disputes within groups are often about the *levelling* of status amongst men.

The !Kung, a people that lived a hunter-gatherer lifestyle on the western edge of the Kalahari desert until quite recently, have a culture and ideology that focus on “the issue of controlling arrogance and anger among people” (Howell, 1979, p. 59). For instance, a successful !Kung hunter will mask his achievement in euphemism and denial, something that is encouraged and reinforced by the others. Boehm (1999 as cited by Lee, 1979, p. 244-246) make this point by quoting an insightful informant from the !Kung community:

When a young man kills much meat, he comes to think of himself as a chief or a big man, and he thinks of the rest of us as his servants or inferiors. We can't accept this. We refuse one who boasts, for someday his pride will make him kill somebody. So we always speak of his meat as worthless. In this way we cool his heart and make him gentle.

It could be tempting to over-emphasize the egalitarian culture in the !Kung, and argue with Rousseau that humans are by nature “noble savages” and that modern violence, war-mongering, and economic inequality are driven exclusively by corrupting institutions. In fact, removed from the shackles of hunter-gatherer cultural sensibilities and the natural constraints of nomadic lifestyles, inequality has clearly increased in the modern world¹. Modern inequalities in wealth are generated partly by the ability to *store* wealth, a process that started with the agricultural revolution and took off during the industrial revolution. Again, the evidence indicates that pre-historic humans were egalitarian, but not peaceful (Pinker, 2012, 2018). The hunter-gatherer egalitarian ethos is there precisely *because* the hierarchical tendencies so easily manifest itself. If humans were not equipped with adaptations for status-seeking and domination of others, there would be no need for leveling mechanisms, no need for anything to cool in men's hearts in the first place.

As a consequence, there is reason to believe that humans have adaptations related to the domination of others, which includes the capacity for warfare and genocide.

¹ Which does not justify any sentimental longings for the egalitarian past. Arguably, it is not inequality per se that is morally relevant, but the absolute number of people living in extreme poverty. In the vast breadlines of the USSR, everyone's equal, but none, of course, are any better off.

The human capacity for aggression, war, and genocide

There is evidence of warfare throughout human pre-history (Lekson, 2002). Archeological evidence from the late Pleistocene and early Holocene suggest that mass graves contain skeletons belonging to mostly adult males, often with evidence of weapon-related damage, such as spears (Bowles, 2009). Hence, the human mind evolved in a context of *intergroup* domination and warfare (Tooby & Cosmides, 1988, 2010). Many have argued that humans have a broad set of psychological adaptations that supports the formation of coalitions and the engagement in coalitional conflict. Note that this coalitional psychology is an abstract capacity. For example, racial categorization seems to be a byproduct of detecting coalitions, and not an adaptation in itself (Kurzban, Tooby, & Cosmides, 2001; Pietraszewski, Cosmides, & Tooby, 2014).

Ironically, intergroup warfare requires a high degree of social cooperation and altruistic sacrifice (Zefferman & Mathew, 2015). It would be necessary, for example, to detect cheating free-riders (Cosmides & Tooby, 1992), and also to manage the costs and benefits involved in conflict and warfare (Tooby & Cosmides, 1988).

A key fact regarding intergroup warfare is that it is almost exclusively performed by men, both historically and currently (McDonald, Navarrete, & Van Vugt, 2012). Due to a greater variance in men's reproductive success, men have an incentive structure that biases them towards risk-taking behavior (Trivers, 1972), including the risks involved with war (Zefferman & Mathew, 2015). In some cases, war provides the opportunity for men to gain access to territory, mates and social status (McDonald et al., 2012). In a set of experiments, men who were primed with pictures of attractive members of the opposite sex, supported warfare to a greater extent (Chang, Lu, Li, & Li, 2011). This was not the case with women who viewed attractive members of the opposite sex. This is consistent with the view that ancient evolved coalition systems in the minds of men are activated when reminded of potential rewards.

Men are more likely to be prejudiced as well as actively discriminate against others, but men are also overrepresented as *targets* of discrimination. Indeed, discrimination is usually targeted towards outgroup-males (Navarrete, McDonald, Molina, & Sidanius, 2010; Navarrete et al., 2009). One study found that women's subjective fear of being exposed to crime such as violent attacks and sexual assaults in their neighborhood (but not actual crime in their neighborhood) was associated with a preference for aggressive-formidable men (Snyder et al., 2011). The authors suggest that this pattern occur because women calculate a

trade-off between the protection that may be provided by aggressive mates, to the risk such aggressive mates would constitute to their own safety. Crucially, it also gives us a hint that the selective pressures that have led to sexual dimorphism in aggression and coalitional psychology is, at least in part, due to sexual selection and female choice.

As the introductory dialogue from Kubrick's film suggests, the evidence available suggests that humans have evolved proclivities towards both war and peace: A capacity for submission, appeasement and prosocial cooperation; but also hawk-like domination and even orchestrated genocide. These proclivities also vary dramatically between people. I will shed light on this last point with two historical examples before we move on to the psychological notion of the authoritarian personality.

Authoritarian genocide and individual differences: two historical examples

Human pre-history, as well as modern history, has made it clear that many humans have the potential for authoritarian aggression and intergroup warfare. This includes genocide—the deliberate destruction of all or most members of a group of people.

Consider the 1994 genocide of the Tutsi in Rwanda. During the span of a few weeks, close to a million people were brutally murdered by their neighbors. Hutu civilians were encouraged by their Hutu-led republic to kill all Tutsi neighbors, including infants, and to rape the women and steal all Tutsi property. Not all Hutu participated in the killings, but an estimate is that 200,000 people participated in the killings, where some killed many, some killed a few (Straus, 2004).

These facts reflect not just the human ability to unquestionably obey authority, even when it involves murdering neighboring groups, but also that this willingness *varies between people*.

Under Nazi Germany, the Order Police (*Ordnungspolizei*), were a major perpetrator of the Holocaust in occupied Poland. One example is the Reserve Police Battalion 101, a unit of about 500 men, of which most were middle-aged, too old for the army. Few were members of the Nazi party, but were ordinary working-class men. Yet, they methodically terrorized and massacred individual Jewish men, women and children.

The historian Browning, in his book *ordinary men*, writes (2001, pp. 24-25):

the number of men recruited from native populations into auxiliary units under the Order Police increased nearly tenfold in 1942, from 33.000 to 300.000. There was a constant tendency to assign the actual shooting duties to these units, in order to shift the psychological burden from the German police to their collaborators.

Clearly, it was not hard to recruit murderers. Even so, some of the men, especially after finding themselves covered in blood, bone splinters and brain tissue after, point-blank, shooting rows of Jews in the neck, asked to be excused from the task, and they were. For example, about a dozen men from Police Battalion 101 were excused by the leadership and sent home, without hesitation or any personal repercussions. The relatively voluntary nature of this would have led to a strong selection of the relevant personality traits that leads to a willingness, or even desire, to kill perceived deviants and to blindly follow orders. Indeed, some Jews escaped the ghettos before capture, leading some of the Battalion men to hunt Jews in the nearby forest for sport.

We will now turn to variation in the *authoritarian personality* and the fact that it seems to exist in the normal population. Consistent with the idea that such traits exists, Brown (2001, p. 223) observes that “modern governments that wish to commit mass murder will seldom fail in their efforts for being unable to induce ‘ordinary men’ to become their ‘willing executioners’.”.

The authoritarian personality

The individual's pattern of thought, whatever its content, reflects his personality and is not merely an aggregate of opinions picked up helter-skelter from the ideological environment.

- Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950, p. 176

To explain the popular appeal of anti-Semitism and fascism in 20th century Europe, Adorno, Frenkel-Brunswik, Levinson and Sanford devised the concept of *the authoritarian personality* in a landmark book of the same name (1950). The book challenged the assumption that fascism could be reduced to fringe politics. They set out to identify a psychology of the fascist. And the book aimed to do this with the conjecture that fascism is better understood as the manifestation of an underlying psychological core that forms in early

childhood, and later hardens into a coherent syndrome of attitudes on hierarchy, power, toughness, sexuality and tradition (Gordon, 2019). Their key observation that different prejudicial attitudes—towards Jews, blacks, gays, atheists, and so on—tend to correlate is by now a well-replicated finding, still forming a key part of the modern psychology of prejudice (Akrami, Ekehammar, & Bergh, 2011; Guimond, Dambrun, Michinov, & Duarte, 2003; Sibley & Duckitt, 2008; Sidanius, Cotterill, Sheehy-Skeffington, Kteily, & Carvacho, 2016). Another key idea was that this personality syndrome could become widespread under threatening social conditions, because people would then be especially vulnerable, emotionally and cognitively, to ethnocentric hostility towards minorities, as well as fascist ideology (Adorno et al., 1950; Duckitt, 2015).

Adorno et al developed the F-scale (fascist scale) to measure this underlying authoritarian trait (see p. 226 in 1950). Examples of items include relatively direct and obvious ones in postwar America, such as, “after we finish off the Germans and the Japs, we ought to concentrate on other enemies such as rats, snakes, and germs”, but also “although many people may scoff, it may be shown that astrology can explain a lot of things”, and, “the sexual orgies of the old Greeks and Romans are nursery school stuff compared to some of the goings-on in this country today, even in circles where people might least expect it”.

The items with sexual undercurrents were based on the psychoanalytical idea that repeated sexual repressions in childhood leads to authoritarianism, an environmental etiological assumption we will return to. The important idea is that it is possible to triangulate on a meaningful underlying trait that generates authoritarian and anti-democratic tendencies with nonobvious items. This laid the groundwork for future developments in political psychology: Namely, that it was possible to measure the fundamental parts that *could manifest* itself as antidemocratic attitudes, but might in itself be pre-political. However, the items of the F-scale were found to be too unfocused leading to inadequate psychometric properties, including high agreement bias. An update was provided by Bob Altemeyer, in the construct of Right-Wing Authoritarianism (RWA) (1981). We use a short version of RWA (Zakrisson, 2005) in paper two and three in this thesis. RWA focus on three highly covarying dimensions, taken from a set of Adorno et al’s original conceptions: (1) *Conventionalism*, the tendency to adhere to traditions, and a dislike of deviance from social norms in society; (2) *Authoritarian submission*, the tendency to defer to established authorities; and (3) *Authoritarian aggression*, a hostile attitude towards what established authorities perceive as social deviants and outgroups.

People high in RWA seek to minimize diversity, and are in favor of restricting speech and punish political dissidents and immigrants. They feel that traditional moral values are to be enforced. Note that the three dimensions are by design relatively abstract, in order to capture higher-order tendencies that work across contexts. What is considered social deviancy, for example, will vary in time and in different places.

Although Altemeyer, and most early scientists in political psychology focused on *right-wing* authoritarianism, aggressive adherence to authorities is of course not exclusively right-wing. Antidemocratic attitudes often manifest themselves in *tribalism*, and recent evidence has suggested that authoritarianism exists on both sides of the political spectrum (Clark, Liu, Winegard, & Ditto, 2019; Conway, Houck, Gornick, & Repke, 2018; Costello, Bowes, Stevens, Waldman, & Lilienfeld, 2020).

Within political psychology it has become clear that right-wing authoritarianism is predictive and important, but is more complete, and explanatory powerful, when viewed in conjunction with *social dominance orientation*.

The socio-relational personality: Social Dominance and the dual-process model

Social dominance orientation measures individual differences in the desire to establish and maintain hierarchies between groups (Pratto, Sidanius, Stallworth, & Malle, 1994; Sidanius & Pratto, 1999 see also paper four in this thesis for a review). From the early 1990s and onward, this has been recognized as a complementary individual difference measure for understanding political psychology and political attitudes.

Modern human societies tend to organize themselves as group-based social hierarchies. Resources, such as territory, prestige, wealth, food, homes, and access to healthcare tend to be unevenly distributed between groups. Why is this the case? Social dominance theory argues that beliefs in *hierarchy-enhancing myths* serve the function of reducing conflicts between people (Sidanius & Pratto, 1999). For example, when people in medieval Europe accepted the absolute and god-given authority of their monarch (the so-called *divine rights of kings*), it provided a metaphysical basis for unequal resource-distribution and the legitimacy of monarchical power. This arguably generates order, unambiguity and coherence for large groups of people. *Myths* that aim, instead, to *attenuate* hierarchies between groups, such as universal human rights, feminism, and socialism, tends instead to emphasize equality, and are impatient with rigid intergroup hierarchies. According

to SDT, these hierarchy-attenuating myths can provide order as well, if everyone agrees with them and their egalitarian means of distributing resources.

The modern constructs of RWA and SDO are both powerful predictors of political and prejudicial attitudes (Altemeyer, 1981; Sidanius & Pratto, 1999), and even willingness to participate in state-sponsored persecution of outgroups (Thomsen, Green, & Sidanius, 2008). People high in RWA emphasize in-group homogeneity and authoritarian submission, while people high in SDO emphasize between-group hierarchy. Sinn and Hayes (2017, 2018) have conjectured that coalitional competition have resulted in the human mind evolving RWA to enhance cooperation within the group and, at the same time, evolved SDO for the capacity for domination of *other* groups in order to access their fitness-relevant resources (McDonald et al., 2012; Sinn & Hayes, 2017, 2018). Hence, there might be a deep synergy between people with high RWA (submissive followers) and people high in SDO (domineering leaders). These constructs are correlated, often between .2 and .4, so some score highly on both. Both RWA and SDO are underlying drivers of different types of prejudice, both have therefore been put together in the *dual process model of ideology* (Duckitt, 2001; Duckitt & Sibley, 2010; Duckitt, Wagner, Du Plessis, & Birum, 2002; Perry, Sibley, & Duckitt, 2013).

High-RWA-high-SDO, or “double-highs” would in the provocative words of Altemeyer (2004, p. 421),

seem to combine the worst elements of each kind of personality, being power-hungry, unsupportive of equality, manipulative, and amoral, as social dominators are in general, while also being religiously ethnocentric and dogmatic, as right-wing authoritarians tend to be

The etiology of the socio-relational personality: Socialization, attachment, and the Standard Social Science Model

How does variation in authoritarianism, social dominance and political attitudes come about? The idea that parenting and early socialization can influence political inclinations and prejudice have long traditions, still important to this day, especially in the attachment literature (see paper two and Bowlby, 1969; Koleva & Rip, 2009). It is certainly plausible *a priori* that authoritarian parenting could cause later political authoritarianism in offspring. Indeed, a key part of attachment theory is that one’s relational strategy, or attachment style—whether one tends to be secure, anxious or ambivalent in relationships—is affected by the

early relationship to caregivers. This has been suggested for a long time for authoritarianism as well: Parenting styles—affectionate or not, domineering or laissez-faire, and so on—should affect adult political attitudes. However, in paper two we fail to find evidence that attachment is related to political phenotypes at all (more on this in the forthcoming discussion on paper 2).

The socialization account forms part of a long tradition in psychology, from psychoanalysis to behaviorism, where environmental determinism is given the upper explanatory hand. The *a priori* assumption of environmentalism forms part of what Tooby and Cosmides (1992) coined *the Standard Social Science Model* in their classic chapter on the psychological foundations of culture. Neale and Maes (1992, p. 3), in their book on the methodology for genetic studies, share a comment from a reviewer that encapsulate the spirit of the standard social science model assumed by many traditional social scientists:

It is probably alright to use the twin study to estimate the genetic contribution to variables which you know are genetic like stature and weight, and it's probably alright for things like blood pressure. But it certainly can't be used for behavioral traits which we know are environmental like social attitudes!

Example of such attitudes is to be found all over Adorno et al.'s *authoritarian personality*. As a sign of its time in the 1950s, it is deeply embedded in psychoanalytic ideas. This becomes especially clear when they discuss the *etiology* of the authoritarian type. In part, the book is based on questionnaire data, but also clinical case studies: Extensive interviews are used throughout the book. An example is a description of a high-scorer on ethnocentrism, "Mack" (Adorno et al., 1950, p. 36). Mack is an Irish-American college freshman who claims to never have "met an Irishman I didn't like", and even reveals that he finds "the polish people interesting" (p. 36). However, he also discloses to the interviewer that he has "a little dislike for Jewish people" and that "Austrians, the Japanese I never cared for; Filipinos—I don't know—I'd just as soon leave them as have them".

Growing up, Mack's mother was often sick, and she died when he was young. Although his father was domineering, Mack reveals that his father "spent all of his time with us after mother died" (p. 788). Sanford (who wrote this part of *the authoritarian personality*) doubts that the father could have spent *all* of his time with Mack, and instead argue that "it is likely that after the mother's death Mack turned to his father for love and comfort, but there is no evidence that he received it in adequate measure" (p.792). Overall, the picture emerging

from Mack's clinical interview is that his "surface attitudes towards his father is one of submission and admiration". This leads Sanford to argue that Mack's dislike for Jews, is based in his father-son dynamics. If we take this causal hypothesis seriously, this would lead us to expect, in behavioral-genetic language (that we turn to in the next section), that the shared environmental variance component should explain a sizable fraction of the fascist syndrome.

That genes can have any influence on social, political, and moral beliefs crash so profoundly with human causal intuition that it has provided one of the last sanctuaries for environmental determinism. How can political beliefs possibly be caused by genes? One the face of it, it seems like a contradiction in terms, bordering the oxymoronic. However, over the last twenty years, the evidence for genetic influences on political traits (for a review, see Dawes & Weinschenk, 2020) have become overwhelming. Within the adult attachment literature, there is a slow turning of the tide as well (Barbaro, Boutwell, Barnes, & Shackelford, 2017; Donnellan, Burt, Levensky, & Klump, 2008), which of course is one of the most explicit environmental theories in all of psychological science.

I will now turn to the methodology of twin studies, a methodology that can help us detect genetic, as well as environmental, influences on variation and covariation of any number of psychological variables, including, needless to say, political phenotypes and social attitudes.

Behavior genetics and the mathematical modelling of individual differences

The goal of behavior genetics is to understand how individual differences in psychological traits come about. Broadly conceived, these differences are produced either by differences in genes, differences in environments, or some interaction between them. The phenotype of an individual can then be thought of as the sum of all genetic effects and all environmental effects:

$$P = G + E \tag{1}$$

This equation says that the phenotype (P) of any individual is the sum of independent effects of genes (G) and environments (E). However, direct measurements of G and E, especially on any one individual, are often not available; we just know that they will sum to P. However, biology predicts how similar individuals will be, because we know the degree to

which variance components will be shared between different types of individuals. That is, if we measure a phenotype—such as a political attitude—on a set of individuals that have a known genetic relationship, for instance between parents and offspring, siblings, or between monozygotic and dizygotic twins, quantitative genetic modelling allows for the estimation of *variance components*:

$$\sigma_P^2 = \sigma_G^2 + \sigma_E^2 \quad (2)$$

Where phenotypic variance (σ_P^2) is equal to the sum of a genetic variance component (σ_G^2) and an environmental variance component (σ_E^2), assuming the covariance between G and E is zero.

Genes and heritability

Within most human cells, there are vast stretches of spiral-formed molecules, DNA, that stores information on how to develop and maintain a human being. The information is distributed across 23 pairs of chromosomes. One member of the pair is inherited from the mother, the other from the father. At any particular locus on a chromosome, there are therefore two available copies (alleles), sometimes these two copies will be identical (homozygous), and sometimes they will differ (heterozygous). Differences between the pairs occur ultimately because of a mutation, which is either new (de novo), or inherited. Across the population at large, there can be many or just a few alleles that compete for the spot at any one loci. This variability can reflect past selection pressures where some gene functions are highly conserved and variability hence kept at a minimum, while it is kept high at other loci (e.g. genes involved with pathogen defense).

If alleles have different effects on a phenotype, and these effects are completely independent of each other, the effects simply add up in a linear fashion, and is called “additive”. Non-additive means that different alleles interact in some way, the two main types being dominance and epistasis. Dominance refers to interactions between two alleles at the same loci (intralocus), where one allele masks or overrides the other variant. Epistasis refers to interactions occurring between alleles across the entire genome (interlocus). For example, an allele could contribute to increased creativity in one genomic context, while promoting risk for mental disorder in another (for a discussion of this, see Nettle, 2001).

We can disentangle the total genetic variance component in equation 2 in the following way:

$$\sigma_G^2 = \sigma_A^2 + \sigma_D^2 + \sigma_I^2 \quad (3)$$

Where σ_G^2 refers to the total genotypic effect; σ_A^2 to additive genetic effects; σ_D^2 to dominance; and σ_I^2 to epistasis. Heritability is the proportion of the total phenotypic variance that is attributable to genotypic variance:

$$H^2 = \frac{\sigma_G^2}{\sigma_P^2} \quad (4)$$

Because the numerator in this fraction contains all of the genetic effects, it is called *broad-sense heritability* (H^2). When the numerator contains only the additive genetic effects, it is called narrow-sense heritability (h^2):

$$h^2 = \frac{\sigma_A^2}{\sigma_P^2} \quad (5)$$

If heritability is greater than 0 it indicates that at least one allele has a measurable effect on *differences* in the phenotype². One way to think about narrow-sense heritability is that it gives an estimate of genetic determination: it gives an estimate of whether a trait will “breed true”, because it contains all the independent effects of alleles and ignores both intralocus and interlocus interaction effects (Falconer & Mackay, 1960/1996). However, as we will see in the section on gene-environment correlations, it is often sensible to think about indirect genetic effects as forming part of heritability in the broad sense. Genes often have effects outside of the organism’s body in addition to simple inside-the-skin effects—they can be part of an extended phenotype (Dawkins, 1982).

² It is therefore meaningless to use the concept of heritability for traits that do not vary, such as the number of eyes across individuals. This does not mean, of course, that genes are causally irrelevant for developing a pair of eyes.

Logic of the twin method

If we measure a psychological trait in biological siblings who grow up in the same family and estimate a correlation coefficient between them, there is no way of knowing if the correlation is caused by shared genes or shared environments. In twin studies, we can take advantage of the key biological fact that monozygotic twins share the vast majority of their genome, while dizygotic twins share .5 of their segregating genes (on average). By comparing the correlation between monozygotic (MZ) and dizygotic (DZ) twins, we can therefore estimate the balance of genetic and environmental effects because we *expect* the DZ genetic differences to be half of the MZ genetic difference:

$$r_{MZ} = h^2 + c^2 \quad (6)$$

$$r_{DZ} = \frac{h^2}{2} + c^2 \quad (7)$$

Here, r_{MZ} refers to the correlation between monozygotic twins, r_{DZ} refers to the correlation between dizygotic twins; h^2 refers, as we have seen, to additive genetics effects, and c^2 to shared environmental effects. If we subtract the r_{DZ} equation from the r_{MZ} equation, we can derive the expression:

$$h^2 = 2(r_{MZ} - r_{DZ}) \quad (8)$$

Narrow sense-heritability is here defined as twice the difference between MZ twins and DZ twins. This formula was first formulated by the geneticist Falconer (1960/1996). His two other equations for the shared and nonshared environment, respectively, are:

$$c^2 = r_{MZ} - h^2 \quad (9)$$

$$e^2 = 1 - r_{MZ} \quad (10)$$

These equations provide a useful intuition: the shared environment is variance that make twins more similar to each other after subtracting heritability. The nonshared environment is a statistical rest category, meaning that it contains all variance that *does not* contribute to similarity between MZ pairs. If there are any differences between monozygotic twins, this will be due to nongenetic differences. It will therefore include not just any effect of

external environments that are specific to the individual, but also measurement error and any inherent stochasticity in molecular development (a topic we return to). The phenotypic variance of both an MZ and a DZ twin will be the sum of all these components:

$$\sigma_p^2 = h^2 + c^2 + e^2 \quad (11)$$

Structural equation modelling of twin resemblance

In modern behavioral genetics, formal model-fitting techniques are used in order to estimate the variance components that I discussed above. Today, structural equation modelling (SEM) is almost uniformly used in twin studies, due to the flexibility it gives (compared to a standard regression approach) (Heath, Neale, Hewitt, Eaves, & Fulker, 1989). With software, such as OpenMx (used for all the papers in this thesis), it is possible to model the observed variance-covariance matrix between DZ and MZ twin pairs. The model will generate an *expected* variance-covariance matrix. One important advantage of using a structural equation approach is that it is possible to compare the fit of several models at the same time. For example, for comparison of an ACE model, AE, and CE model (described below). A fit statistic, usually Akaike's Information Criteria (Akaike, 1987), can be obtained in order to choose the model that (1) is the most parsimonious and (2) generates an expected variance-covariance matrix that match the observed data as closely as possible (Purcell, 2008).

The ACE model

The most commonly used model in behavior genetics is the ACE model, where variance is decomposed into A (additive genetics), C (shared environment), and E (unique environment). Dominance is usually excluded, because the effects of dominance and the shared environmental are not identified at the same time (Evans, Gillespie, & Martin, 2002). This is also the approach used for the papers in this thesis. The expected variance-covariance matrix from an ACE model is summarized in path analytic notation in figure 1.

Figure 1. A univariate ACE twin model in path analytic notation

Note. MZ = monozygotic; DZ = dizygotic; A = genetic; C = shared environment; E = non-shared environment.

This path-analytic figure contains all the information in equations 8-11. The figure illustrates a univariate model. Classical univariate twin analyses compare correlations between monozygotic and dizygotic twins on *one* phenotype and decomposes the variance into genetic and environmental variance components. However, this model can be extended to include even more measured phenotypes (multivariate twin modelling), like we do in the papers in this thesis.

Multivariate ACE models: Genetic and environmental correlations

By including several measured phenotypes on the twin pairs, it is possible to estimate genetic and environmental correlations between them. That is, multivariate genetic analyses can investigate the *origins of covariance* between traits. For example, if we measure openness to experience for one twin and right-wing authoritarianism in the other, we can investigate (and model) the cross-correlation between openness in one twin, and right-wing authoritarianism in the other twin. If the cross-trait correlation is greater amongst monozygotic twins, genetic contributions to the covariance are implied. That is, their phenotypic correlation is in part an expression of shared genetic substrate. Hence, multivariate models take advantage of more correlational information, not just between MZ and DZ twins for the same trait, but between MZ and DZ twins across *different* traits.

The genetic correlation between two traits is the fraction of variance that the traits share due to genetic causes. So a nonzero genetic correlation implies that both traits are at

least partly heritable, and that part of that heritability might be shared between them. It is possible for two traits to have a low phenotypic correlation, but have a high genetic correlation. And, conversely, it is possible for two traits to have a high phenotypic correlation, but a low genetic correlation. If the genetic correlation is 1, it means that the two sets of genetic influences overlap completely, and if it is less than 1, at least some genes are a member of just one of the two sets of genes (Posthuma, 2009). Similar reasoning applies to the environmental correlations too (both shared and unique).

There are several variants of the multivariate model where each have different features that suit different research questions (see Røysamb & Tambs, 2016). See figure two for a visualization of two important ones for this thesis: A correlated factor solution, and the Cholesky model (Loehlin, 1996). The Cholesky model provides an advantageous way of decomposing the multivariate correlation structure of the variables. However, it can be problematic in some scenarios, for example when running sex-limitation models (that is, models where the genetic, shared environmental, and unique environmental correlations are constrained to be equal across sex) (Neale, Røysamb, & Jacobson, 2006).

In the correlated factor solution (visualized to the left in figure 2, here with three variables), the correlations between the latent variables are explicitly modelled (the r_A and r_E pathways). Note that both of these models are algebraically equivalent: they are merely different ways of displaying the same information. The appropriateness of any one of them depends on what kind of information that is of interest for a particular research question.

Figure 2. Two trivariate examples of multivariate ACE modelling

Note. The trivariate model on the left is a correlated factor solution. The trivariate model on the right is a Cholesky model. rA = genetic correlation; rE = unique environmental correlation. For simplicity, the models are displayed without C (shared environment) effects, and with the variables for only one member of the twin pair.

Interactions and correlations between genes and environment

In the equation (eq. 2) where variance in a phenotype (P) is equal to the sum of genetic variance (G) and environmental variance (E) there is an important assumption, namely that both G and E are independent and simply add up. That is, that G and E do not *interact*, or *correlate*. The causal interpretation of genes and environment can break down if these assumptions do not hold. In that case we can expand the abstract equation to:

$$P = G + E + GxE + covGE \quad (12)$$

Here, the GxE term refers to gene environment interaction, and covGE refers to gene-environment correlation (or covariation). GxE interaction refers to the case where genotypes differ in their sensitivity to different environments (Evans et al., 2002). Gene-environment correlations, on the other hand, occur when genetic differences bias variation in environments in which developmental occurs (Lynch, 2017), or in other words, result in the non-random placement of different genotypes in different environments (Evans et al., 2002). Whether or not it is important to add terms for interaction and/or correlation is phenotype-dependent, and ultimately an empirical question.

A note on interactions between genes and environment

The notion of gene-environment interaction sometimes create confusion, due to an conflation of “common-sense” interaction and statistical interaction (Sesardic, 2005). The common-sense notion is that two causes, A and B, cannot by themselves produce an outcome, C, because one cause is entirely dependent upon the other (e.g. the presence of oxygen and the striking of a match interact to produce fire). Some have used the common-sense interaction idea to claim that heritability estimates in humans are misguided or irrelevant (For an excellent in-depth discussion of this, see Sesardic, 2005). It is of course true in a metaphysical sense that an environmental effect cannot occur in the absence of genes, or that genetic effects cannot occur without environments (whatever that would mean). However, the statistical interaction is different. If present, it says that a change in one variable, A, does not produce the same outcome, C, across all situations, because the effect varies depending upon the value of B. Let’s consider an example where we have an equal distribution of two alleles in a population (A1 and A2), and two environments (E1 and E2). An example of an extreme GxE interaction would be the case where A1 produces a low phenotypic value in E1 and a high phenotypic value in E2, while A2 produces a high phenotypic value in E1, but a low phenotypic value in E2. In this extreme scenario, it is indeed meaningless to talk about any *main* effect of either genes or environments. The net effect of moving from A1, to A2, for example, cancel out because they have opposite effects in the two environments. Hence, the statistical interaction explains all of their effect.

For complex human psychological traits such as political ideology, where there are usually hundreds of alleles involved (polygenic), and where every gene has several effects (pleiotropy), GxE are likely to be much smaller than in our artificial example (although there could be important variation depending on the phenotype in question).

Gene-environment correlations

As we saw, gene-environment correlation is the non-random placement of genotypes into environments. This can happen passively, evocatively, or actively (Plomin, DeFries, & Loehlin, 1977).

Passive G-E correlation can occur when parents provide not just their children’s genes, but also their developmental environment. If two parents both have strong anti-democratic beliefs, and we assume that this trait is heritable, their children will not just share many of

those genes, but also the developmental environment that their anti-democratic parents provide (e.g., the availability of communist literature, propaganda posters of Mao and Stalin).

Evocative (or reactive) G-E correlation on the other hand can occur when the developmental environment is imposed upon an individual due to the display of their heritable trait. If, for example, liberal political attitudes lead to complete social exclusion in a community, and we again assume that liberal attitudes are heritable, the display of her political preference results in complete social exclusion from her community, leading to lower social skills. In our made up scenario, genes causing liberal political attitudes thus lead, indirectly, to lower social skills, but this effect is entirely mediated by ostracization, an environmental variable.

Should passive, evocative, or active G-E correlations be subsumed under genetic or environmental variance? Causal intuitions here can vary depending on the phenotype or whether we perceive the phenotype as “blameworthy” (see Lynch, 2017; Lynch & Bourrat, 2017). Here, we will focus our discussion on active gene-environment correlations.

How to pick your niche or make your gene-environment correlations active

In active G-E correlation the developing individual is not just a passive recipient of the environment, but instead *shape* the environment depending on genetic proclivities. This process might act as an amplifier of the genetic effects in political attitudes and ideology, and possibly also personality traits. The logic behind active G-E correlation bears resemblance to Richard Dawkins (1982) concept of the *extended phenotype* where the effect of genes is not just those produced by internal synthesis of proteins, but also the effects of behaviors on the world. Dawkins use examples such as the beavers dam or the cathedral-like structures of some termite species. These are effects of genes that are clearly outside of the boundaries of the organism’s bodies. For this reason, many argue that active-gene correlation should be regarded as part of broad-sense heritability (H^2) (Lynch, 2017; Lynch & Bourrat, 2017; Sesardic, 2005).

In an interesting experiment on inbred mice, all living in the same enriched environment, Freund et al (2013, p. 759) observed that there was a “massive magnification of individual differences in explorative behavior”. This evidence strongly suggests that there is some important process that *amplify* differences in this trait over time, even in the absence of genetic differences. Indeed, Freund et al concludes that the rich environment gave life to a “life space” and a “mouse individuality”. This is similar to the arguments that have been made

for human personality. In a review on the evolutionary genetics of personality, Penke and Jokela writes (2016, p. 106):

Individuals of our species are especially good at seeking out and creating environments that suite their individual preferences, needs and capabilities. This tendency, variably called active gene–environment correlation, experience-producing drives, or niche picking and construction, can systematically lead individuals to place themselves into environments where their specific personality profiles yield the best-possible fitness pay-off.

Suggestive of such active G-E correlations, or niche-picking tendencies, one study found that high openness and low agreeableness increased the probability that someone will migrate to a different state in the US (Jokela, 2009). A relationship that still held after controlling for sex, age, education, employment status, and neighborhood satisfaction. Something similar seems to be going on with cognitive ability, which also predicts migration to urban areas (Jokela, 2014). Further, data indicate that individuals living on islands in Italy have lower openness and extraversion compared to their mainland counterparts (Ciani & Capiluppi, 2011). Interestingly, the authors conclude that this pattern is best explained by *gene flow* rather than environmental change. That is, the evidence is consistent with the idea that openness and extroversion drives the migration to urban areas, rather than urban areas causally changing personality environmentally. Hence, if different alleles contribute to differences in openness early in life, these initial differences might be amplified over time and contribute to the H^2 of this trait.

Openness in particular is related to creative and intellectual interest, as well as liberal political attitudes. It is therefore unsurprising that high openness individuals tend to prefer jobs involving abstract and creative thought (Ozer & Benet-Martinez, 2006). Indeed, the level of average openness in US states was related to the fraction of individuals working in art and entertainment, the computer industry, as well as per capita patent production, a relationship that still held after controlling for education and income (Rentfrow, Gosling, & Potter, 2008). This shows that individual trait levels are likely to influence choices with fitness consequences. And, in this case, even contribute to high-level societal phenomena such as economic growth.

Let's think about G-E correlation with a political example. Imagine a boy whose interest in hierarchical activities are above average, such as enjoying dominating others in

play. He naturally seeks out like-minded children in order to spend time playing hierarchical and skill-based games. This tendency lasts into adolescence and, over time, reinforces the initial fondness for hierarchical social structures. As an adult, the boy scores high on social dominance orientation and develops attitudes such as being tough on drug-crimes in order to keep addicts, poor people, and the mentally ill in prisons, in order to maintain the existing status hierarchy in society.

This example is obviously fictitious and speculative, but the point is to illustrate that the genetic effects on ideology that we have found in our papers is not necessarily direct. Genes code for proteins, not ideologies. Consistent with this point, the human tendency to pick a niche, seems to lead to individuals reinforcing their political views. For example, one study found that police officers in Los Angeles had the highest average score on social dominance orientation when compared to jurors (representing a random sample of the general population), university students, and public defenders (Sidanius, Liu, Shaw, & Pratto, 1994). Interestingly, the public defenders had the lowest social dominance score of all. This makes sense because choosing to work for people who cannot afford a lawyer is clearly an act that will reduce intergroup inequality, suggesting that you choose professions that either enhance or attenuate hierarchies between groups depending on your initial SDO level. Similarly, border police in Israel had higher authoritarianism scores than career soldiers and airport security guards (Rubinstein, 2006), again suggesting that pre-existing authoritarian traits guide career choices, and might also be reinforced over time.

Future longitudinal studies with genetically sensitive data would be helpful to fully elucidate the causal processes involved here, but overall, the available data indicate that active gene-environment correlations might form part of the heritability of political attitudes.

Why does evolution maintain any genetic variance at all? A note on evolutionary genetics

The evolutionary-genetic notion of *balancing selection* is important to this thesis, especially paper one, and I will therefore give a short introduction to evolutionary genetics here.

Genetic change is the basis for all evolutionary change. However, evolution works by constantly *reducing* genetic variation: it favors adaptive variants and quickly removes nonadaptive variants. The adaptive variants become fixed in the genome, and becomes part of the species-typical nature. Now, behavior genetics in both animals and humans find that

genetic variation is abundant, and plays an important causal role in generating phenotypic differences. A very interesting evolutionary-genetic question then arises: *Why does evolution maintain genetic variation?* If I make the argument that variation in SDO is maintained by evolution for adaptive reasons (as we do in paper 1), namely that both high and low levels of SDO can be adaptive depending on the local ecology, this is an argument that some kind of balancing selection is at work, as opposed to other types of selection. Let me briefly describe these.

There are at least three evolutionary mechanisms, broadly speaking, that maintain genetic variation: (1) neutral selection, (2) balancing selection, and (3) mutation-selection balance (for overviews in a human context, consult Arslan & Penke, 2015; Buss & Hawley, 2011; Zietsch, de Candia, & Keller, 2015).

The neutral selection is simple. Whenever some genetic variation is neutral to fitness, if not to the phenotype (genetic variation in naval shapes, say), it will by definition be inconsequential to evolution. These genetic variants will simply free-ride, or *drift* by chance, across generations.

A second genetic-evolutionary mechanisms that can maintain genetic variation is *balancing* selection. Here, selective pressures on genes change depending on time, space, social environment, genomic context, and so on. One example is the balance of male and female phenotypes, a type of negative frequency-dependent selection: If one sex becomes rarer, it's also more desirable on the mating market, and any slight genetic bias for producing the rarer sex are selected for (Del Giudice, 2012). Another example of balancing selection is migration-selection balance, where the same trait could have different selection pressures in different places (e.g., in sunny or non-sunny areas, in cities or in rural areas), a process that might be important for human personality traits and political attitudes, as we saw in the section on gene-environment correlations.

The third important mechanism is mutation-selection balance. New genetic mutations constantly arise by chance. Given that a mutation occurs in an egg or sperm cell, it can be passed on to the fertilized ovum, and eventually to all the cells in the offspring, and hence affect fitness in the next generation. If a trait is highly polygenic, the trait has an increased likelihood of being "hit" by a random mutation. Some genetic variants have dramatic negative effects on fitness and are therefore quickly removed by selection (e.g., dying before reaching puberty). However, many mutations have only extremely small negative effect on fitness, and will therefore require time to be completely removed from the population. All humans inherit such mutations, some many, some few, but most in a range between 500-1200 (Fay, Wyckoff,

& Wu, 2001). This process might be an important source of genetic differences in personality, intelligence, mental health, attractiveness, as well as political inclinations.

All the papers in this thesis use quantitative genetic designs that tell us the degree to which traits are generally heritable and/or environmental, and whether correlations reflect shared genetic substrates or environmental processes that boost both. These designs can provide powerful hints about the selective pressure acting on these traits. We now turn to the notion of behavioral syndromes, a useful concept from biology and behavioral ecology that can describe both adaptive and maladaptive *covariation* of traits.

Animal personality and evolved behavioral syndromes

Consistent individual differences exist across many species, including fish, mammals, birds, amphibians, arthropods (e.g., insects, crustaceans) and mollusks (e.g., snails) (Gosling, 2001). Some individuals within these species are more aggressive, some are bolder, some more exploratory—and these differences tend to be heritable (Drent, van Noordwijk, van Oers, de Jong, & Kempenaers, 2005; Van Oers, Drent, De Goede, & Van Noordwijk, 2004) and fitness-related (Dingemanse & Réale, 2005; B. R. Smith & Blumstein, 2008). A meta-analysis that looked at the *repeatability* of behaviors across several taxa—the degree to which animal personality can be said to exist—found that 35% of variation in behavior could be attributed to stable individual differences (Bell, Hankison, & Laskowski, 2009).

The term *behavioral syndrome* is a concept used in behavioral ecology and refers to a suite of correlated behaviors across situations (Sih, Bell, & Johnson, 2004; Sih & Bell, 2008), which is analogous to how human personality traits work. Behavioral syndromes can be an important limit on optimal behavioral plasticity, and also a means by which evolution can maintain individual variation. Let's look at a few animal examples.

A study by Laskowski and Bell (2014) concluded that strong personalities, not social niches, drive social behaviors in sticklebacks, a fish known for its behavioral variation and sociality. The first explanation postulates that repeated social interactions, all by itself, generates individual differences in behavior. This can happen when the presence of others leads each individual to behave differently in order to reduce costly competition. In this scenario, the selective benefit of behaving predictably increases (called the niche specialization hypothesis). The alternative explanation is that the social behavior of the individual sticklebacks reflects their behavior in other contexts, or their *behavioral type*. They experimentally tested these two competing explanations. Essentially, this mirrors a classic

tension between social-psychological explanations of behavior with personality explanations: are differences in behavior produced by the situation or the forces within individuals?

For our interest here, Laskowski and Bell (2014) found no evidence that repeated social interactions amongst the fish resulted in greater inter-individual variation in social behavior, but was entirely related to variation in behavioral types. Altogether, the individuals showed stable individual differences in exploration, shoaling (swimming together in groups for safety reasons) and aggression. Again mirroring human personality psychology, the authors conclude that “our results provide strong support for the hypothesis that individuals can retain their distinctive personalities even in a dynamic social situation” (Laskowski & Bell, 2014, p. 294).

Further, they found evidence “of a larger behavioral syndrome linking these behaviours” (Laskowski & Bell, 2014, p. 293): a stickleback’s behavioral type in shoaling behavior was related to its willingness to explore a new food source. That is, individuals that shoaled less—who were more willing to leave the safety of the group—were also more likely to quickly take advantage of a new food source.

So the argument here is twofold. First, individual differences seem to be innate, stable, and to be important causal generators of behavior. Secondly, such innate and stable tendencies correlates across individuals, often in a logical fashion: It makes evolutionary sense that bold individuals are also more individualistic and aggressive.

Let’s look at another animal example, the desert grass spider (*Agelenopsis apera*). This spider spins a web to the ground, and an adjacent funnel to hide in. In the event of an insect landing on the web, the spider quickly protrudes from the funnel to seize the prey. Hedrick (1993) found that the individual spiders that quickly emerged from the funnel during web disturbance were also much more likely to win agonistic encounters with other spiders. In other words, there is a tendency for some spider to be aggressive. This tendency leads to a greater likelihood that these individuals will be aggressive towards prey *and* a willingness to quickly attack other members of the same species, suggesting a behavioral syndrome that affects behavior across contexts. It seems like individuals with the “I am aggressive” phenotype are bold while hunting and foraging, *as well as* during same-sex competition and mating.

It is a central proposition of this dissertation that such adaptive behavioral syndromes might explain covariation in political phenotypes in humans as well, as we argue for example in paper one. A well-known example is that men with higher physical formidability, also tends to hold anti-egalitarian attitudes. This suggests that a greater ability to physically

dominate other individuals and groups, might bring with it anti-egalitarian, winner-takes-all attitudes in terms of economic distribution in society (Petersen & Laustsen, 2019; Sheehy-Skeffington, 2020 #3223; Petersen, Sznycer, Sell, Cosmides, & Tooby, 2013; Price, Sheehy-Skeffington, Sidanius, & Pound, 2017). If a male human is both formidable and attractive, it might best serve his interest to be against distribution of resources across many different contexts.

Alternative explanations of trait covariation: Nonadaptive behavioral syndromes

Above we emphasized that behavioral syndromes can be synergistic, where the traits feed of each other in adaptive ways. However, behavioral syndromes are not necessarily adaptive. For example, two traits can correlate due to pleiotropy, where the genetic variants responsible for one trait, simply co-produce another, even though that association might be maladaptive. In fact, genetic correlations between traits can be a *constraint* on evolutionary processes, precisely because it hinders the independent evolution of adaptive traits.

This point can be vividly illustrated with the sexual cannibalism of the fishing spider (the genus *Dolomedes*), where the female sometimes eats the male after sperm transfer. It has been postulated that this is an example of extreme paternal investment—blood sacrifice in this case—increasing the chance that the mother will survive (Thornhill, 1976). However, Arnqvist and Henriksson (1997) ran experiments on fishing spiders (*D. fimbriatus*) and found that the consumption of a male did not “increase offspring quantity (number) or quality (size) in the fishing spider” (1997, p. 263), and that the female spider did not “balance the male's economic value as a meal versus his value as a sperm donor in the adaptive manner predicted.” Instead they found that “females behaved stereotypically and aggressively, and many females in the laboratory were left unmated at the time of egg laying despite numerous mating opportunities” (Arnqvist & Henriksson, 1997, p. 264).

In fact, highly aggressive juvenile females will consume more food, grow larger, and lay more eggs (Arnqvist & Henriksson, 1997). And here is the problem. This leads to a strong selection for general aggression in young female spiders, providing a genetic constraint that sometimes lead to over-aggressive adult mating behaviors.

Arnqvist and Henriksson (1997, p. 265) write,

The high levels of general aggression will tend to spill over into the adult stage, and adult females will generally be more aggressive and exhibit less discrimination between conspecifics and heterospecific prey than would be optimal at this life-history stage.

The adaptive value of high aggression enjoyed by young female hunters ceases in adulthood. Indeed, some of the female fishing spiders eat *all* potential sexual partners *before* copulation. A clear maladaptation. This reflects the crucial point that this behavioral syndrome—individual aggression correlating across situations—reflects an evolutionary tradeoff, not an adaptation.

The papers in this thesis find that there is both phenotypic and genetic covariation between some personality traits, authoritarianism, desire for intergroup dominance, and political attitudes. These facts alone cannot prove or disprove that they covary due to an adaptive behavioral syndrome, or the degree to which they reflect nonadaptive trade-offs. Most psychological traits, and presumably also the covariation between these traits, are highly polygenic, and the genetic variants that are involved are often extremely rare (minor allele frequency $< .01$). This pattern can be explained by mutation-selection balance rather than balancing selection.

Recently the “missing heritability”³ for height and BMI is not missing anymore because whole-genome sequencing have identified the *rare* variants involved, again consistent with mutation-selection balance (Wainschtein et al., 2019). Even for human intelligence, this seems to be the case, where heritability estimates based on single-nucleotides, including rare mutations, matches twin-based heritabilities (Hill et al., 2018). Interestingly, this is not the case, at least so far, for personality traits (Hill et al., 2018).

³ “Missing heritability” refers to the general problem that twin studies often generate larger heritability estimates than heritability estimates based on molecular data, or SNP-based heritability (SNP = Single-nucleotide polymorphisms). There are many potential causes of this discrepancy. A plausible candidate is that SNP-based heritability estimates are based on SNPs that are present amongst at least 1% of individuals in the population: They are often not genome-wide, and hence do not capture rare causal variants generated by random mutations. A related problem is that gargantuan sample sizes are required for having enough statistical power to actually detect the effects of rare variants – hence SNP-based heritability estimates often fail to reach the heritabilities identified through quantitative genetics. However, as discussed in the text, this is not the case anymore for some psychological traits. Future work will probably identify the missing heritability for many traits, and it will be informative to see whether it will be the case for political phenotypes as well.

A classic finding in humans is that both perpetrators and victims of homicidal conflicts tend to be unmarried and unemployed young men. These same men are also at greater risk for being victims to gambling or motor vehicle accidents. This pattern suggests that risk-taking and aggression are related and constitutes what Daly and Wilson famously called the “young male syndrome” (Daly & Wilson, 1988; Wilson & Daly, 1985). Hence, the covariation of these behaviors can be viewed as the outcome of sexually selected abilities for bold, aggressive and risky behaviors in young males. However, dying in car accidents is not adaptive, and hence it is likely that selection for a general tendency to take risks, also have non-adaptive side effects. That is, the general tendency to take risks can produce risky behavior in contexts where it fails to produce adaptive outcomes.

It is possible that covariation between traits that seem coherent and adaptive, such as aggressiveness and risky behavior, or bodily formidability and SDO, or openness to experience and attitudes to gay marriage, are mostly due to underlying mutation load generating random polygenic effects, and are therefore maladaptive across the entire lifetime. If the political traits are polygenic and pleiotropic, they can covary phenotypically and genetically for purely non-adaptive reasons. The animal literature indicates that some trait covariations are synergistic and evolutionary useful, while some are maladaptive. However, all of the lines of evidence above suggest caution in interpreting phenotypic and genetic correlations between behavioral phenotypes in humans as *adaptive* behavioral syndromes.

However, the animal literature just reviewed also shows the explanatory power of adaptive behavioral syndromes, suggesting that it is worth pursuing in human trait covariation as well, especially for personality traits.

To my estimation, this will one of the great challenges of future work in evolutionary and behavioral genetics: identify the traits that vary and covary for adaptive reasons (e.g. are under balancing selection), and which ones vary and covary for non-adaptive reasons (due to mutation-selection balance).

There are of course interesting problems with the environmental variance that has been identified within evolutionary and behavioral genetics as well, especially regarding the unique or nonshared component. One of the challenges is to understand the role played by randomness in generating variability in phenotypes, including political ones.

Nongenetic causes of phenotype formation: molecular stochasticity or external “environments”?

Decades of research in behavior genetics consistently find that variance in psychological traits can be attributed not just to genetic variance, but to the non-shared environmental component (from now on referred to as E). This E estimate often hover around .4 -.6. This is also true for the papers in this thesis: Political attitudes, personality traits, authoritarianism, social dominance, and attachment styles all have a modest or large component explained by E. What exactly does this unique component entail? As we saw in equation 10, E is a residual and therefore contains all of the measurement error, which forms parts of most psychometric instruments. However, even when we take this into consideration, measurement error alone cannot explain why the E component tends to be so large.

Members of the same family are often remarkably *dissimilar* in their psychological traits. Hence, literally any causal force with the potential to make family members different can become part of the E estimate. The mothers diet and drug use during pregnancy? The effects of being bullied at school? Of being struck by lightning? Peer interactions in kindergarden? Growing up in an environment with above-average levels of toxicity?

The attempts of identifying E factors have focused on classic *external* environmental effects on phenotype formation. And this has so far been largely unsuccessful (Mitchell, 2018), the research so far suggest that their effect sizes at best reach 3% (Turkheimer, 2000).

To be sure, it would still be premature to conclude that external E factors are causally irrelevant for human traits. Consider molecular genetics again for a moment. Individual alleles typically account for an extremely small fraction of phenotypic variance, but when all of them are added together, they could potentially account for the large heritabilities found in twin studies (the “missing heritability” problem). Something analogous could be the case with external E: any individual environmental effect is extremely small, but added together they could account for all the E variance in twin studies. Additionally, there could be interactions, or “epistasis” between external E factors. For example, any effect of individual-specific friendships on neuroticism in adolescence, might be dependent upon the warmth of the child-teacher relationship.

Even with these caveats in mind, the research paradigm that identifies E effects from *external experiences* looks unpromising, and there are reasons to believe that this will continue to be so. One of them is a non-external E factor: inherent stochasticity during neural development (see Tikhodeyev & Shcherbakova, 2019).

Randomness and the uniqueness of the individual

We ought then to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it—an intelligence sufficiently vast to submit these data to analysis—it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes.

Pierre-Simon Marquis de Laplace, *A philosophical essay on probabilities* (1812/1902, p. 4)

The classical Newtonian universe is deterministic. Given an initial state, the clockwork of physical law will simply unfold. All events are completely predictable, at least in principle. With the onset of quantum mechanics early in the 20th century, this worldview was shattered. A quantum mechanical system will evolve over time according to a rule (the Born rule), but all it does is calculate probabilities for every possible measurement outcome, hence the measurement cannot be predicted perfectly, even in principle⁴ (Carroll, 2019). In the Newtonian worldview, however, randomness does not *really* exist, but can instead be thought of as a measure of our own ignorance. If we cannot predict the occurrence of an event, we call it “random”, while in reality there are hidden variables that actually generate the event.

The Newtonian worldview is often implicitly baked into our scientific assumptions. For example, the famous behavior geneticist Robert Plomin in a paper on why siblings tend to be so different from each other, writes: “Chance might only be a label for our current inability to identify the environmental processes by which children growing up in the same family come to be so different” (Plomin, 2011, p. 585). This worldview is intuitive. If two identical twins grow up in the same family, and one of them is, say, disagreeable and politically conservative, while her sister is agreeable and politically liberal, their dissimilarity cannot be explained by shared genetics or shared environments, but by developmental events that are unique to them. But “events” are not necessarily the components that psychologists have traditionally identified, whether it is early toilet training, the mother-child relationship, or

⁴ Of course, whether quantum mechanical models, although extremely successful in making accurate predictions, actually corresponds to any physical ontology is still unknown and debated by physicists and philosophers. That is, there might be a fundamental difference between the statistical models of reality, and actual reality. See Carroll and Ashmead (2019) and Carroll (2019) for useful overviews on this.

influences from peers. In the preface of a book exclusively dedicated to the non-shared environment, tellingly titled *separate social worlds of siblings*, Hetherington, Reiss, and Plomin, write: "... in order to understand individual differences between siblings it is necessary to examine not only the shared experiences but also the *differences in experiences* of children growing up in the same family" (1994, p. vii emphasis mine). This of course emphasizes *external* NSE.

Another example of this line of reasoning can be found in Judith R. Harris book *The Nurture Assumption*, where she argues that parents do not directly influence the personalities of their children, at least not to the extent typically assumed by many professionals and laypeople alike. Instead, she argues that the large E factor in the developing personality is caused instead by peer interactions outside of the home (*group socialization theory*). Consider the example where children of immigrants tend to develop the accent reflecting that of the local children, rather than that of their parents (Pinker, 1994). It is perfectly reasonable that a similar pattern might extend to the development of phenotypic variation in personality, political attitudes, and so on; that is, that children will tend to acquire the political "accent" of their peers rather than that of their parents.

However, on a closer look, this idea makes a peculiar assumption, namely that the external experiences that influences the development of political views, personality, and so on, are not just (1) significant and large, but also (2) can only cause differences between people *as long as these are not shared with other family members*. If we are prepared to take this seriously, we would have to argue that the development of political views can be influenced by a friend, but not by your mother, father or siblings.

I am not implying that this is impossible—evolution could have shaped psychological adaptations designed to be sensitive to kinship, similar to the well-documented incest-avoidance mechanisms in human mating (Lieberman, Tooby, & Cosmides, 2007)—but it would certainly be a stretch to argue that the E factor in not just personality, but also political attitudes, intelligence, attachment, subjective well-being, psychopathology, and so on, are all due to an evolved preparedness to be influenced by others *as long as you did not grow up with them*.

Any *complex*, or *chaotic* system, like the climate on Earth or the developing human brain, has to make "choices" at certain points that lead to different causal trajectories, and this "choosing" can be inherently unpredictable, random, or *stochastic*. Even organisms that share their genotype exactly and develop under strictly controlled environmental conditions, differ

in their phenotype, which is known as fluctuating asymmetry, incomplete penetrance, or variable expressivity.

In 2019 the entire neural wiring diagram (connectome) of the roundworm *Caenorhabditis Elegans* was mapped. It has exactly 302 neurons. Research on this simple worm opens up opportunities for experimental control that is impossible in humans. By removing external guidance cues inside the worm that regulate the probability that an axon outgrowth will grow in one direction or another, there is evidence that these outgrowths start to behave like a random-walk model (Kulkarni et al., 2013). That is to say, the evidence strongly suggests that there is an inherent and inescapable stochasticity in the worm's neural development.

There is good reason to believe that this will occur in humans as well. Indeed, probably more so, given the enormity of synaptic connections made during the development of the human brain. If it is the case that stochasticity in axonal outgrowths play a large role in humans, it is very unsurprising, for this reason alone, that the two brains of identical twins—sharing all their genes, and growing up in very similar environments—should still differ from each other in their psychological traits.

There are other sources of stochasticity in psychological phenotype formation. As we saw in the section on genetics and heritability, the majority of human cells contain two copies of the same gene, one located on the chromosome inherited from the father, one from the mother. Often, both alleles in a heterozygote cell will equivalently express itself. But there are exceptions. Both alleles will be expressed in some cells, in others only the maternal allele, and in others still, just the paternal allele. The point for our purposes here is that the “choice” of whether or not to express one allele rather than the other in any particular cell is sometimes due to chance. This is called *autosomal random monoallelic expression*, only really understood from the 1990s in biology (Chess, 2013). It has been estimated that 5-10% of human autosomal genes could have such stochastic expression (Gimelbrant, Hutchinson, Thompson, & Chess, 2007). If this also affects brain cells, it could produce differences between MZ twins and contribute to E.

Humans have around 25,000 protein-coding genes, but we have 86 *billion* neurons, each of which have thousands of synaptic connections (Azevedo et al., 2009). Hence, genes cannot deterministically hardwire every neuron and every synaptic branch enveloping from them. Rather, genes provide an algorithmic guidance on how to make aminoacids that make up complex proteins, which produces tissue, and ultimately organs such as the human brain. The information required to construct any particular brain cannot, even in principle, be found

in the genome of that individual. Nor is it likely to be found within the set of all nonshared external experiences of an individual.

Whatever the future of a psychological science of individual differences will bring, an important part of the mosaic of causal forces underlying it might be non-Newtonian, non-systematic, and fundamentally stochastic. If God does play dice with the universe, human variability might be an inevitable part of this picture.

Discussion of the four papers in the thesis

General discussion

The first three papers in this thesis use twin methodology, and I therefore start with two important assumptions of this method that can have implications for the results: The equal environment assumption, and the random mating assumption. From there, I move on to short discussions of the four individual papers, where some of the subject matter we have unpacked so far in this thesis will be connected with the specific problems under investigation in each paper.

How random is mating, and how equal are environments?

The twin method assume that the environments between monozygotic twins and dizygotic twins are the same (equal environment assumption) and that only half of additive effects are shared between dizygotic twins (random mating assumption).

It is an empirical question whether any of these assumptions are reasonable for any particular phenotype. Humans do select sexual partners based on similarity (assortative mating), although it varies dramatically on a trait-by-trait basis. If the phenotypes of the parents of twin study participants are measured, it is possible to estimate deviations from the random mating assumption. For instance, one study found that spouses correlate close to .6 on political attitudes, but close to 0 for personality (Alford, Hatemi, Hibbing, Martin, & Eaves, 2011). Such high degrees of assortative mating on heritable traits will make the similarity of segregating genes in dizygotic twins *above* .5. If this is the case, the phenotypic correlation difference between monozygotic and dizygotic twins will be smaller and the heritability estimate will be deflated, and the shared environmental estimate will be inflated, even if genes do in fact causally contribute to trait variance. It is possible that the heritability estimates and genetic correlations of the variables in our sample, especially for the political variables, would

increase if assortative mating was accounted for. Future children-of-twin studies (see McAdams et al., 2014) of RWA and SDO would be informative in this regard.

Another issue of concern is the equal environment assumption, if it does not hold, if the environment of monozygotic twins tends to be more similar than it is for dizygotic twins, it can over-estimate heritability (assuming that the environment actually has a causal effect on the trait). However, empirical tests usually find that the assumption that MZ and DZ twins have equal environments holds. DZ twins that wrongly believe they are MZ, are usually not more similar on psychological traits on average than DZ twins that have accurately identified themselves as such (Conley, Rauscher, Dawes, Magnusson, & Siegal, 2013). This is also true for political ideology in particular (K. Smith et al., 2012).

Paper 1: Correlations between social dominance orientation and political attitudes reflect common genetic underpinnings

In paper 1, published in the proceedings of the national academy of sciences (PNAS) (Kleppetø et al., 2019), we focused on social dominance orientation and its two subfacets, Dominance (SDO-D), and Anti-egalitarianism (SDO-E), as well as six concrete political attitudes: (1) Severe punishment for criminals, (2) Strict immigration control, (3) Accept more asylum seekers (reversed), (4) Stronger worker's unions (reversed), (5) Deport the Roma, (6) Reduced aid for developing countries.

As have seen, social dominance theory (SDT) is a broad multi-level theory about the processes that produces and maintains the group-based social hierarchies that exists across most societies. And social dominance orientation is derived from this larger theory and is intended to measure individual differences in the support of group-based hierarchies. Evidence has indicated that SDO has two subcomponents: SDO-Dominance and SDO-anti-Egalitarianism (Ho et al., 2015; Ho et al., 2012). SDO-D is conceptually more related to an overt desire for discrimination of other groups in order to maintain the existing hierarchy and status boundaries, while people high in anti-egalitarianism desire a more laissez-faire attitude regarding hierarchies (that is, no desires for overt suppression of groups, but nevertheless wanting to maintain existing hierarchies).

We replicated the well-documented correlation between Social Dominance Orientation and political attitudes related to hierarchy, resources and territory. Crucially, we also find that both subfacets of SDO, as well as the political attitudes, were all heritable, and that the genetic correlations between both SDO subfacets and all of the political attitudes were high, while the environmental correlations were low. This suggest that the genetic variance that

causally contribute to these traits are overlapping. We conclude that our findings are consistent with the notion of a broad and genetically grounded behavioral syndrome related to hierarchy and control of resources and territory.

As we mention in the paper, earlier behavioral genetic research by Kandler and colleagues (2016; 2015) indicated that SDO was not heritable. It is extremely unusual that complex psychological traits show no indication of heritability at all, and this finding could be attributed to the fact that their sample was much smaller than ours. However, another interpretation is that cultural differences explains the results. Perhaps the German cultural context minimizes the acceptance of having attitudes relating to the superiority of some human groups over another, which will influence reliable measurement and hence make it harder to detect heritability.

Nevertheless, results like this point to the importance of cross-cultural twin studies. Given that the political climate of different cultures is so different, it will be important to investigate if genetic and/or environmental influences on political ideology changes as a function of cultural differences.

Another important point of discussion, that we did not have room to untangle at all in the paper itself, is that behavioral syndromes, although genetically founded, are not necessarily adaptive (see the section above on behavioral syndromes). For example, anxiety and depression have a high phenotypic correlation, as well as a very large genetic correlation (Roy, Neale, Pedersen, Mathe, & Kendler, 1995). One interpretation is that both anxiety and depression are evolved adaptations, and that they covary because they work together in adaptive ways. That is, they could solve different problems even more effectively when they both are high, or low, at the same time in any one individual (for critical discussions, see Kennair, Kleppestø, Larsen, & Jørgensen, 2017; Kleppestø, Kennair, Jørgensen, Borgan, & Larsen, 2017). Another (more plausible in this case) interpretation is that clinical anxiety and depression are disorders caused, in part, by a high underlying mutational load. If the mutated variants also have high degrees of pleiotropy (each genetic variant have many different phenotypic effects), it could generate a high genetic covariation for nonadaptive reasons.

It seems likely that adaptations dealing with the calibration of attitudes towards hierarchy and the monopolization of resources would be highly dependent on an individual's own formidability, the political norms in one's group (e.g., distributionism versus isolationism), and the power and status of the group one belongs to. I therefore think it plausible that evolution (through some kind of balancing-selection) has equipped humans, as well as other hierarchical animals, with different genetically-grounded strategies to deal with

the navigation of social hierarchies. And, additionally, the ability to change these strategies slightly depending on information available in the environment. For example, in order to avoid rampant intergroup aggression towards neighboring groups, when one's own group is clearly weaker.

Given the historical record of humans engaging in hierarchal behavior and intergroup warfare (literature reviewed above), it is clear that the selection pressures for solving these adaptive problems were there. Hence, an interpretation of the genetically grounded behavioral syndrome with SDO and political attitudes as a maladaptive syndrome seems unlikely (but not falsified). Furthermore, the data we provide suggests that the abstractions of SDO-D and SDO-E, as well as the concrete and hierarchy-related political attitudes, all cohere in the direction you would expect: either valuing hierarchy and inequality or disavowing it. However, interpretations of our findings as generated by maladaptive processes cannot be ruled out, and future molecular genetic studies, as well as genetically informative cross-cultural studies, will be helpful in strengthening our knowledge regarding the nature of human political adaptations even more.

Paper 2: Attachment and politics are two functionally distinct systems, but both share genetics with interpersonal trust and altruism

In paper two we turn our attention to adult attachment patterns (anxious and avoidant), in addition to right-wing authoritarianism and social dominance orientation. We also include measurements of interpersonal trust and of altruism, both of which have important relationships to both attachment and politics.

As we have seen, the idea that parenting and early socialization can cause individual differences in attachment patterns, as well as political phenotypes, have a long tradition in psychology, continuing to this day.

However, if this is the case we would expect (1) that there is a phenotypic covariation between insecure attachment styles and authoritarianism, and (2) that variation in both authoritarianism and attachment is explained, at least in part, by shared environment, and (3) that there is a shared environmental covariation between the traits.

In this paper we fail to find evidence that support any of these three statements.

First of all, we find that the phenotypic covariation between authoritarianism and adult attachment is close to zero. Further, attachment styles are just as heritable as everything else, and we find no shared environmental effect (reflecting the rearing environment in the family),

a result that replicates already published results on adult attachment (Barbaro et al., 2017; Donnellan et al., 2008).

Leaving political phenotypes aside, I think the classic conjecture in attachment theory that the early parent-child relationships cause later functioning in adult relationships is uncorroborated: if it was the case, we would expect to see significant effects of the shared environments on adult attachment. We don't do that in this study, nor is it the case in other well-powered studies (e.g., Donnellan et al., 2008).

However, although we find and conclude that politics and attachment are unrelated to each other in this paper, we find that they both have a strong (inverse) phenotypic and genetic relationship with interpersonal trust. Our results therefore suggest that both insecure attachment patterns as well as authoritarianism and dominance, provides inverse sources of variance to interpersonal trust. This is also true for altruism, but to a lesser degree.

Overall, I think our results suggest that the classic assumption that both attachment and politics are formed by early interpersonal experience is unfounded. Nevertheless, given that both attachment and the socio-relational traits contribute to trust and altruism at the genetic level, it suggests that they both capture important aspects of human nature.

Paper 3: The socio-relational personality: The genetic underpinnings of right-wing authoritarianism and social dominance orientation explains prejudice beyond big five personality

The two giants of human individual differences—general intelligence, and big five personality—takes an impressive amount of human variability under its wing. When new concepts are introduced to the science of human individual differences, a key question is whether the new concept really contributes anything new beyond these classic measures (Geher, Miller, & Murphy, 2008). Technically, new measures often fail to show good discriminant validity (predicting behavior differently than existing constructs), as well as good incremental validity (predicting behavior better than constructs already in existence).

Given that humans have evolved in a context of intergroup warfare, it is reasonable to expect that we have specific adaptations (like the traits captured by RWA and SDO) to deal with the complexities of in-group cooperation, as well as a desire for intergroup domination. But this still leaves open the questions of whether or not big five personality and RWA and SDO would be genetically related, and hence provide us with hints of whether or not they evolved together, or perhaps even are reducible to each other.

In paper three we therefore focus on the big five traits of personality—Extroversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experience. As well as the socio-relational traits of right-wing authoritarianism (RWA), and social dominance orientation (SDO). We also made an index variable of four of the concrete political attitudes used in paper one, "Deport the roma", "Reduced aid for developing countries", "Accept more asylum seekers" (reversed), and "Strict immigration control". We called it *in-group monopolization of territory and resources* (IMTR). This index variable with the four attitudes work together really well: they are normally distributed and have an alpha of .77. This suggests that they do indeed measure concrete preferences for in-group control of territory and resources.

Given that the big five traits are designed to capture long-term trends in affect, cognition, and behavior, it is very reasonable to expect that personality would be relevant for political attitudes. The trait openness to experience in particular is a very broad trait that captures the tendency to be intellectually curious and variation in one's aesthetic sensibilities. Most importantly here, openness also measures *values* (although the *big five inventory* that we use here does so to a lesser degree than for example the NEO-PI-3). Low openness suggests a person who value tradition and conventionality. Hence, high openness individuals tend to be liberal, while low openness individuals tend to be conservative. Indeed, many studies have shown that big five personality traits are related to political attitudes generally (Caprara & Vecchione, 2013; Fatke, 2017; Gerber, Huber, Doherty, & Dowling, 2012; Gerber, Huber, Doherty, Dowling, & Ha, 2010; Gerber et al., 2011; Jonason, 2014; Vecchione & Caprara, 2009), as well as for prejudicial attitudes (Chen & Palmer, 2018; Crawford & Brandt, 2019; Sibley & Duckitt, 2008).

Nevertheless, we find that right-wing authoritarianism and social dominance orientation both correlate with political attitudes (the IMTR) to a much greater extent than big five personality traits, and that these correlations are genetically grounded. We also find that RWA and SDO share more genetic variance with IMTR, even after the genetic variance in RWA and SDO that is shared with big five personality is controlled for.

Even though personality can predict political attitudes reasonably well on its own, I think our findings strengthen the interpretation that RWA and SDO are independent contributors to political attitudes and prejudice, as argued by social dominance theory (Sidanius & Pratto, 1999), and the dual-process model (Duckitt, 2001). Plenty extant studies suggest that RWA and SDO are themselves related to big five personality traits, especially low openness (and sometimes high conscientiousness) for RWA, and low agreeableness for

SDO (for a meta-analysis, see Sibley & Duckitt, 2008). Like our data, the majority of these studies do not suggest that all of the variance underlying RWA and SDO are reducible to big five personality, but rather that RWA and SDO independently predict attitudes above and beyond big five. Our large sample, with genetically informative data, strengthen this view: the two most important driver of attitudes are RWA and SDO.

We do find that openness to experience and RWA, and agreeableness and SDO, have small but significant phenotypic as well as genetic relationships to each other. This suggests that the socio-relational traits and the big five are not *completely* independent. In fact, they have a synergistic relationship: they can be said to share goals. That is, it could prove challenging for a very agreeable person to also desire the forced subjugation of other groups. Or for an open-minded, liberal, art-interested, and intellectually curious person (high openness) to also want to desire conformity to a strong leader, and prefer anti-democratic social structures and leadership (high RWA). Given that low agreeableness and high SDO, and low openness and high RWA, tends to go together, it suggests a synergistic relationship – an adaptive behavioral syndrome.

We find that RWA and SDO have a moderate phenotypic correlation, but very high genetic correlations, suggesting that the differentiation between them is mostly driven by the unique environment. In the paper, we interpret this as suggesting that the developmental “choice” of going for an RWA phenotype (desiring conformity, and a follow-the-leader strategy), or an SDO phenotype (more of a domineering leader strategy), is driven by unique experiences that an individual has. This is an idea worth pursuing in future longitudinal studies, because the “decision” of whether or not to develop high RWA and/or SDO would be an important one evolutionary speaking. For example, how adaptive RWA and/or SDO would be, depends on the *other* traits that an individual happens to have, as well as the surrounding ecological context, such as bodily formidability and how large the individuals social network is. Hence it is a plausible scenario that both RWA and SDO are input-sensitive adaptations (see Sinn & Hayes, 2018; for an in-depth discussion of facultative adaptations, see Tooby & Cosmides, 2015).

However, as we saw in the section on the non-shared (E) environment, it could also be the case that some individuals inherit sets of alleles that all contribute to a *general* hierarchy-preference (both RWA and SDO combined), and that the RWA and/or SDO phenotype comes along largely as the result of random processes during neural development. The fact that all of the variables have large E components individually, suggest that stochastic processes could at least partly be at work here, and is an idea worth pursuing in future studies.

Paper 4: *Social Dominance Orientation (SDO)*

Paper four is a review of social dominance orientation published in the *encyclopedia of evolutionary psychological sciences* (Kleppesø, Eftedal, & Thomsen, 2020). As we have seen, social dominance orientation (SDO) measures a general desire to establish and maintain hierarchies between groups, regardless of one's own position within that hierarchy (Sidanius et al., 2016).

An important issue regarding SDO is that scores are usually skewed towards the lower end of the scale. The scale ranges from 1 to 7, yet most people do not score highly on the scale in an absolute sense: In our sample the overall SDO mean is 2.25. It is likely that this is an expression of social desirability bias, people might be reluctant admitting agreement with items such as, "Some groups of people must be kept in their place.". However, such social desirability is revealing in itself because it tells us that *most people desire egalitarian intergroup strategies*, at least in egalitarian countries like Norway. Interestingly, even though SDO variance is restricted to the lower end of the scale in most societies (although SDO levels do change meaningfully across societies—it is related to the social inequality and violence within societies, see Kunst, Fischer, Sidanius, & Thomsen, 2017), it is still highly predictive of political attitudes across societies, meaning it probably captures important variation in human political psychology despite its restricted range of variance.

In this review we also discuss the dimensionality of SDO, its trait-like status, as well as its contingency on context, the ways that social dominance orientation is different from other constructs (like interpersonal domination, and right-wing authoritarianism), and the evolution of sex differences. To avoid repeating these discussions here, I direct the reader to the review itself.

Conclusion

A clear picture emerges from the findings in this thesis: We provide genetically (and environmentally) informative data that political and prejudicial attitudes are indeed extensions of deeper traits, as suggested by Social Dominance Theory and the dual-process model (Duckitt & Sibley, 2010; Sidanius & Pratto, 1999). That is, political attitudes are extensions from the general/abstract socio-relational traits of desiring in-group cooperation and submission to norms (as tapped by right wing authoritarianism) and the desire for out-group domination (as tapped by SDO), over and above the effects of big five personality traits of openness to experience and agreeableness on political attitudes.

We find that both specific political attitudes related to monopolizing territory and resources for the in-group, RWA, SDO, as well as the big five personality traits are heritable, and, crucially, that the covariation of political attitudes with SDO, RWA and big five personality traits are grounded in common genetic underpinnings. However, the variance in the socio-relational traits is irreducible to big five variation. We therefore conclude that RWA and SDO constitutes an important, genetically grounded, stand-alone part of the architecture of the human political mind.

Overall, we conjecture that these results are suggestive of a genetically founded behavioral syndrome in human nature, designed to produce different adaptive strategies for the navigation of social hierarchies. We posit that this behavioral syndrome produces stable individual differences reflecting either egalitarian or domineering strategies. These strategies might be maintained by balancing selection because the adaptiveness of an egalitarian or domineering strategy change over time and place. In other words, political attitudes cannot be viewed as haphazard collections of attitudes that are simply picked up from the socializing environment in which one finds oneself. Rather, political and prejudicial attitudes are extensions of deeper principles in human nature: The reason why they covary with SDO and RWA is largely explained by overlap in their underlying genetics.

Furthermore, a classic conjecture regarding political attitudes is that they are caused by early socialization and family relationships, and in particular, derived from one's early attachment to primary caregivers. All of the political phenotypes under study here did show large sources of environmental variation, but almost always from the non-shared (or unique) environment, not the shared (or family) environment. This suggests that what matters in the environment is the personal experiences unique to each individual twin (and/or due to

molecular stochasticity during development), not by their shared upbringing in the same family.

Interestingly, we show that both attachment and the general socio-relational traits of SDO and RWA provide important sources of variation to interpersonal trust and altruism. Overall, however, our findings do not support the conjecture that early family socialization have any important role to play in the formation of adult political phenotypes. Instead, we find that variation in adult attachment is in itself heritable (supporting already existing findings), and, crucially, that the covariations between attachment and the socio-relational traits are very small. We therefore suggest that attachment is *not* part of our suggested behavioral syndrome related to the navigation of social hierarchies and the differential resource distribution which they entail.

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Correlations between social dominance orientation and political attitudes reflect common genetic underpinnings

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A foundational question in the social sciences concerns the interplay of underlying causes in the formation of people's political beliefs and prejudices. What role, if any, do genes, environmental influences, or personality dispositions play? Social dominance orientation (SDO), an influential index of people's general attitudes toward intergroup hierarchy, correlates robustly with political beliefs. SDO consists of the subdimensions SDO-dominance (SDO-D), which is the desire people have for some groups to be actively oppressed by others, and SDO-egalitarianism (SDO-E), a preference for intergroup inequality. Using a twin design ($n = 1,987$), we investigate whether the desire for intergroup dominance and inequality makes up a genetically grounded behavioral syndrome. Specifically, we investigate the heritability of SDO, in addition to whether it genetically correlates with support for political policies concerning the distribution of power and resources to different social groups. In addition to moderate heritability estimates for SDO-D and SDO-E (37% and 24%, respectively), we find that the genetic correlation between these subdimensions and political attitudes was overall high (mean genetic correlation 0.51), while the environmental correlation was very low (mean environmental correlation 0.08). This suggests that the relationship between political attitudes and SDO-D and SDO-E is grounded in common genetics, such that the desire for (versus opposition to) intergroup inequality and support for political attitudes that serve to enhance (versus attenuate) societal disparities form convergent strategies for navigating group-based dominance hierarchies.

political attitudes | social dominance | evolution | behavioral genetics | prejudice

Philosophers from Thucydides to Foucault have argued that politics—the distribution of resources, rights, obligations, and sanctions and the negotiation of common rules to justify it (1, 2)—is fundamentally underpinned by the question of who will dominate whom (3): Who will claim preferential access to resources, living conditions, and decision rights, and who must yield? Consistent with this notion, the precursors of politics and negotiations among nonhuman primates also appear to center around issues of hierarchy and coalitional power (4, 5). Indeed, dominance hierarchies occur across species, in which more formidable individuals are more likely to claim and fight for contested resources and territory, whereas less formidable individuals will yield to avoid injury (6). Early ethological observations even demonstrated the formation of stable dominance hierarchies among human infants in daycare centers (7), and recent experimental evidence confirms that human infants understand social dominance and use it to navigate their social world (8, 9).

Egalitarian processes, too, have deep evolutionary roots. In a number of primate species, coalitions form within groups among lower-ranked males to gain access to the resources of those of highest rank (10, 11). Leveling mechanisms directed at keeping anyone from obtaining despotic control also manifest across cultures among hunter-gatherers (4, 10, 11). Representations of

equality or fairness emerge early in ontogeny, and infants who react to uneven distributions among third parties are more likely to share resources themselves, consistent with the notion of a common underlying psychology of resource distribution (12, 13). Together, this evidence demonstrates that representations and motives for dominance versus equality between individuals emerge across phylogeny and very early in ontogeny, and across culture and subsistence systems (see also ref. 14), suggesting that they represent evolved, adaptive strategies for navigating the social world.

Hierarchy or equality can be implemented not only within the group but also between groups, maximizing or minimizing the degree to which some coalitions enjoy privileged influence, access to resources, and better conditions of living than do others. Indeed, all known surplus-producing human societies feature some form of hierarchy between social groups (1), and the archaeological and ethnographic records suggest that the human mind evolved in a context of violent coalitional conflict (15, 16). Consistent with this, humans are adept at detecting cooperative coalitions from social cues, and this social alliance detection underpins political cognition and categorization by who-is-allied-to-whom, manifesting already in early childhood (17, 18). Together, this evidence suggests that humans may have evolved predispositions to represent and strategically navigate hierarchy versus equality between groups, as long argued by social dominance theory (1).

Significance

Deciphering the underlying psychology of societal attitudes and prejudices is important in times of political unpredictability. We focus on the foundational construct of preference for (or against) hierarchies between groups, as reflected in the 2 subdimensions of social dominance orientation (SDO). Studying SDO with a large-sample twin design, we show that both its sub-dimensions are heritable, share common genetic influences, and overlap genetically with 6 political attitudes that serve to enhance versus attenuate societal hierarchy. This suggests that desire for versus opposition to intergroup hierarchy, in abstract and concrete forms, constitutes a genetically-grounded behavioral syndrome, thus explaining an important part of the long-observed association among political views of various kinds.

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Here we investigate whether individual variation in such hierarchical versus egalitarian strategies is partly heritable, while also responding to the environment in which individuals find themselves. Behavioral ecological modeling suggests that the degree to which egalitarian or hierarchical forms of resource distribution will stabilize depends on resource availability and their benefits of consumption, and on the cost of monopolizing them (19). Because the adaptive consequences of hierarchical versus egalitarian strategies also depend on the relational strategies of one's conspecifics (weighing both total expected costs and benefits), and to the extent that people may seek out the ecological niches in which their relational strategies are most adaptive, balancing selection may maintain variation in both strategies within a population, akin to how personality variation is argued to be maintained (refs. 20–24, but see also refs. 25 and 26).

In fact, the degree to which individuals generally endorse or oppose community arrangements where some social groups dominate others is a stable trait reliably varying in human populations, and highly predictive of political and intergroup attitudes (1, 27–50). Such social dominance orientation (SDO) positively predicts policies and ideologies that serve to justify and sustain societal hierarchies governing the distribution of power and resources (such as fiscal conservatism, laissez-faire economics, and harsh punishment of criminals), as well as support for ethnic persecution and warfare (29–32). Conversely, SDO negatively predicts hierarchy-attenuating ideologies (such as socialism, feminism, and multiculturalism) and policies (such as generous social welfare, foreign aid, acceptance of immigrants and asylum seekers, and support for strong workers' unions) (29–32).

At the same time, the proposal that evolved motives for enhancing versus attenuating group-based hierarchies vary meaningfully between individuals, and predict intergroup attitudes across time and context, has generated considerable controversy within social and political psychology: Some researchers have argued that SDO is little more than a context-specific response to particular intergroup relationships, and that its correlation with political attitudes is merely a result of those attitudes being in mind as one completes the SDO scale (51, 52). Here, we investigate the degree to which individual levels of SDO are partly heritable versus shaped solely by the environment, and whether the correlations of SDO with political attitudes concerning the distribution of resources, living conditions, and decision rights reflect common genetics versus shared environmental influences.

Experimental, correlational, and cross-national evidence has demonstrated that SDO is sensitive to context, but in a manner consistent with the perspective on intergroup hierarchy suggested by social dominance theory: Dominance motives, as well as their predictive power, increase among high-status groups as the inequality between groups becomes greater or more salient (1, 30, 35, 38, 39). Also, experimental manipulations that increase SDO cause corresponding changes in political and intergroup attitudes relevant to hierarchy versus equality (38, 39). An individual's level of SDO also reflects the hierarchy-enhancing or attenuating functions of their institutional setting, as well as their organizational and societal position (1, 28–37, 40). Importantly, contextual effects on SDO and downstream political attitudes do not compromise its rank order stability (the fact that individuals who are relatively high on social dominance in one context remain so across other contexts) nor its ability to predict social attitudes over time (1, 29, 30, 35, 41–44).

This pattern of findings parallels recent advances in behavioral ecology, where attention has expanded from the classical focus on how the adaptive constraints of a given context affect all individual animals across the board to encompass the influence of behavioral types or animal personalities (53). Such behavioral types may form a behavioral syndrome across domains and contexts—a suite of traits governing how different organisms respond to the same environmental conditions in different ways, reflecting evolutionary trade-offs within a population across contexts where no single optimal strategy exists (cf. refs. 20, 23, and 54–58). While ideological preferences have often been viewed as socially or contextually determined, it is now well established that they are also influenced by genetics (with heritabilities from a range of cultural settings

typically ranging from 30 to 60%), as are personality traits (59–63). The correlation between personality traits and political attitudes is also well established, and recent evidence using genetically sensitive data suggests that this correlation is grounded in a common genetic factor influencing them both (64). This points to the possibility that SDO and support for policies that enhance or attenuate inequality between groups may also share common genetic origins that underpin a behavioral syndrome regarding intergroup resource distribution and territoriality.

However, the only published behavioral genetic evidence on the heritability of SDO, based on the same small German sample of 394 twin pairs, found a very low (0.07%) (65) or essentially zero (66) heritability and, hence, also that SDO did not share any genetic sources with negative attitudes toward foreigners. Here, we use a random sample of 1,987 Norwegian twins to conduct a more definitive test of the extent to which, if at all, SDO is heritable.

In addition to SDO, we measured support for hierarchy-enhancing policies that monopolize resources and territory and sanction subordinates (strict immigration control, deportation of Roma, severe punishments for criminals, reduced foreign aid) and for hierarchy-attenuating policies (strengthening workers' unions and accepting more asylum seekers), all of which have been previously found to correlate with SDO (31–33, 45, 46, 50). Using standard behavioral genetic analyses, we partition the sample variance into that which is heritable (especially shared by monozygotic [MZ] rather than dizygotic [DZ] pairs of twins), shared by family environment (pertaining equally to MZ and DZ pairs), and the remaining unique environmental variance for each individual twin. This current study presents the strongest test yet of the heritability of SDO. In addition, because recent evidence suggests that SDO consists of 2 facets, we also test the degree to which the genetic and environmental underpinnings of orientations toward social dominance (SDO-D) and egalitarianism (SDO-E) are distinct. Most importantly, the current study enabled us to investigate whether the relationship between SDO and key political attitudes springs from their overlapping environmental influences (environmental correlation), as has been suggested (65, 66), or shared genetic influences (genetic correlation). Evidence for this latter possibility would be consistent with the notion that different levels of SDO reflect different hierarchical or egalitarian behavioral types that coordinate strategies toward territoriality, resource distribution, and punishment across contexts.

Results

The logic of the twin method consists of analyzing correlational differences between MZ twins, who share all of their genes, and between DZ twins, who share only half of their segregating genes. For descriptive statistics of SDO and political attitudes, and for phenotypic correlations by sex and zygosity group, see *SI Appendix, Tables S1–S7*.

At the phenotypic level, we found that a bidimensional confirmatory factor model of SDO in our sample had superior fit (root-mean-squared error of approximation [RMSEA]: 0.062; comparative fit index [CFI]: 0.916; Tucker–Lewis index [TLI]: 0.902) as compared to a unidimensional confirmatory factor model (RMSEA: 0.121; CFI: 0.678; TLI: 0.628). Men scored significantly higher than women on both SDO-D and SDO-E [$t(863.52) = 3.7165$, $P < 0.001$, and $t(883.14) = 2.9754$, $P < 0.001$, respectively, consistent with previous research (1, 67)]. The effect size (Cohen's d) of the sex difference in our sample was 0.26 for SDO-D and 0.18 for SDO-E, smaller than the average effect size for gender differences found in a cross-cultural metaanalysis, 0.43 (47).

Genetic Modeling.

Bivariate model. The MZ correlations were higher than the DZ correlations for both SDO-D and SDO-E, across both sexes, which indicates heritability (*SI Appendix, Tables S3–S6*). For the 6 different biometric models our analysis compared, see *SI Appendix, Table S8* and methods.

The best-fitting model according to the Akaike Information Criterion (AIC) was the AE Cholesky without sex limitation (*SI Appendix, Fig. S1*). In this model, the overlap between SDO-D and SDO-E is estimated as genetic. Genetic overlap (r_A),

however, may include effects that are mediated through environmental mechanisms, as opposed to environmental correlations (r_E), which encompass all environmental effects that are independent of genes (68). If the same genetic factor influences both constructs, the genetic correlation is one; if there is no overlap at all, it is zero. The same applies for the environmental correlation. We found that the estimated heritability was 37% for SDO-D and 24% for SDO-E. Their genetic correlation was 0.48 (95% confidence interval [CI]: 0.28 to 0.67), and their environmental correlation was 0.37 (95% CI: 0.29 to 0.45).

Sex limitation models capture the idea that the same factors could cause variation in males and females, but to different degrees (69, 70). This is tested by constraining the latent genetic, nonshared environmental, and shared environmental correlations (r_A , r_E , and r_C) across sex in order to see whether the parameters (a , c , e , left unconstrained) still differ significantly. If they do, in fact, differ, the sex limitation model should show the best fit to the data. The fact that the model without sex limitation fit our data best thus suggests that any differences in the heritability of SDO across the sexes are insignificant.

Analyses of SDO and political attitudes. The political attitudes, individually, had heritabilities ranging from 20 to 45% (*SI Appendix, Table S9*). Further, with the exception of “strict immigration control” and “deport the Roma,” which both had a 19% effect of shared environment (C), no other attitude had any shared-environment effect.

After finding that the AE model without sex limitation had the best fit for SDO-D and SDO-E, we used this model for our subsequent trivariate analyses of SDO-D, SDO-E, and each of the 6 political attitudes. The genetic and environmental effects on each of the political attitudes are presented in Fig. 1. Within every bar, the SDO-specific genetic and environmental effects that account for variance in the political attitudes are visualized. These particular estimates are based on a trivariate Cholesky model of SDO and the political attitudes (*SI Appendix, Fig. S2*).

Fig. 2 shows the genetic and environmental correlations between SDO-D, SDO-E, and each political attitude. The genetic correlation refers to the overlap in genetic influences on the traits. Similarly, the

unique environmental correlation estimates the amount of overlap the traits have due to the same (nonshared) environmental forces. As seen in Fig. 2, SDO-D, SDO-E, and all of the political attitudes share genetic influence to large degrees (mean genetic correlation = 0.51), but the overlapping unique environmental influences are very low (mean environmental correlation = 0.08).

Discussion

The distribution of resources such as food, territory, and mates is a critical question for all social species. Dominance hierarchies are the most widely implemented way of governing such distributions, and, as a result, adaptive representations and strategies for navigating them emerge across species and very early in human ontogenesis (see refs. 1, 8, and 9). Once human societies started producing an economic surplus, such dominance hierarchies took an intergroup form. Today, individual differences in endorsement of between-group hierarchy, as tapped by SDO, are a robust predictor across time and contexts of support for policies and attitudes that function to enhance or attenuate the unequal distribution of resources, territory, rights, and sanctions between human groups (1, 29). This suggests that endorsement of, or opposition to, between-group hierarchy and the policies that sustain it build on a universal adaptation for navigating social hierarchies, while exhibiting variation in the manner of a functionally integrated behavioral syndrome. By this account, individual levels of SDO specify variation in support for different types of strategies for navigating the distribution of resources and living conditions. Given the range of ecological conditions (e.g., levels of resource availability) and social contexts (e.g., existing distribution of hierarchical motives in a population) that affect the fitness consequences of one strategy over another, it is unlikely that a single optimal level of hierarchy preference exists. It is thus plausible that balancing selection sustains coordinated heritable variation in hierarchy-relevant attitudes, as has been argued for the case of personality (refs. 20–24, but see also refs. 25 and 26).

Fig. 1. Estimates of A (additive genetics) and E (unique environment) of the political attitudes based on a trivariate Cholesky model (with SDO pooled for SDO-D and SDO-E). The percentages above each bar represent the variance accounted for by genetics overlapping with SDO (the SD of every political attitude is available in *SI Appendix, Table S2*).

Fig. 2. Trivariate estimates of genetic (r_A) and environmental correlations (r_E) between SDO-D, SDO-E, and support for 6 political policies (with 95% CI).

Such coordinated heritability is precisely what is indicated by the current set of results. It shows, first, that a moderate amount of the variability in both facets of SDO—relating to dominance (SDO-D) and to antiegalitarianism (SDO-E)—is heritable (36% and 24%, respectively). Still, the unique environment for each individual twin explains the largest amount of variance in both SDO and each political attitude. This is consistent with the previously documented role of one's position and role within the societal dominance hierarchy in shaping one's (anti)egalitarian preferences. However, we found no evidence that the family environment shared by twins sets their SDO levels. We also found that a model without sex limitation fit our data best, suggesting that the magnitude of genetic and environmental effects on the phenotypes does not differ significantly between men and women.

The finding of moderate heritability in SDO is in line with research on the behavioral genetics of political attitudes, in particular the negligible role of shared environment, with similar implications for rethinking the classic literature on political socialization (62, 63). It contrasts, however, with accounts of SDO that deny its status as an enduring trait (51, 52) or report that it has no meaningful genetic underpinning (65, 66). Our work differs from this previous behavioral genetics research on SDO, all of which was conducted with the same relatively small sample, in that we use a considerably larger twin sample (708 same-sex twin pairs as opposed to 327 same-sex twin pairs), increasing confidence in the robustness of the current set of estimates. The present sample was also of a markedly older age (mean age 65 y as opposed to 34 y), which is important, given findings that heritability estimates tend to increase with age (71). Finally, it is also possible that the heritability estimates of SDO and related political attitudes found in the current Norwegian sample differ from the previous German sample due to contextual factors and gene–environment interactions. For example, given Germany's recent history, the expression of prejudiced attitudes toward other groups might potentially be subject to stronger social desirability effects such that the measurement of prejudice would be less reliable, making it harder to pick up any heritability effects on SDO. Moving from separate heritability estimates to an analysis of the latent structure of correlations, we demonstrated moderately sized genetic (0.48) and nonshared environmental (0.37) correlations between SDO-D and SDO-E. This implies not only that a substantial portion of the genetic influences on one dimension of SDO also affect the other dimension, but also that each dimension is influenced in similar ways by the unique environments experienced by each individual twin, but not shared with their twin.

Even more significant is the finding that both facets of SDO are moderately genetically correlated with 6 specific political attitudes with hierarchy-enhancing versus attenuating implications for the distribution of territory, resources, and sanctions in society. In other words, substantial parts of the genetic variance underlying each political attitude are overlapping with the genetic variance of both SDO-D and SDO-E. In contrast, this is not the case for the environmental variance underlying the SDO subdimensions; we found no evidence that this environmental variance is overlapping with

the environmental variance underlying specific political attitudes, i.e., that the same environmental experiences shape both SDO and political attitudes in a convergent manner. The finding of correlated genetic influences without correlated environmental influences is unlikely due to the role of measurement error in the latter, as we found both genetic and environmental correlations among the SDO subdimensions. Furthermore, to the extent that SDO can be considered a stable, general trait, these results are in line with earlier behavioral genetics evidence that the covariance between personality traits and political attitudes is due to shared latent genetic factors (72).

While the idea that orientation toward intergroup hierarchy is a genetically grounded behavioral syndrome addresses one persistent question concerning the origin of political attitudes and their covariation, it raises several other questions. Most notably, the present results do not speak to the specific ways in which such coordinated heritable variation is grounded in molecular genetics and correlated with the environmental exposure, nor sustained at the population level. We have suggested a role for processes of balancing selection broadly construed, the plausibility of which depends on the emergence of empirical work directly testing specific selective mechanisms at the population level, in a manner consistent with evidence at the molecular level on the inheritance of genetic polymorphisms (20, 21).

An important question is what factors feed into the selection of hierarchical versus egalitarian attitudes. In line with the notion of facultative adaptations (25) and the importance of gene-by-environment interactions (73), a universal ability to navigate social hierarchy will likely manifest in a particular orientation toward hierarchy for any one individual at any one place and time by drawing on multiple sources of influence. We conjecture that these sources include inherited individual genetic attitudinal proclivities and components of embodied capital such as formidability, along with ecological factors such as the nature of the surrounding intergroup hierarchy, one's position within it, and the existing distribution of (anti)egalitarian behavioral strategies. For example, an individual with strong innate fighting ability and capacity to form alliances may be more likely to inherit a tendency toward relatively high SDO-D, and, with it, high SDO-E and antiegalitarian political views. When placed near the top of a highly unequal society with large rewards for success, in which some (but not too many) others also value hierarchy, these biological proclivities might manifest as a strong orientation in favor of intergroup dominance and inequality, and, with it, support for political policies that enhance such inequality. Evidence on the interplay between dispositional and structural factors in political psychology is consistent with such a pattern (34), while the potential role of balancing selection in this process suggests that variation in both hierarchical and egalitarian phenotypes may be maintained at the population level (20–25), as is observed cross-nationally (34, 36, 37, 47–49). These population and ecological variations would support complex temporal dynamics and equilibria of intergroup relations unfolding across country and time period, as is found in the historical record (74).

There are, of course, important caveats to be considered alongside the current findings. As with all twin studies, our research is subject to the critique that potential violations of the assumption that MZ and DZ twins are treated equally similarly (i.e., the equal environments assumption) will lead to inflated heritability estimates. Note, however, that the impact of such violations on heritability estimates was found to be small to negligible when directly tested in the case of ideology (75). As with all studies, the heritability and correlation estimates are also limited to the current sample (i.e., in terms of age, culture, ethnicity, and socioeconomic status). This matters, as prior research demonstrates that macrostructural inequality increases SDO levels among dominant groups across nations (34, 36, 47). Thus, while we found no effect of shared (family) environment on SDO within this sample of Norwegian twins, we would likely have found a shared (national) environment effect of macrostructural inequality on SDO, had we been able to sample twins cross-nationally.

Recent multilevel research also indicates that, while average SDO levels among dominant groups are set across nations and states by their macrostructural inequality, the downstream effects of SDO on negative intergroup attitudes and violence nevertheless occur at the individual, psychological level, rather than at the macrostructural

level (34). This finding is fully compatible with the present result that the correlations between SDO and intergroup political attitudes reflect shared genetic underpinnings that adjust both in a convergent manner, rather than shared environmental influences.

As we have outlined above, all heritable characteristics are realized in the environment of the world and so the fact that a predisposition is heritable does not mean it operates in a vacuum from the environment. It is likely that people actively select and shape their environment based on their heritable traits (active gene–environment correlation). This might imply, for instance, that 2 MZ twins are more likely to choose hierarchy-enhancing (versus attenuating) environments that further increase (versus decrease) their support for (or opposition to) intergroup hierarchy because of their shared, inherited dispositions for high (versus low) levels of SDO. Indicative of such a causal pathway is existing evidence that SDO predicts self-selection to both hierarchy-enhancing roles and contexts of socialization (1, 28, 40). Indeed, this ecological niche-picking of contexts in which one's degree of hierarchy-enhancing versus attenuating motives will be most adaptive may help balancing selection sustain heritable variation in both types of strategies in the population (20–24). In addition, different environments may, in turn, trigger differential expression of genetic differences in SDO, a case of gene–environment interaction. Although such active gene–environment correlations and interactions may account for some of the genetic correlation between SDO and political attitudes, we concur with political behavioral geneticists and philosophers of biology (68, 75, 76) that any such mediating and moderating role for environment of the upstream impact of genetics is appropriately included as part of broad-sense heritability.

These results add to emerging evidence that the associations of myriad social psychological phenomena are at least partly genetically underpinned in this broad sense. Specifically, they suggest that both specific political attitudes and more broad preferences for or against hierarchies are deeply embedded and interrelated as a behavioral syndrome at the individual level in human nature. They lend credence to an account in which different kinds of orientations toward intergroup hierarchy, ranging from strong preferences in favor of inequality to strong preferences against it, constitute partly heritable, coordinated strategies for resolving dilemmas regarding the distribution and monopolization of power and resources, which are nevertheless input-sensitive by design. Combined with research on the genetics of other components of political attitudes, they support a literal interpretation of the saying that humans are, indeed, a political animal.

Methods

Sample. The twins were recruited from the Norwegian Twin Registry (NTR), which consists of several cohorts of twins (77). This cohort, as registered by the NTR, consisted only of same-sex twins. The current study drew a random sample from the cohort born between 1945 and 1960, and the questionnaire was filled out in 2016. The mean age was 63.5 y (SD = 4.49 y). The target sample was 3,090 twins, and the final sample was 1,987 twins, yielding a response rate of 64%. We had 1,416 pair responders, and 571 single responders. For complete pairs with valid SDO scores, our sample consists of 131 male MZ, 204 female MZ, 127 male DZ, and 194 female DZ twin pairs. Zygosity has been determined by a questionnaire shown to correctly classify 97 to 98% of the twins (78). Our study was approved by the Regional Committee for Medical and Health Research Ethics of South-East Norway. Informed consent was obtained from all research participants, and all methods were performed according to the relevant guidelines and regulations.

Measures. The participants completed a Norwegian translation of the SDO-7 scale. The SDO scale consists of 8 items measuring SDO-D, such as, “Some groups of people must be kept in their place,” and 8 items measuring SDO-E, such as, “We should not push for group equality” (reverse-coded). Heeding

methodological warnings that respondents may not reliably process and respond to negative-worded items (79), all SDO-7 items were administered protrait (for group dominance or for group equality, respectively) to avoid having 2 mutually opposing negatively worded sets of items (against group dominance and group equality, respectively). For the analyses of support for political policies, we used the following 6 attitudes, measured as support for or against on a 7-point scale ranging from –3 to +3: 1, severe punishments for criminals; 2, strict immigration control; 3, accept more asylum seekers; 4, stronger workers' unions; 5, deport the Roma (a European itinerant ethnic group); and 6, reduced aid for developing countries.

Twin Method. MZ twins are genetically identical, while DZ twins share, on average, only half of their segregating genes. All twins are born at the same time, and the twins analyzed here grew up together. The differential genetic overlap is the only thing that separates MZ twins from DZ twins. This allows us to decompose the variance into additive genetic effects (A), shared environmental effects (C; e.g., shared experiences within the family, interacting with the same peers), and unique environmental effects (E; e.g., experiences specific to the individual) (69). In univariate twin analysis, this decomposition of variance is estimated for one single phenotype at a time. Just as this can be done for variation in a single trait, the analysis can be expanded to partition the covariation between several phenotypes, resulting in multivariate twin analysis. Further, we can compare a full ACE model with a simpler AE or CE model to see whether dropping the effects of shared environment and/or additive genetic effects leads to a worse or better fit to the observed data (E is always included because it contains all of the measurement error).

Twin Analyses. For our initial bivariate model of SDO-D and SDO-E, we ran and compared 6 biometric nested models (*SI Appendix, Table S8*). We selected these models because it allowed us to test whether 3 variance components (A, C, and E) are necessary, or whether a more parsimonious model was sufficient. Further, they allowed us to test whether any genetic effects are shared or unique, and to see whether there are any quantitative sex differences. All of our model parameters are based on the Cholesky model (69). A Cholesky model is a structural equation model where the A, C, and E components are latent variables and the measured phenotypes are observed variables. The first latent variable loads on the first measured variable and all of the remaining ones. The second latent variable loads on the second observed variable and all of the remaining observed variables, and so on (80). The Cholesky model can be transformed into a “correlated factor solution,” where every variable is separately decomposed into genetic and environmental components and the correlation between those is estimated (80).

Our full model was a Cholesky model with scalar sex limitation, containing additive genetic variance (A), and shared (C) and unique (E) environmental influences. In scalar sex limitation models, parameters are allowed to vary across the sexes, but the genetic correlation (r_A), shared environmental correlation (r_C), and unique environmental correlation (r_E) are constrained to be equal for females and males (see ref. 70). The second bivariate model is similar, except that the effects of the shared environment are removed. The third model is a full ACE model again but without sex limitation (all of the remaining models are without sex limitation). The fourth model is an AE model, meaning it is without the effects of the shared environment (C). The fifth model is an AE model where the effect of additive genetics that is specific to the second variable (SDO-E) is reduced to zero. This is to check whether all of the genetic variance of the 2 components is explained by the genetic effects specific to SDO-D. In the sixth and final model, only the common A is dropped to zero. That is, the effect of SDO-D–specific genetic effects on SDO-E is reduced to zero, leaving only the genetic effect that is specific to SDO-D and SDO-E intact. All model parameters were estimated using full information maximum likelihood, by means of the R package OpenMx (81). AIC was used as the measure of fit of our models, and hence as the identifier of the best-fitting model (82).

The best-fitting model, namely the AE model without sex limitation, was the basis for the trivariate analyses of SDO-D, SDO-E, and the 6 political policies.

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Supplementary Information for

“Correlations Between Social Dominance Orientation and Political Attitudes Reflect Common Genetic Underpinnings: A Twin Study”

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Figs. S1 to S2
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Figures

Fig. S1. Bivariate AE model (here shown as a correlated factor solution) without sex limitation showing latent genetic (A1, A2) and unique environmental (E1, E2) components with path estimates (95% CI) on the measured phenotypes, Social Dominance Orientation-Dominance, and Social Dominance Orientation-Anti-Egalitarianism. The genetic correlation (r_A) and unique environmental correlation (r_E) are shown as the double-headed arrow between the latent variables.

Trivariate, Correlated factor solution

Trivariate, Cholesky

Fig. S2. Trivariate models of the Genetic (A) and Environmental (E) contributions to the variance and correlation between traits. Here two algebraically equivalent models are shown: The correlated factor solution model (r_A = genetic correlation, r_E = environmental correlation) and Cholesky decomposition.

Tables

Table S1: Means and standard deviations of the SDO dimensions differentiated by sex

		Mean (SD)
SDO-D	Male	2.58 (1.17)
	Female	2.29 (1.09)
SDO-E	Male	2.21 (1.07)
	Female	2.02 (1.07)

Note: SDO-D = Social Dominance Orientation-Dominance, SDO-E = Social Dominance Orientation-Egalitarianism

Table S2: Means and standard deviations of the seven political policies differentiated by sex

		Mean (SD)
Severe punishments for criminals	Male	5.53 (1.50)
	Female	5.70 (1.41)
Strict immigration control	Male	5.23 (1.55)
	Female	5.05 (1.60)
Accept more asylum seekers	Male	3.60 (1.72)
	Female	3.92 (1.73)
Stronger workers' unions	Male	4.80 (1.61)
	Female	5.15 (1.50)
Deport the Roma	Male	3.32 (1.80)
	Female	3.43 (1.78)
Reduced aid for developing countries	Male	3.42 (1.85)
	Female	3.39 (1.86)

Table S3. Phenotypic correlation matrix for males (below the diagonal) and for females (above the diagonal) (with 95% Confidence Intervals)

	SDO-D	SDO-E	Severe punishments for criminals	Strict immigration control	Accept more asylum seekers	Stronger workers' unions	Deport the Roma	Reduced aid for developing countries
SDO-D	1.00	0.39 (0.32-0.46)	0.24 (0.15-0.31)	0.27 (0.19-0.35)	-0.22 (-0.30--0.14)	-0.05 (-0.13--0.04)	0.25 (0.17-0.33)	0.23 (0.15-0.31)
SDO-E	0.42 (0.34-0.50)	1.00	0.07 (-0.01-0.16)	0.17 (0.09-0.25)	-0.20 (-0.28--0.12)	-0.25 (-0.33--0.17)	0.21 (0.13-0.29)	0.18 (0.10-0.26)
Severe punishments for criminals	0.33 (0.24-0.41)	0.09 (-.01-0.19)	1.00	0.57 (0.51-0.63)	-0.35 (-0.42--0.28)	-0.06 (-0.14-0.03)	0.32 (0.25-0.40)	0.35 (0.27-0.42)
Strict immigration control	0.37 (0.28-0.45)	0.17 (0.08-0.27)	0.61 (0.55-0.67)	1.00	-0.51 (-0.57--0.45)	-0.08 (-0.16-0.00)	0.44 (0.37-0.51)	0.44 (0.37-0.50)
Accept more asylum seekers	-0.33 (-0.41--0.24)	-0.19 (-0.29--0.10)	-0.35 (-0.44--0.27)	-0.57 (-0.64--0.51)	1.00	0.16 (0.08-0.24)	-0.39 (-0.46--0.32)	-0.39 (-0.46--0.32)
Stronger workers' unions	-0.23 (-0.32--0.14)	-0.22 (-0.32--0.13)	-0.13 (-0.22--0.03)	-0.15 (-0.24--0.05)	0.17 (0.07-0.26)	1.00	-0.08 (-0.16-0.00)	0.01 (-0.07-0.10)
Deport the Roma	0.28 (0.19-0.37)	0.18 (0.08-0.27)	0.32 (0.23-0.41)	0.48 (0.40-0.55)	-0.41 (-0.49 -0.32)	-0.06 (-0.15-0.04)	1.00	0.45 (0.38-0.51)
Reduced aid for developing countries	0.25 (0.16-0.34)	0.21 (0.12-0.30)	0.34 (0.25-0.42)	0.48 (0.40-0.55)	-0.45 (-0.52--0.36)	-0.08 (-0.17-0.02)	0.53 (0.46-0.60)	1.00

Between-twin correlation tables with within and across trait correlations. Differentiated by sex.

Table S4. MZM twin correlations (with 95% confidence intervals)

	SDO-D	SDO-E	Severe punishments for criminals	Strict immigration control	Accept more asylum seekers	Stronger workers' unions	Deport the Roma	Reduced aid for developing countries
SDO-D	.40 (.25, .54)	.31 (.14, .45)	.38 (.22, .52)	.22 (.05, .38)	-.36 (-.50, -.20)	-.26 (-.42, -.10)	.25 (.08, .40)	.20 (.03, .36)
SDO-E	.13 (-.04, .29)	.19 (.02, .35)	.14 (-.03, .31)	.07 (-.11, .24)	-.15 (-.32, .02)	-.37 (-.51, -.21)	.17 (-.00, .33)	.16 (-.02, .32)
Severe punishments for criminals	.35 (.19, .49)	.06 (-.11, .23)	.50 (.35, .62)	.30 (.13, .45)	-.30 (-.45, -.14)	-.13 (-.30, .04)	.25 (.08, .40)	.32 (.15, .46)
Strict immigration control	.41 (.25, .54)	.17 (-.01, .33)	.55 (.41, .66)	.28 (.11, .44)	-.35 (-.50, -.19)	-.17 (-.34, .00)	.37 (.21, .51)	.38 (.22, .52)
Accept more asylum seekers	-.15 (-.31, .03)	-.15 (-.32, .02)	-.29 (-.44, -.13)	-.24 (-.39, -.06)	.28 (.11, .43)	.12 (-.05, .29)	-.37 (-.51, -.21)	-.33 (-.47, -.16)
Stronger workers' unions	-.10 (-.27, .07)	-.04 (-.21, .13)	-.13 (-.30, .05)	-.13 (-.30, .04)	.06 (-.12, .23)	.37 (.21, .51)	-.04 (-.21, .14)	-.02 (-.19, .15)
Deport the Roma	.22 (.05, .38)	.15 (-.02, .31)	.39 (.23, .53)	.23 (.06, .39)	-.35 (-.49, -.19)	-.12 (-.28, .06)	.41 (.26, .55)	.36 (.20, .50)
Reduced aid for developing countries	.31 (.15, .46)	.19 (.02, .35)	.49 (.34, .61)	.22 (.04, .38)	-.26 (-.42, -.10)	-.06 (-.23, .11)	.35 (.19, .49)	.50 (.36, .62)

Note: MZM = Monozygotic male

Table S5. DZM twin correlations (with 95% confidence intervals)

	SDO-D	SDO-E	Severe punishments for criminals	Strict immigration control	Accept more asylum seekers	Stronger workers' unions	Deport the Roma	Reduced aid for developing countries
SDO-D	.17 (-.00, .34)	-.00 (-.17, .17)	.03 (-.15, .20)	-.06 (-.23, .11)	-.06 (-.23, .11)	-.09 (-.26, .09)	.01 (-.16, .19)	-.04 (-.22, .13)
SDO-E	-.04 (-.21, .14)	-.03 (-.20, .15)	-.01 (-.19, .16)	.02 (-.16, .19)	.00 (-.17, .18)	.04 (-.14, .21)	.07 (-.10, .24)	.04 (-.14, .21)
Severe punishments for criminals	.06 (-.11, .23)	.07 (-.10, .24)	.25 (.08, .41)	.13 (-.04, .30)	-.10 (-.27, .07)	.05 (-.13, .22)	.26 (.09, .42)	.23 (.06, .39)
Strict immigration control	.05 (-.12, .22)	-.03 (-.20, .14)	.17 (-.00, .34)	.16 (-.02, .32)	-.10 (-.27, .07)	.06 (-.12, .23)	.18 (.00, .34)	.10 (-.08, .27)
Accept more asylum seekers	-.01 (-.18, .17)	.06 (-.11, .23)	-.15 (-.31, .03)	-.27 (-.42, -.10)	.06 (-.12, .23)	.03 (-.15, .20)	-.18 (-.34, -.00)	-.02 (-.19, .15)
Stronger workers' unions	-.06 (-.23, .11)	-.13 (-.29, .05)	.08 (-.10, .25)	.05 (-.13, .22)	-.05 (-.23, .12)	.05 (-.12, .22)	.03 (-.15, .20)	.10 (-.07, .27)
Deport the Roma	.07 (-.10, .24)	-.05 (-.22, .13)	.23 (.05, .38)	.25 (.08, .41)	.01 (-.16, .19)	.09 (-.09, .26)	.32 (.15, .46)	.19 (.01, .35)
Reduced aid for developing countries	.05 (-.13, .22)	.07 (-.11, .24)	.13 (-.04, .30)	.22 (.04, .38)	-.01 (-.18, .16)	-.02 (-.19, .16)	.19 (.02, .35)	.11 (-.07, .28)

Note: DZM = Dizygotic male

Table S6. MZF twin correlations (with 95% confidence intervals)

	SDO-D	SDO-E	Severe punishments for criminals	Strict immigration control	Accept more asylum seekers	Stronger workers' unions	Deport the Roma	Reduced aid for developing countries
SDO-D	.35 (.22, .46)	.24 (.10, .36)	.10 (-.04, .23)	.18 (.05, .31)	-.19 (-.31, -.05)	-.14 (-.27, -.01)	.23 (.10, .36)	.27 (.14, .39)
SDO-E	.05 (-.09, .19)	.27 (.14, .39)	.09 (-.04, .22)	.11 (-.03, .24)	-.11 (-.24, .03)	-.04 (-.17, .10)	.20 (.07, .33)	.13 (-.01, .26)
Severe punishments for criminals	.12 (-.02, .26)	.11 (-.03, .25)	.33 (.21, .45)	.26 (.12, .38)	-.35 (-.46, -.22)	.04 (-.10, .18)	.31 (.18, .42)	.31 (.18, .43)
Strict immigration control	.21 (.08, .34)	.34 (.21, .46)	.39 (.27, .50)	.32 (.19, .43)	-.38 (-.49, -.26)	.05 (-.08, .19)	.37 (.25, .48)	.34 (.22, .46)
Accept more asylum seekers	-.17 (-.30, -.04)	-.27 (-.39, -.14)	-.26 (-.38, -.13)	-.20 (-.33, -.07)	.29 (.16, .41)	-.01 (-.15, .12)	-.27 (-.39, -.14)	-.26 (-.38, -.13)
Stronger workers' unions	.02 (-.12, .16)	-.20 (-.33, -.07)	.01 (-.12, .15)	-.12 (-.25, .01)	.06 (-.08, .19)	.33 (.21, .45)	-.09 (-.22, .05)	-.10 (-.23, .03)
Deport the Roma	.15 (.01, .28)	.28 (.15, .40)	.26 (.13, .38)	.23 (.10, .35)	-.33 (-.44, -.20)	-.00 (-.14, .13)	.35 (.23, .47)	.32 (.20, .44)
Reduced aid for developing countries	.25 (.12, .38)	.27 (.14, .39)	.27 (.14, .39)	.15 (.02, .28)	-.29 (-.41, -.16)	-.03 (-.16, .10)	.26 (.13, .39)	.40 (.28, .50)

Note: MZF = Monozygotic male

Table S7. DZF twin correlations (with 95% confidence intervals)

	SDO-D	SDO-E	Severe punishments for criminals	Strict immigration control	Accept more asylum seekers	Stronger workers' unions	Deport the Roma	Reduced aid for developing countries
SDO-D	.19 (.05, .32)	.01 (-.13, .15)	.20 (.06, .33)	.07 (-.08, .21)	-.02 (-.16, .12)	-.08 (-.22, .06)	.16 (.02, .30)	.08 (-.06, .22)
SDO-E	.09 (-.05, .23)	.17 (.02, .30)	.12 (-.02, .26)	.07 (-.07, .21)	-.09 (-.23, .05)	-.18 (-.32, -.04)	.05 (-.09, .19)	-.01 (-.15, .13)
Severe punishments for criminals	.22 (.08, .35)	.04 (-.10, .18)	.18 (.04, .31)	.21 (.07, .34)	-.07 (-.21, .07)	-.01 (-.15, .13)	.11 (-.03, .25)	.16 (.02, .29)
Strict immigration control	.07 (-.08, .21)	-.01 (-.15, .13)	.36 (.23, .48)	.18 (.04, .31)	-.12 (-.26, .02)	.02 (-.12, .16)	.29 (.15, .41)	.28 (.15, .41)
Accept more asylum seekers	-.05 (-.19, .09)	-.11 (-.25, .03)	-.21 (-.34, -.07)	-.05 (-.19, .09)	.07 (-.07, .21)	.03 (-.11, .17)	-.21 (-.34, -.07)	-.07 (-.21, .07)
Stronger workers' unions	.05 (-.09, .19)	-.09 (-.23, .05)	-.14 (-.27, .01)	-.03 (-.18, .11)	.06 (-.09, .19)	.33 (.20, .45)	-.10 (-.24, .04)	.01 (-.13, .15)
Deport the Roma	.13 (-.01, .27)	.18 (.04, .31)	.27 (.13, .40)	.08 (-.07, .21)	-.10 (-.24, .04)	.05 (-.10, .19)	.22 (.08, .35)	.13 (-.02, .26)
Reduced aid for developing countries	.10 (-.04, .24)	.10 (-.04, .24)	.26 (.13, .39)	.04 (-.10, .18)	-.06 (-.20, .08)	.13 (-.01, .26)	.20 (.07, .33)	.26 (.12, .38)

Note: DZF = Dizygotic female

Table S8. Fitting of bivariate Genetic models of SDO-D and SDO-E

	Model	-2 LL	df	AIC	LL diff	df diff	p
1	ACE, Cholesky scalar sex limitation	11088.00	3779	3529.997	NA	NA	NA
2	AE, Cholesky scalar sex limitation	11092.36	3784	3524.358	4.361	5	0.498
3	ACE, Cholesky with no sex limitation	11093.66	3785	3523.660	5.663	6	0.461
4	AE, Cholesky with no sex limitation	11094.61	3788	3518.615	6.617	9	0.676
5	AE, no sex limitation, drop As to zero	11111.86	3789	3533.864	23.867	10	0.07
6	AE, no sex limitation, Common A dropped to zero	11110.24	3789	3532.240	22.243	10	0.013

Note: Scalar sex limitation: model with a scalar that equalizes the standardized sex-specific parameters. LL = LogLikelihood, df diff = differences in degrees of freedom as compared to base model. p = p-values from test of difference from base model. Best fitting model indicated in **bold**

Table S9. Univariate model fitting estimates of a full ACE (additive genetic, shared environmental and nonshared environmental respectively) model for every political attitude

	Variance components (95% CIs)		
	A (Contribution of heritability)	C (contribution of shared environment)	E (contribution of unshared environment)
Severe punishment for criminals	0.45 (0.37-0.52)	0.00 (0.00-0.19)	0.55 (0.48-0.63)
Strict immigration control	0.23 (0.00-0.48)	0.19 (0.00-0.40)	0.58 (0.50-0.66)
Accept more asylum seekers	0.27 (0.18-0.36)	0.00 (0.00-0.36)	0.72 (0.64-0.82)
Stronger workers' unions	0.32 (0.04-0.46)	0.06 (0.00-0.28)	0.62 (0.53-0.72)
Deport the roma	0.20 (0.00-0.44)	0.19 (0.00-0.37)	0.63 (0.54-0.72)
Reduced aid for developing countries	0.43 (0.22-0.51)	0.00 (0.00-0.18)	0.57 (0.50-0.65)

Note: As determined by AIC an AE model was the best fit for every attitude except “Deport the Roma”, where an ACE model had best fit.

Table S10. Trivariate model-fitting estimates of the genetic and environmental correlation between all six political policies and Social Dominance Orientation-Dominance and Social Dominance Orientation-Egalitarianism

	rA - SDO-D	rA - SDO-E	rE - SDO-D	rE - SDO-E
Severe punishments for criminals	0.54 (0.39 – 0.7)	0.21 (0.01 – 0.43)	0.07 (-0.02 – 0.17)	0.06 (-0.03 – 0.16)
Strict immigration control	0.60 (0.46 – 0.73)	0.48 (0.29 – 0.69)	0.11 (0.02 – 0.2)	0.09 (0.0 – 0.182)
Accept more asylum seekers	0.63 (0.43 – 0.84)	0.66 (0.41 – 0.95)	0.06 (0.03 – 0.16)	0.12 (0.03 – 0.21)
Stronger workers' unions	0.24 (0.08 – 0.42)	0.54 (0.33 – 0.77)	0.10 (0.0 – 0.2)	0.13 (0.04 – 0.23)
Deport the Roma	0.53 (0.37 – 0.69)	0.64 (0.9 – 0.43)	0.09 (-0.02 – 0.19)	0.04 (-0.05 – 0.13)
Reduced aid for developing countries	0.58 (0.43 – 0.74)	0.52 (0.31 – 0.76)	0.06 (-0.03 – 0.16)	0.03 (-0.06 – 0.12)

Note: rA = Genetic correlations, rE = unique environmental correlation