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Linking Genes and Political Orientations: Testing the Cognitive Ability as Mediator Hypothesis

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Recent research has demonstrated that genetic differences explain a sizeable fraction of the variance in political orientations, but little is known about the pathways through which genes might affect political preferences. In this article, we use a uniquely assembled dataset of almost 1,000 Swedish male twin pairs containing detailed information on cognitive ability and political attitudes in order to further examine the genetic and environmental causes of political orientations. Our study makes three distinct contributions to our understanding of the etiology of political orientations: (1) we report heritability estimates across different dimensions of political ideology; (2) we show that cognitive ability and political orientations are related; and (3) we provide evidence consistent with the hypothesis that cognitive ability mediates part of the genetic influence on political orientations. These findings provide important clues about the nature of the complex pathways from molecular genetic variation to political orientations.

KEY WORDS: political orientation, cognitive ability, heritability

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There is a growing literature demonstrating that individual differences in political attitudes and preferences could in part be attributed to genetic differences (Alford, Funk, & Hibbing, 2005; Eaves & Eysenck, 1974; Hatemi, Hibbing, et al., 2010; Hatemi, Medland, et al., 2007; Martin et al., 1986). Using samples from different countries and employing the classic twin design, these studies report that genetic factors account for 30–50% of the variation in issue orientations, ideology, and party identification.

For many political scientists, these results are both intriguing and counterintuitive, and, not surprisingly, they have caused a lot of debate, mainly concerning methodological caveats of the twin model (Charney, 2008; Shultziner, 2013). On a more fundamental level, the question arises as to why political scientists in general, or for that matter society at large, should care about these findings (Goldberger, 1979). Although important, the finding that genetic endowments explain a moderate to large share of the variation in political attitudes can only take us so far. Important questions concerning the genetic etiology of political traits still abound. Thus, to seriously contribute to and engage in the mainstream political science research on mass political behavior, further steps are needed among scholars studying the heritability of political orientations.

First, the bulk of previous studies on the heritability of political orientations are based on the untenable and often implicit assumption that political ideology is a unidimensional concept that can be measured using a single or composite indicator along a general liberal-conservative or left-right continuum (Alford et al., 2005; Funk et al., 2013; Hatemi, Funk, et al., 2009). However, earlier research has shown that individuals' political orientations are multidimensional in nature (Jost, Federico, & Napier, 2009). Above all, people tend to keep orientations across policy domains (e.g., economic vs. social domains) distinct (Feldman & Johnston, 2014). Thus, a better understanding of the genetic origins of political orientations necessitates the use of measures that can tap into different subdimensions of the ideology concept.

Second, the quest to find plausible mechanisms mediating the relationship between genes and political outcomes has proven elusive. Shedding light on this question is an important next step in the research agenda because, as noted by a number of authors, there is a heterogeneous set of complicated pathways through which genetic variation could ultimately impact political orientations (Smith, Oxley, et al., 2011; Verhulst, Hatemi, & Martin, 2010).

In this article, we argue that cognitive ability is a possible mechanism that can account for some of the heritable variation in political orientations. Earlier studies have shown that cognitive ability is strongly heritable (Bouchard & McGue, 2003) and correlated with political orientations (Deary, Batty, & Gale, 2008a; Morton, Tyran, & Wengström, 2011; Schoon, Cheng, Gale, Batty, & Deary, 2010; Stankov, 2009). However, so far no study has investigated the genetic links between cognitive ability and political attitudes.

We provide evidence on the relationship between cognitive ability and political orientations using survey data from almost 2,000 Swedish male twins aged 52–67 years. The survey was administered between 2009 and 2010. To measure political orientations, we focus on six outcomes: a standard left-right self-placement scale and five indices derived from a factor analysis of a battery of 34 political attitudinal items. To measure general cognitive ability, we use results from four tests (logical, verbal, spatial, and technical) completed during mandatory military conscription around the age of 18 years.

We use our sample of twins to document the degree to which the different dimensions of political orientations are heritable. In order to further investigate the genetic and environmental etiology of political orientations, we next move from a univariate to a bivariate framework of analysis. We show that our measures of political attitudes are related to cognitive ability. Individuals scoring high on cognitive ability tend to support privatization, oppose high taxes and redistribution of wealth, and favor cosmopolitan immigration and foreign policies. Next, we employ bivariate Cholesky models to decompose the covariation between cognitive ability and political orientations

into genetic and environmental sources. We demonstrate that a common genetic source underlies both cognitive ability and political preferences. Our findings are consistent with the hypothesis that cognitive ability is a causal mechanism linking genes and political orientations.

Cognitive Ability and Political Orientations

Recent work in behavior genetics and political science has suggested that political attitudes and behavior are partly influenced by genetic endowments. Eaves and Eysenck (1974) and Martin et al. (1986) first demonstrated the heritability of social attitudes based on British and Australian samples. Alford et al. (2005) later showed that genetic variation could account for a moderate share of individual differences in political orientations based on U.S. and Australian samples, a result that was replicated by Hatemi, Hibbing, et al. (2010) employing a more sophisticated research design which included pedigree data other than twins. Similar heritability estimates for political attitudes based on Canadian data have also been reported (Bell, Schermer, & Vernon, 2009).

Although the finding that individual differences in political orientations can partly be explained by genetic variation is important, it begs the question of *how* genes affect political orientations. After all, political preferences are many steps away from molecular genetic variation and biological processes in the chain of causation. One approach to answering this question is to look directly for associations between molecular genetic variation and the variable of interest, but because effect sizes of individual genetic variants are almost guaranteed to be very small and sensitive to local environmental conditions, the inferential challenges are staggering (Benjamin et al., 2012).

Another approach is to look for causal mediators, or so-called endophenotypes, that are more proximal to the direct effects of the genes than the distal phenotype in focus (e.g., political orientations). The basic idea is that the distal phenotype is caused by endophenotypes, which in turn are caused by genetic variants (Rietveld et al., 2013). Consequently, a mediator linking genes to political orientations must meet three requirements: it should be (1) highly heritable; (2) related to political orientations; and (3) causally prior to political orientations.

In this vein, Gerber, Huber, Doherty, and Ha (2010) and Smith, Oxley et al. (2011) have argued that since personality traits—such as the Big Five traits—are highly heritable (Bouchard & McGue, 2003) and thought to be causally prior to political orientations, they are plausible pathways linking genes and political orientations. This conjectured pathway is bolstered by the burgeoning political behavior literature showing a strong link between personality traits and political orientations. The core finding is that individuals rating high on the trait "openness to experience," described as interested in new ideas and intellectually curious, tend to be more liberal in social and economic issues whereas conscientious individuals, who are characterized as organized and goal oriented, tend to be more conservative (Gerber et al., 2010). However, this argument has also been criticized. Using a Direction of Causation model, Verhulst, Hatemi, and Eaves (2012) did not find empirical support for the hypothesized causal pathway in which genes influence personality traits that in turn influence political attitudes. Instead, they argue that the relationship between personality traits and political orientations is correlational and driven by common genetic influences.

This suggests a need to broaden the repertoire of potential mechanisms connecting genetic endowments and political ideology to include basic psychological traits other than those that have been considered to date. In this study, we argue that cognitive ability is one such possible mechanism.

There are several mechanisms through which cognitive ability may influence political orientations. In his dynamic theory of conservatism, Wilson (1973) argues "that the common basis for all the various components of the conservative attitude syndrome is a *generalized susceptibility to experiencing threat or anxiety in the face of uncertainty*" (p. 259; italics in original). Wilson (1973) further suggests that both heritable factors—among others, low cognitive ability, trait anxiety, and stimulus aversion—and environmental factors, such as parental treatment and social class, will

influence feelings of uncertainty and insecurity. This line of reasoning is similar to more recent work by Stankov (2007) who argues that "perceived threat may vary depending on cognitive level—sources of threat such as complexity, novelty, and ambiguity may be more threatening to those who score low as opposed to those who score high on cognitive tests" (p. 295).

Wilson's theory has received correlational support in studies of the psychological bases of political conservatism. In a meta-analysis, Jost, Glaser, Kruglanski, and Sulloway (2003) show that psychological variables such as intolerance of ambiguity, uncertainty tolerance, fear of threat and loss, and self-esteem predict political conservatism. The authors conclude that "the avoidance of uncertainty (and the striving for certainty) may be particularly tied to one core dimension of conservative thought, resistance to change" (p. 369).

Taking a step back in the causal chain, recent studies have reported that cognitive ability is negatively related to risk aversion (Dohmen, Falk, Huffman, & Sunde, 2010). Moreover, based on a laboratory intervention subjecting a sample of high school students to a distracting task, Benjamin, Brown, and Shapiro (2012) show that cognitive load increases a measure of small-stakes risk aversion.

A handful of studies have also established a direct link between cognitive ability, using a variety of different measures, and political orientations. Deary, Batty, and Gale (2008a, 2008b) reported that general intelligence measured at around age 10 is positively related to antiracism, social liberalism, pro-working-women attitudes, and vote choice at around age 30 in a British sample. Schoon et al. (2010) replicated these results using a different British sample. Stankov (2009) showed that general social conservatism is negatively related to performance on cognitive ability tests. However, Morton et al. (2011) found that IQ increased right-wing economic ideological preferences (left-right self-placement, attitudes towards government responsibility for individuals' well-being, and preferences for competition) and intended party choice in a Danish sample.

These seemingly conflicting results suggest that the relationship between cognitive ability and political orientations may be context sensitive, as argued by Sidanius (1978, 1985). Sidanius' context theory implies "that one cannot draw any conclusions about an individual's personality given his sociopolitical beliefs *until* one attends to the specific cultural-historical time-space or context in which the individual finds himself" (1985, p. 639). For example, the typical laissez-faire advocate in 19th-century Great Britain might focus on very different issues than the typical laissez-faire advocate in today's Cuba. Thus, whether a person should be considered conservative or liberal cannot be determined solely on the basis of his or her belief system. The context within which specific political attitudes are held also needs to be taken into account. Put differently, if a conservative response to fear and uncertainty entails increased resistance to change (Jost, Glaser, et al., 2003), we need to consider the vantage point from which such change is supposed to occur.

In light of this argument, the results reported in Morton et al. (2011) make perfect sense. In the Scandinavian countries—characterized by large, publically managed and encompassing welfare states and relatively egalitarian income distributions—resistance to change should push individuals lower in cognitive ability towards what we normally call left-wing economic policy opinions—support for (continued) high taxes and redistribution of wealth in combination with opposition to privatization of publicly controlled social insurance and service systems. In more inegalitarian and market-oriented countries such as the United States or the United Kingdom, we should instead expect individuals higher in cognitive ability to more often embrace similar leftist political attitudes in the economic realm.

In summary, there is growing empirical evidence that cognitive ability is associated with political orientations. The argument put forth in these studies is that since formation of basic psychological traits predates the formation of political attitudes, we can safely assume that cognitive ability causes political orientations (Smith, Oxley, et al., 2011). Furthermore, cognitive ability has been shown to be highly heritable (Bouchard & McGue, 2003). This suggests that a causal relationship may go from genes to cognitive ability to political orientations.

Sample and Data Collection

The Swedish Twin Registry is the world's largest twin registry, and it routinely administers surveys to Swedish twins (Magnusson et al., 2013). This article uses data from a recently administered survey called SALTY (Screening across the Life-span Twin [Younger] cohort study). The SALTY study was a collaborative effort between researchers in epidemiology, medicine, economics, and political science initiated in 2007. Data collection was completed in the summer of 2010.

Beginning in the spring of 2009, SALTY was sent out to 24,914 Swedish twins born between 1943 and 1958, and the final reminders were sent out in the spring of 2010. The survey generated a total of 11,578 responses. Out of these, 11,261 (97.2%) respondents gave informed consent to have their responses stored and analyzed. Zygosity was resolved either by questionnaire items with high reliability or, when available, by analysis of biosamples (Magnusson et al., 2013). In total, our sample is comprised of 973 complete male same-sex twin pairs (467 monozygotic and 506 dizygotic twin pairs).

The SALTY study stands out in two respects—the number and breadth of the items measuring political attitudes and behavior and the large sample size. Many of the earlier studies on the heritability of political attitudes and behaviors have relied on secondary analyses of data collected for entirely different purposes (Alford et al., 2005; Hatemi, Medland, et al., 2007; Hatemi, Funk, & Medland, et al., 2009). Only a handful of indicators directly relevant to political scientists are included in these surveys. However, a couple of recent surveys based on twin registries in Denmark (Klemmensen et al., 2012), Canada (Bell et al., 2009), and Minnesota (Funk et al., 2013) are beginning to overcome these limitations. The SALTY study adds to this arsenal of new twin studies with a focus on political attitudes and behavior.

Measures

The bulk of earlier studies on the heritability of political orientations are based on some version of the Wilson-Patterson (W-P) conservatism scale (Martin et al., 1986; Alford et al., 2005; Hatemi, Medland, & Eaves, 2009; Hatemi, Funk, et al., 2009) and/or a single liberal versus conservative self-placement scale (Bell et al., 2009; Funk et al., 2013). A few studies have also focused on partisan identity (Hatemi, Alford, et al., 2009; Settle, Dawes, & Fowler, 2009; Hatemi, Medland, et al., 2007) or actual vote choice (Bell et al., 2009).

The implicit assumption in these studies is that a unidimensional conceptualization of ideology provides an adequate basis for the study of the determinants of political orientations.[1] However, a large strand of research across different countries has shown that a unitary left-right or liberal-conservative dimension may obscure the multifaceted structure of political ideology (Oscarsson, 1998; Jost et al., 2009; Treier & Hillygus, 2009). In particular, people tend to keep attitudes along the traditional economic left-right dimension distinct from attitudes within other policy domains. Following Feldman and Johnston (2014), we argue that empirical examinations of political ideology that disregard such complexity may hinder our efforts to understand the determinants of political orientations.

Past research emphasizes the importance of left-right related attitudes for Swedes to navigate and evaluate the political landscape (Holmberg & Oscarsson, 2004; Kumlin, 2004; Särlvik, 1974). Based on an analysis of the dimensionality in citizens' party evaluations, Oscarsson (1998) concluded that "throughout the period 1956–1996, the left-right dimension has been Swedish voters'

[1] Bell et al. (2009) provide an exception. In addition to a liberal-conservative self-placement scale they use six issue dimensions—attitudes toward religiosity and social conservatism, environmentalism, an activist state on social issues, economic equality, ethnic and racial minorities, and competition and business—to examine the etiology of political attitudes in a Canadian context.

most important tool for handling and evaluating information about the ideological conflicts between the parties" (p. 308). Although still dominating Swedish citizens' evaluations of the political world, competing dimensions—such as an ethical-moral dimension, a green environmental dimension, a European Union dimension, a xenophobic-cosmopolitan dimension, and a foreign policy dimension—exist and have grown stronger in recent years (Bennulf & Holmberg, 1990; Oscarsson, 1998; SCB, 2008).

In line with this, we use multiple indicators to measure political orientations. First, a single item indicator of the dominant left versus right dimension in Swedish politics is used: "In politics you sometimes talk about left and right. Where would you place yourself on a scale from 1–10 where 1 equals strongly left and 10 equals strongly right?" Second, to tap into further ideological dimensions among the Swedish citizenry, we analyze a large battery of attitudes toward 34 different policy issues, the responses to which could be reduced to five indices measuring five underlying issue dimensions. The indices are based on the results of a principal component analysis. For more information on item wordings and the principal component analysis, see the online appendix.

The first index—opinions on economic policy—involves attitudes toward taxes, the welfare state, and privatization. Higher values indicate preferences for lower taxes, a smaller welfare state, and privatization of public resources. This index can be assumed to tap into the core of the dominant left-right dimension as understood within the Swedish context—opinions on the role of government in economic life (Oscarsson, 1998). Consequently the correlation between this indicator and the left-right self-placement item is high ($r = 0.60$). The second index reflects opinions towards economic redistribution and includes items concerning attitudes on economic support to rural areas and regulation on shorter working days. Higher values denote resistance against further redistribution. The third index—immigration policy opinions—consists of five items reflecting the core of the xenophobic-cosmopolitan dimension (attitudes towards aliens and refugees) but also the ethical-moral dimension (opinions on the importance of preserving traditional values). Higher values on this indicator reflect a more cosmopolitan or liberal outlook. The fourth index concerns environmentalism—attitudes on measures to prevent environmental damages and decrease carbon dioxide emissions—with higher values denoting more positive opinions towards progressive environmentalist policies. The fifth index measures foreign policy orientations—advocates of closed versus open foreign policies—and includes items about attitudes toward the EU, NATO, and the UN.

To measure cognitive ability, we used social security numbers to match the men in the SALTY sample to conscription data provided by the Military Archives of Sweden. All men in our sample were required by law to participate in military conscription around the age of 18. We were able to successfully match 95% of the male twins to the information in the Military Archives. For the men born after 1950, approximately half of our sample, the military data has been digitalized. For the remaining twins, we manually retrieved the information from the Military Archives.

The enlistment procedure during the period we consider spanned two days and involved tests of health status, physical fitness, and cognitive and noncognitive abilities. It was not possible to avoid the military service by obtaining a low score on the cognitive ability test. Exemption from the military service altogether was determined by health status (Lindqvist & Vestman, 2011).

The first test of cognitive ability used by the Swedish Military was implemented in 1944, and it has subsequently been revised and improved on a few occasions (Carlstedt, 2000). The male SALTY respondents studied in this article took four subtests: logical, verbal, spatial, and technical. The first subtest about logical ability was called "Instructions" and measured the ability to understand complicated instructions (the test had a raw score of 0–40). The second subtest about verbal ability was called "Selection," and in these questions, the subjects had to pick out one out of five words that differed from the four other words (the test had a raw score of 0–40). The third test was a test of spatial ability called "Composition" where the subjects had to see which pieces fit with a specific figure (the test had a raw score of 0–25). The final test was called "Technical Comprehension," and

here the subjects answered questions about technical problems with the guidance of graphs (the test had a raw score of 0–52). To construct our measure of cognitive ability, we summed the raw test scores for the four subtests. We then transformed the subjects' summed test scores to the percentile rank in that birth year (using a standardization sample of all twins for whom cognitive ability data from the Military Archives was available, not just the SALTY respondents). This transformation ensures that there is no trend in cognitive ability over time in the data.[2]

Carlstedt (2000) discusses the history of psychometric testing in the Swedish military and provides evidence that the compound measure of cognitive ability is a good measure of general intelligence. As such it encompasses both fluid and crystallized intelligence (Cattell, 1971).[3] The Swedish conscription data has been used in several previous studies on the relationship between cognitive ability and political and economic outcomes (Lindqvist & Vestman, 2011).

Table 1 lists mean values and standard deviations by zygosity for the political orientation indices and the cognitive-ability measure discussed above. The political variables are recoded to the 0 to 10 range. Since we only have cognitive-ability data for the men in our sample, we restrict the analysis to male twins.

Results

We use univariate and bivariate twin models to estimate the pattern of genetic and environmental influences on political orientations. We will only briefly introduce these modeling strategies in connection to the presentation of the results. A more detailed description of the biometric models used in this article, and some of the assumptions they rely on are presented in the online appendix.[4]

Univariate Results

In the classical univariate twin design, the phenotypic correlation among monozygotic (MZ) twins, who share 100% of their genes, are compared to the correlation among dizygotic (DZ) twins, who share on average half of their segregating genes, in order to estimate to what extent a trait is influenced by additive genetic (*A*), common (or shared) environment (*C*), and unique (or nonshared) environment (*E*) factors. MZ correlations less than unity reflect the influence of nonshared environment. Greater concordance in MZ compared with DZ twins reflects genetic influence. Finally, a DZ correlation greater than half of the corresponding MZ correlation reflects the influence of shared environment factors.

Estimates of additive genetic (*A*), common (*C*), and unique (*E*) environmental sources of variance in the traits are presented in Table 2.[5] In all but two cases—leftist versus rightist attitudes and economic policy opinions—the point estimate of the *C*-component is close or equal to zero and statistically insignificant. In contrast, the heritability estimates are significantly different from zero in all but one case, ranging from a low of 0.05 (left-right self-placement) to 0.67 (cognitive ability). The average heritability estimate across the six measures of political orientations is 0.31.

[2] The test of noncognitive skills was conducted by means of an interview by a certified psychologist. As a basis for this interview, the psychologist had access to the results from the physical, health, and cognitive-ability tests. The objective of the test of noncognitive skills was to assess the conscript's ability to cope with the psychological requirements of military service and combat situations.

[3] Fluid (g_f) and crystallized (g_c) intelligence are supposed to be discrete factors of general (g) intelligence. Fluid intelligence includes abilities such as pattern recognition, abstract reasoning, and problem solving whereas the crystallized is hypothesized to be more amenable to change as it relies on specific, acquired knowledge such as vocabulary, general information, and analogies (Cattell, 1971).

[4] For an easily accessible introduction to these models intended for the political science community, see Medland and Hatemi (2009).

[5] The variance components models are estimated using maximum likelihood on raw data using the software Mx (Neale, Boker, Xie, & Maes, 2004). All models include age as a covariate influencing the mean values of the traits.

Table 1. Descriptive Statistics

Variable	MZ (sd)	DZ (sd)
Left-right self-placement	5.11	4.64
	[2.70]	[2.75]
Economic policy opinions	4.61	4.42
	[1.96]	[2.04]
Redistribution policy opinions	4.22	4.06
	[2.30]	[2.28]
Immigration policy opinions	3.81	3.96
	[1.90]	[1.97]
Environmental policy opinions	8.04	8.07
	[1.79]	[1.85]
Foreign policy opinions	5.62	5.33
	[2.52]	[2.49]
Cognitive ability	0.24	0.15
	[0.91]	[0.94]

Note. Summary statistics for the indicators of political orientations and cognitive ability for male twins. Columns 1 and 2 report mean values and standard deviations for male MZ and DZ twins, separately. The political variables are recoded to the 0 to 10 range. Higher values on the six political variables indicate (1) strongly rightist attitudes (left-right self-placement); (2) preferences for lower taxes, a smaller welfare state, and privatization of public resources (economic policy opinions); (3) preferences against economic support to rural areas and regulation on shorter working days (redistribution policy opinions); (4) preferences in favor of immigration and refugees (immigration policy opinions); (5) preferences in favor of measures to prevent environmental damages and decrease carbon dioxide emissions (environmental policy opinions); and (6) preferences in favor of the EU, NATO, and the UN.

Table 2. Heritability Estimates for Political Orientations and Cognitive Ability

Variable	Heritability	Common Environment	Unique Environment
Left-right self-placement	0.05	0.41	0.55
	[0.00, 0.23]	[0.25, 0.49]	[0.48, 0.61]
Economic policy opinions	**0.22**	0.23	0.55
	[0.02, 0.42]	[0.06, 0.38]	[0.48, 0.63]
Redistribution policy opinions	**0.49**	0.00	0.51
	[0.33, 0.55]	[0.00, 0.13]	[0.45, 0.58]
Immigration policy opinions	**0.48**	0.09	0.43
	[0.30, 0.62]	[0.00, 0.25]	[0.37, 0.49]
Environmental policy opinions	**0.20**	0.00	0.80
	[0.04, 0.28]	[0.00, 0.12]	[0.72, 0.88]
Foreign policy opinions	**0.42**	0.08	0.50
	[0.22, 0.56]	[0.00, 0.25]	[0.44, 0.57]
Cognitive ability	**0.68**	0.12	0.21
	[0.54, 0.81]	[0.00, 0.25]	[0.18, 0.24]

Note. Heritability estimates for the indicators of political orientations and cognitive ability. Parameter estimates and 95% confidence intervals in brackets are shown for univariate ACE models including age as a covariate influencing the mean value of the traits. Significant heritability estimates are bolded. The results are based on models using male twins.

Overall these results substantiate the argument about the relevance of using multiple measures to tap into the complex nature of the concept of political ideology. The etiology of political orientations differs across issue dimensions. The findings for immigration, environmental, foreign, and redistribution policy opinions are in line with previous studies reporting significant and moderately large heritability and negligible shared environment estimates for the general liberalism-conservative dimension as measured by the Wilson-Patterson attitude inventory (Alford et al., 2005; Funk, Smith, et al., 2013; Hatemi, Funk, et al., 2009; Martin et al., 1986). Bell et al. (2009) showed that a larger set of issue dimensions—attitudes toward religiosity and social conservatism, economic equality, ethnic and racial minorities, and views on competition and business—have heritable components in the Canadian context. Thus, our study provides a large sample confirmation of the heritability of a wide range of political orientations.

However, with respect to left-right issues and economic policy opinions, we also find evidence for a significant influence of environmental factors shared by the individuals in a twin pair. Given the strong connection between leftist versus rightist attitudes on economic issues and voting preferences in the Swedish voting population (Holmberg & Oscarsson, 2004), these results are consistent with earlier studies on party preferences and partisanship. Hatemi, Medland, et al. (2007) found that party preferences are influenced both by additive genetic and shared environmental factors in an Australian sample. Alford et al. (2005), Hatemi, Alford, et al. (2009), and Settle et al. (2009) reported that the direction of partisan attachment is not heritable but instead more affected by shared environmental influences.

Bivariate Results

In order to investigate the relationship between genes, cognitive ability, and political orientations, it is necessary to move from a univariate to a bivariate framework of analysis. The departure point is the correlations between each of the ideological dimensions and cognitive ability. These are presented in the first column of Table 3.

In line with Morton et al. (2011), we find that cognitive ability is positively related to left-right self-placement and right-wing preferences on economic and redistribution issues. Individuals scoring high on the conscription tests have a tendency to support privatization, oppose high taxes, and contest measures to redistribute wealth. As expected, cognitive ability positively predicts pro-immigration policy opinions. The magnitude of this relationship ($r = 0.28$) is on par with correlations between cognitive ability and antiracism attitudes and social liberalism reported in previous studies. Deary et al. (2008a) and Schoon et al. (2010) find that the correlations between verbal and nonverbal measures of cognitive ability and indicators of antiracism and social liberalism vary between 0.13 and 0.26. Using three measures of cognitive ability and an overall indicator of general conservatism, Stankov (2009) reports correlation coefficients between –0.23 and –0.40.[6]

Concerning environmental and foreign policy opinions, we know of no previous studies on the influence of cognitive ability. However, our results—an insignificant and substantially negligible correlation between cognitive ability and environmental policy orientations and a positive relationship between cognitive ability and foreign policy opinions—are compatible with previous findings on the influence of the related trait of education on political attitudes. Earlier research has documented both positive (Jones & Dunlap, 1992), negative (Uyeki & Holland, 2000), and zero (Guth, Green, Kellstedt, & Smidt, 1995) effects of education on environmentalism. Brewer, Gross, Aday, and Willnat (2004) reported a strong positive effect of education on internationalism in world affairs among American citizens.

[6] Since Morton et al. (2011) only reported results from multivariate regression models, we cannot directly compare the strength of the relationships between cognitive ability, left-right self-placement, and right-wing preferences on economic and redistribution issues across the Danish and Swedish contexts.

Table 3. Phenotypic, Genetic, and Environmental Correlations Between Political Orientations and Cognitive Ability

Variable	(1) Phenotypic correlation (r)	(2) Share of r due to genetic factors	(3) Share of r due to common environment	(4) Share of r due to unique environment	(5) Genetic correlation (r_a)	(6) Common Environmental correlation (r_c)	(7) Unique environmental correlation (r_e)
Left-right self-placement	0.18	–	–	–	–	–	–
	[0.15, 0.22]	–	–	–	–	–	–
Economic policy opinions	0.10	–	–	–	–	–	–
	[0.06, 0.13]	–	–	–	–	–	–
Redistribution policy	0.32	0.60	0.27	0.13	0.37	1.00	0.12
opinions	[0.29, 0.36]	[0.29, 0.92]	[–0.01, 0.54]	[0.03, 0.23]	[0.20, 0.51]	[–1.00, 1.00]	[0.03, 0.22]
Immigration policy opinions	0.28	0.75	0.26	–0.01	0.35	0.60	–0.01
	[0.25, 0.31]	[0.33, 1.22]	[–0.16, 0.64]	[–0.13, 0.10]	[0.16, 0.57]	[–0.99, 1.00]	[–0.11, 0.09]
Environmental policy	–0.02	–	–	–	–	–	–
opinions	[–0.06, 0.02]	–	–	–	–	–	–
Foreign policy opinions	0.15	0.97	–0.11	0.14	0.32	–0.19	0.07
	[0.12, 0.19]	[0.29, 1.69]	[–0.75, 0.50]	[–0.04, 0.32]	[0.09, 0.56]	[–1.00, 1.00]	[–0.02, 0.17]

Note. Column 1 presents correlation coefficients and 95% CIs for the relationship between cognitive ability and political orientations. The political variables are recoded to the 0 to 10 range. Higher values on the six political variables indicate (1) strongly rightist attitudes (left-right self-placement); (2) preferences for lower taxes, a smaller welfare state, and privatization of public resources (economic policy opinions); (3) preferences against economic support to rural areas and regulation on shorter working days (redistribution policy opinions); (4) preferences in favor of immigration and refugees (immigration policy opinions); (5) preferences in favor of measures to prevent environmental damages and decrease carbon dioxide emissions (environmental policy opinions); and (6) preferences in favor of the EU, NATO, and the UN. Columns 2–4 present the share of total correlation due to genetic and environmental factors and 95% CIs from bivariate Cholesky ACE models of cognitive ability with political orientations. Columns 5–7 present genetic and environmental correlations and 95% CIs from bivariate Cholesky ACE models of cognitive ability with political orientations. The results are based on models using male twins.

The phenotypic correlations are a first sign of the relevance of cognitive ability as a possible mechanism linking genes to political orientations. To address the mediation hypothesis, we must proceed from univariate to bivariate twin modeling. The logic of the univariate twin model can be extended to the bivariate (or multivariate) case using so called Cholesky decomposition. We use the univariate *ACE*-model to decompose the variance in a trait (e.g., cognitive ability or immigration policy opinions) into its genetic (*A*), common environmental (*C*), and unique environmental (*E*) components. Likewise, we employ bivariate Cholesky decomposition in order to estimate the amount of *covariation* between two traits (e.g., cognitive ability and immigration policy opinions) that can be accounted for by genetic (*A*) and environmental (*C* and *E*) sources.

The Cholesky decomposition is based on the cross-twin cross-trait correlations (i.e., the correlation between one trait in the first twin [e.g., cognitive ability] and the other trait in the second twin [e.g., immigration policy opinions]). The interpretation of these cross-twin cross-trait correlations carries over from the univariate case. For example, correlations higher in MZ than DZ twins indicate that genetic factors influence both traits and therefore account for part of the covariance between them.

Apart from the share of the total correlation due to genetic and environmental factors, the parameter estimates generated by the Cholesky model can be used to construct so-called genetic (r_a) and environmental (r_c and r_e) correlations. The genetic correlation quantifies the degree to which the latent genetic endowments of two traits covary. A correlation of 0 means that the two traits are influenced by completely different genes and a correlation of 1 (or −1) means that the same genes influence both traits.

When the phenotypic relationships are weak, the bivariate model requires very large samples to be adequately powered. Therefore, we limit further analyses to those relationships that had at least moderately strong correlations equal to or greater than 0.15. We also restrict the Cholesky models to political traits for which we found a heritability estimate statistically distinguishable from zero. Furthermore, while dropping insignificant parameters from the model is common practice in behavior genetics, it is not without its critics (Goldberger, 2002) because the reported *p*-values do not reflect the model selection procedure. Therefore, we present the results for unrestricted models.

The share of the total correlation due to genetic and environmental factors and the genetic and environmental correlations are reported in columns 2 through 7 in Table 3. All estimates of the share of the phenotypic correlation attributable to genetic factors in column 2 are statistically significant and range between 60% and 97%. These estimates suggest that the bivariate relationships between political orientations and cognitive ability are largely driven by common genetic sources.

Further insight into the relationship between cognitive ability and political attitudes is provided by the genetic correlation coefficients in column 5. The genetic correlations are both substantial and statistically significant. Squaring the genetic correlations implies that the genetic variance in cognitive ability accounts for between 10% and 14% of the genetic variance in political attitudes.[7] However, it is also important to note that these results suggest that the majority of the genetic variance in political orientations is not accounted for by the covariance with cognitive ability and that other possible mechanisms connecting genes to political ideology should be identified in future research.

Discussion and Conclusion

The current study extends previous research on political orientations in several aspects. First, our use of multiple measures to better tap into the different dimensions of the political ideology construct

[7] It should be noted that these estimates likely are conservative given that the models include insignificant environmental correlations. When excluding these insignificant paths, cognitive-ability accounts for 11–23% of the genetic variance in the political traits.

provided a more nuanced picture of the genetic and environmental etiology of political orientations. On the one hand, the empirical results we present are consistent with the growing literature demonstrating that individual-level differences in genetic endowments account for a moderate to large share of the variation in political orientations. In line with previous studies, we found heritable variation in five of our six measures of political orientations (Alford et al., 2005; Bell et al., 2009; Hatemi, Hibbing, et al., 2010; Martin et al., 1986). The average heritability estimates across the six indicators are 0.31. Thus, based on a new sample and national context, we provide further evidence that individual differences in political ideology can be attributed to both environmental and genetic factors.

On the other hand, as opposed to most previous studies, we find evidence for a significant influence of shared environment with respect to left-right issues and economic policy opinions. This finding is all the more impressive considering that the twins in our sample are in their fifties and sixties and since it is in stark contrast to conventional wisdom within the behavior genetics literature that any family effects "largely wash out by late adolescence" (Loehlin, Horn, & Ernst, 2007, p. 643).[8]

A possible explanation for these results is that parental (or other) socialization explains at least *some* political orientations. We should expect the role of parents in influencing their offspring to be strongest for political issues that are highly politicized and closely linked to partisanship and thus more often talked about in society and within the home (Westholm & Niemi, 1992). We have already noted that the economic left-right dimension is the most important ideological divide among Swedish parties and within the Swedish electorate. The centrality of the left-right dimension is further substantiated by the correlations between our six measures of political orientations and bloc party vote choice in the 2006 general election in Sweden.[9] Both left-right self-placement ($r = 0.76$) and economic policy opinions ($r = 0.56$) are strongly related to voting for left/green versus the right block. The corresponding correlations for the other four indicators of political orientations are considerably weaker: redistribution policy opinions ($r = 0.28$); immigration policy opinions ($r = -0.14$); environmental policy opinions ($r = -0.11$); and foreign policy opinions ($r = 0.33$). Therefore, the finding that shared environmental factors account for a significant part of the variation in left-right self-placement and economic policy opinions within our sample of Swedish twins should come as no surprise.

However, any conclusions about the role of parental socialization based on our results or twin models in general should be approached with a healthy dose of skepticism. First, as with any post hoc explanation, ours is a hypothesis in need of further tests in future studies. Second, environmental factors shared by the individuals in a twin pair is not equal to just parental influences but also include variables such as socioeconomic status, religion, common friends, or any event that happens to both twins, affecting them in the same way. Third, and most importantly, evidence of strong genetic and weak shared environmental influences does not necessarily preclude socialization mechanisms stipulating a significant role for the family and parents in the development of political attitudes and behavior. This misunderstanding rests on an often implicit assumption that genetic effects imply the existence of a direct physiological pathway from genes to outcomes (Jencks, 1980). However, such a narrow biological model of how genes influence complex human behavior is almost certainly incorrect. As argued in Cesarini, Johannesson, and Oskarsson (2014, p. 85), we should instead expect

[8] Similarly, Hatemi, Funk, et al. 2009 reported that the proportion of variation in political attitudes explained by shared environmental factors accumulates gradually during adolescence and then begins to decline around the time children leave home.

[9] The respondents were asked which party they voted for in the 2006 general elections. The bloc party vote-choice variable is constructed by dividing the seven parliamentary parties into two groups: the left/green bloc (the Left Party, the Social Democratic Party, and the Green Party) versus the right bloc (the Centre Party, the Liberal Party, the Moderate Party, and the Christian Democratic Party).

environmental factors and, above all, parental behaviors to mediate the influence of genes on traits such as political orientations:

> As an illustration, suppose some children find reading books more enjoyable because of an inherited predisposition and further, that parents respond to these differences by creating more cognitively stimulating environments for children who express an early interest in reading. Small initial differences could then give rise to substantial heterogeneity in reading skills and the ability to process political information. Such heterogeneity, in turn, could translate into vast differences in political knowledge (Verba, Schlozman, & Brady, 1995) and political interest (Prior, 2010), with downstream effects on an array of political behaviors. (p. 85)

The second main contribution of this study concerns the relationship between cognitive ability and political orientations. Based on previous work, we hypothesized that cognitive ability is negatively related to political conservatism. Consistent with this assertion, we found moderately strong relationships between three of our measures of political ideology and cognitive ability: opinions on redistribution, immigration, and foreign policies. Moreover, the results suggest that the relationship between cognitive ability and political orientations is context sensitive (Sidanius, 1978, 1985). According to this argument, common left-wing opinions on economic policies—support for higher taxes and redistribution, a large and encompassing welfare state, and opposition to privatization of government responsibilities—should be viewed as resistance to change in the case of Sweden since the country is characterized by a large and publically managed welfare state and a relatively egalitarian income distribution. In this way, our findings resolve some of the ambiguous results reported in earlier studies on the relationship between cognitive ability and different dimensions of political orientations. The important lesson from this part of the analysis is that to understand the relationship between cognitive ability and political orientations one needs to focus on both the specific contents of a belief system and the context within which these ideas are manifested.

In the final step of the analysis, we employed bivariate Cholesky decomposition in order to examine the genetic and environmental etiology of the relationship between cognitive ability and political orientations. We found evidence that most of the phenotypic relationship can be attributed to a common genetic factor. More specifically, genetic factors account for between 60 and 97% of the correlations between cognitive ability and the political traits. Furthermore, cognitive ability accounts for 10–14% of the genetic variance in the political traits. These results are consistent with the hypothesis that cognitive ability is a causal mechanism linking genes and political orientations.

Our analysis leaves open at least two partly interrelated questions on the nature of the relationship between cognitive ability and political orientations. First, evidence of significant covariance between the heritable variation in cognitive ability and political preferences is in line with, but does not in itself prove, causal mediation. It may be the case that genes influence cognitive traits that in turn influence political ideology. However, the reverse may also be true: genes influence attitudes that in turn affect cognitive ability. Or, a common genetic source may signal reciprocal causation, where cognitive ability influences political orientations but political orientations also influence cognitive ability. Finally, it is also possible that the same set of genes is influencing political attitudes and cognitive ability independently—a relationship known as pleiotropy.

Facing similar interpretational problems, Verhulst et al. (2012) employed a special submodel of the general bivariate twin model—a Direction of Causation (DOC) model—in their study of personality traits as possible mechanisms mediating the relationship between genes and political orientations. Their results contradicted the personality as mechanism hypothesis and instead suggested that the relationship between personality traits and political orientations is correlational and driven by common genetic influences.

To facilitate comparison with Verhulst et al. (2012), we present results from DOC models on the relationship between cognitive ability and political orientations in the online appendix. The estimates indicate that cognitive ability is causally prior to political orientations. In two out of three cases (opinions on redistribution and foreign policies), the results suggest that the best fitting model is one where cognitive ability causes political attitudes.[10] However, as discussed in the online appendix, the DOC model rests on a set of strong assumptions (Duffy & Martin, 1994). Therefore, we are reluctant to put too much faith in these results. Instead, our interpretation of the causal ordering between cognitive ability and political orientations rests on the argument outlined in the theoretical section of this article, according to which cognitive ability is a cause of political orientations. Also, there appears to be no logical explanation to support the opposite suggestion that political orientations influence the formation of cognitive abilities.

However, the interpretation of our results as support for the hypothesis that cognitive ability mediates part of the relationship between genes and political preferences may still be problematic. Because we employ bivariate models, we cannot rule out the possibility that our results are confounded by unobserved factors. We have already noted that the standard account of the heritability of political attitudes and behavior suggests that personality traits are a link between genes and the political outcomes (Gerber et al., 2010). Moreover, several studies report evidence of a strong positive link between intelligence and personality traits, especially openness to experience (Ackerman & Heggestad, 1997; Bratko, Butkovic, Vukasovic, Chamorro-Premuzic, & von Stumm, 2012; Moutafi, Furnham, & Crump, 2006; Moutafi, Furnham, & Paltiel, 2004).

Consequently, the interpretation of the results presented in this study depends on our assumptions about the relationship between cognitive ability and personality traits. On the one hand, if we assume that cognitive ability is causally prior to the formation of personality traits, our conclusion that cognitive ability mediates part of the influence of genes on political orientations would still be valid. This interpretation is consistent with adaptive models, according to which noncognitive factors such as personality traits can be explained as adaptations to variations in cognitive patterns (Matthews, 1999). In line with this argument, Moutafi, Furnham, and Paltiel (2004) propose "that the negative relationship observed between intelligence and C[onscientiousness] is because in a competitive environment less intelligent individuals become more Conscientious in order to cope with their disadvantage, or that more intelligent individuals do not become so conscientious, as they can rely on their fluid intelligence to accomplish most tasks" (p. 1020).

On the other hand, it is also possible that certain personality characteristics—e.g., the tendency for open individuals to be intellectually curious and engage in novel activities—influence the formation of cognitive abilities (Moutafi et al., 2006). Under such a scenario, our findings would support the standard hypothesis stating that the genetic influence on political orientations is mediated by noncognitive personality traits.

Ultimately, the results reported in the current study provide a departure point for further research into the genetic and environmental causes of political orientations. Above all, future studies should investigate how cognitive ability, personality traits, and political orientations are interrelated. This research endeavor should ideally involve the use of longitudinal studies which would track individuals' development of personality traits and cognitive abilities from an early age to adulthood in order to better understand the causal pathways between genes and political orientations.

[10] For immigration policy opinions, the estimates imply that the relationship between cognitive ability and political attitudes is a function of reciprocal causation. According to the coefficient estimates, the phenotypic correlation reflects a combination of a strong and expected positive effect of cognitive ability on immigration policy attitudes combined with a much unexpected negative but substantially weaker effect in the opposite direction.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure A1: The Univariate ACE Model
Figure A2: Bivariate Cholesky Decomposition
Figure A3: Direction of Causation Models
Table A1: Principal Component Analysis Results
Table A2: Model Fitting Results and Parameter Estimates for DoC models