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Genetic and Environmental Variation in Political Orientation in Adolescence and Early Adulthood: A Nuclear Twin Family Analysis

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Political orientation is often assumed to be shaped by socialization processes; however, previous studies have shown substantial genetic variance components in party affiliation, political attitudes and behaviors, or closely related personality traits. The majority of these studies have relied on the Classical Twin Design, which comes with restrictive assumptions, some of which are easily violated. Moreover, most analyses lack a perspective of age-group differences. In this study, we investigated political orientation in adolescents (age: 16–18) and young adults (age: 21–25) in a cross-sectional Nuclear Twin Family Design. We used data of the German TwinLife project, including data from same-sex twins reared together, their biological parents, and nontwin full siblings. We found genetic variation in political orientation, which was significant in the older cohort, possibly indicating an increasing importance of active gene-environment correlation from adolescence to adulthood. Individual differences in political orientation because of passive gene-environment correlation and shared environmental effects were larger in the younger cohort, substantiating the same theoretical consideration and the importance of shared socialization contexts for adolescents' political views. By running Nuclear Twin Family model analyses, and considering age-group differences, as well as the relationship of political orientation with the Big Five personality traits, our study extended previous work, and resulted in more robust and fine-grained estimates of genetic and environmental sources of variance in political orientation. Therefore, it contributed to a better understanding of the complex nature–nurture interplay that forms political orientation in emerging adulthood.

Keywords: political orientation, behavioral genetics, nuclear twin family design, TwinLife

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Individual differences in political orientation have long been the subject of research in various scientific disciplines, including behavior genetics. The current study extended the existing literature on political orientation by using an elaborated behavioral genetic approach and a German twin family sample with two different age cohorts of twins. This enabled us to obtain more differentiated estimates of genetic and environmental contributions to individual differences in political orientation, operationalized via a right–left placement of the political parties people identify with, and to get a refined understanding of how different forms of gene-environment correlations act to influence political orientation.

Researchers often assemble individual political opinions along one dimension of political orientation (Jost, 2006; Kandler, Bleidorn, & Riemann, 2012): Whereas conservatism and liberalism are frequently used terms of this dimension's poles in a U.S. American or Canadian context, in Europe the labels *right* and *left* are more common, and were therefore, used in the present study. Likewise, political parties can also be ranked along this dimension according to the content of their manifesto or based on how they are publicly perceived. Therefore, individual identification with a certain party can be seen as an indirect measure of political orientation, which is often called the *direction* of party identification, in contrast to its *intensity* (Hatemi, Alford, Hibbing, Martin, & Eaves, 2009).

This study shed light on the differences in the origins of the direction of political orientation in two important periods of young individuals' emerging political lives: We focused on the genetic

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and social sources of individual differences in political orientation of adolescents who have not been allowed to vote so far, but can be a member of a party when they turn 16, as well as of young adults who have been allowed to vote and could even run for office in national elections.

In the past, political scientists, psychologists, and sociologists broadly agreed that political attitudes and behaviors are largely, or even completely, socially transmitted. From a traditional sociological point of view, political orientations are mainly attributable to learning and socialization processes, where the social transmission of preferences from parents to offspring is assumed to be of major importance (Jennings, Stoker, & Bowers, 2009).

Interdisciplinary research, however, has cast doubt on a purely environmental explanation. For example, a vast and solid body of psychological research has shown that political ideologies and partisanship have stable associations with some of the Big Five personality traits, especially with openness to experience and conscientiousness: (e.g., Bakker, Hopmann, & Persson, 2015; Gerber, Huber, Doherty, & Dowling, 2012; Sibley & Duckitt, 2008). These connections are relevant because personality traits are known to develop early in life, and to be substantially heritable and stable across the life span (Briley & Tucker-Drob, 2014). In the following, we briefly review behavioral genetic studies on both political orientation and party identification.

Behavior Genetic Research on Political Orientation and Party Identification

Behavioral genetic studies have found that interindividual differences in most human traits—ranging from personality, attitudes, and even behaviors—can, in part, be explained by genetic differences (Cesarini et al., 2008; Knopik, Neiderhiser, DeFries, & Plomin, 2017; Olson, Vernon, Harris, & Jang, 2001; Polderman et al., 2015; Vukasović & Bratko, 2015). In general, behavior genetic research aims to find out about the relative impact of genetic differences on the variation (i.e., heritability) of a certain trait. The most commonly used method is the Classical Twin Design (CTD). The CTD takes advantage of the fact that there are two types of twin pairs, monozygotic (MZ) and dizygotic (DZ) twins, and that MZ twins are genetically identical, whereas DZ twins share, on average, 50% of their segregating genes. The simplified logic is that if there are differences in the similarities of MZ and DZ twins reared together, those differences must be because of genetic sources because both MZ and DZ twins are assumed to share the same amount of influences of the rearing environments that act to increase both MZ and DZ twins' similarity (i.e., shared environmental influences). The bigger the difference between MZ and DZ twin correlations, the higher the impact of genes, and the smaller the influences of the shared environment.

In contrast to the strict social sciences' point of view, the heritability estimates for political opinions and ideologies—including broad political orientations, such as conservatism (Jost, 2006), right-wing authoritarianism (Altemeyer, 1996), and social dominance orientation (Pratto, Sidanius, Stallworth, & Malle, 1994), or specific political opinions, such as attitudes toward homosexuals—range from moderate to high (Alford, Funk, & Hibbing, 2005; Bell, Schermer, & Vernon, 2009; Kandler, Bell, & Riemann, 2016; Zapko-Willmes & Kandler, 2018). However, it has been argued that the closeness to a certain party might be more environmentally influenced than individual differences in political attitudes in general. A broad spectrum of political convictions can especially be found among the partisans of big parties. Regarding left–right placement (usually assessed with a single item or the Wilson-Patterson Inventory; Wilson & Patterson, 1968), or the preference for a certain political party placed between left and right, the existing literature shows some inconsistencies of the estimates, and results seem to depend, in part, on the choice of measurement (see Bell & Kandler, 2015, for an overview).

Hatemi and colleagues (2009), for example, reported no genetic and strong shared environmental effects on the direction of party identification (3-point scale from Republican to Democrat) in a sample of middle-aged U.S. twins. With middle- to older-aged participants from Sweden, Oskarsson, et al. (2015) found estimates of strong additive genetic influences on specific political opinions, but a negligible additive genetic contribution of only .05 to individual differences in a single-item left–right placement. By contrast, Bell and colleagues (2009; Canadian and U.S. sample, age range from 16 to 92 years) found heritability estimates for feelings toward a special party in the range from .40 to .51, and for left–right placement of .57, which corresponds to the findings of Funk et al. (2013) in a U.S. sample. In their study of U.S. middle-aged (M = 55.2 years) twins, Bell and Kandler (2015) found a contribution of additive genetic effects of .50 to individual differences in the direction of party identification (5-point continuum from Strong Democrat to Strong Republican), with the rest of the variation explained by the individual environment. They obtained similar heritability estimates for political orientation measured from liberal to conservative (7-point scale). In a U.S. sample (mean age 36), Settle, Dawes, and Fowler (2009) found comparable heritability estimates for the direction of partisanship (a^2 = .67).

This brief overview shows not only inconsistent results because of the choice of measurement, but also reveals that selectivity issues weaken the generalizability of previous studies because the majority based their analyses on U.S. samples and, therefore, on a more or less two-party system. Consequently, their estimates might not be suitable for other nations and more diverse political landscapes. In Germany, there are also two major parties (Volksparteien), but overall, five or more parties play a role in the political landscape, being a part of the parliament or even government. It is possible that underlying political views could be more important for political orientation here than in a two-party system and that therefore, the results derived from different political systems cannot be compared with each other.

Besides the characteristics of the sample (and, therefore, the political system) and the measures, age differences are also crucial when studying the sources of political attitudes and affiliations (Hatemi et al., 2009). This is particularly the case during adolescence and young adulthood because substantial changes in gene expression take place while the number of environmental opportunities notably grows (Bergen, Gardner, & Kendler, 2007). Most adolescents still live with their families and are more directly influenced by apparently shared environments, such as living conditions, topics of family conversations, and parents' socioeconomic status. These familial environmental influences may be more or less correlated with parents' heritable tendencies and traits, which, in turn, are genetically related to their offspring. This phenomenon has been called passive gene-environment correlation

(Scarr & McCartney, 1983), and acts to increase siblings' resemblance irrespective of their genetic similarity (Briley, Livengood, & Derringer, 2018).

In young adulthood, most people move out of their parents' households. As a result of this transition, shared environmental influences may decrease, whereas genetic variance may increase (Hatemi & McDermott, 2012). The increasing genetic differences during emerging adulthood may reflect a shift from a rather passive gene-environment correlation to a more active or reactive gene-environment transaction because adults actively select and create environments or evoke social reactions that fit their heritable tendencies, leading to an increase of the genetic component of individual differences (Scarr & McCartney, 1983). A meta-analysis by Bergen et al. (2007) showed that this is actually the case for most behavioral phenotypes.

Age differences concerning passive and (re)active gene-environment correlations might be particularly relevant for political orientation, because adolescence is also considered to be the most critical phase for familial and peer socialization processes (Jennings et al., 2009). Eaves and colleagues (1997) reported age effects for conservatism in their study, which match the patterns described above, with shared environmental effects larger than genetic influences at a younger age, and stronger genetic effects for older age groups. In a longitudinal adoption study, Abrahamson, Baker, and Caspi (2002) found a small increase in heritability and a decrease in effects of the shared environment from 14 to 15 years for religious attitudes. For conservatism, effects of the shared environment decreased from age 12 to 15, but heritability was negligible in this age range, suggesting that genetic differences may unfold via active gene-environment correlation in later adolescence. Despite this evidence for age-specific effects, most studies have relied on samples consisting of older participants who are, on average, already beyond this crucial turning point, or with large age ranges, which could possibly water down differences in estimates. Having a distinct look at different age groups of younger persons would help to shed more light on the underlying gene-environment transactions regarding political orientation, and the hypothesized age differences in passive and active forms of gene-environment interplay.

Limitations of the Classical Twin Design

Content-related aspects notwithstanding, most of the behavioral genetic studies on political orientation have relied on the CTD, which only uses data from twin pairs to estimate the net impact of genes and the environment. However, despite being of fundamental importance, the CTD has various limitations. In the following, we review the critical aspects that are most relevant for our research question. First of all, it is not possible to estimate different genetic and environmental factors (i.e., additive and nonadditive genetic, and shared and nonshared environmental sources[1]) in one model with the information obtained from MZ and DZ twins' similarity only because such a model is not identified. Therefore, if there were shared environmental and nonadditive genetic influences actually involved the CTD still could only estimate one of the parameters and thus, bias the results.

Second, one important assumption of the CTD is the absence of assortative mating, which means that there is no similarity between spouses and, thus, between mothers and fathers of twins regarding the trait of interest (i.e., random mating). If nonrandom (i.e., assortative) mating is present nevertheless, the CTD bears the risk of overestimating the influence of the shared environment because assortative mating may enhance the genetic similarity between twins' parents. This leads to an increase of DZ twins' genetic similarity and phenotypic correlations, but not to an increase of the correlations of genetically identical MZ twins. This issue is especially important because it has been shown that spouses substantially correlate on social attitudes (Alford, Hatemi, Hibbing, Martin, & Eaves, 2011; Martin et al., 1986), and associations between partners are especially high for political behaviors and attitudes (Alford et al., 2005; Hatemi et al., 2010). Even though it might be possible that nonrandom spouse correlations arise from assimilation over time, or a shared social background (i.e., social homogamy), there is evidence that genetically driven phenotypic assortment is particularly present for political traits (Alford et al., 2011; Funk et al., 2013; Kandler et al., 2012). In other words, people seem to select their partners partly based on their political views and how much they correspond with their own. Taking this aspect into account is, thus, paramount for reliable estimates of the respective variance components.

Third, the univariate CTD is limited in its ability to provide estimates of the interplay between genes and the environment, such as the previously described gene-environment correlations. There are different types of gene-environment correlations and gene-environment interactions, and those complex mechanisms can bias the genetic and environmental estimates if not taken into account (Briley et al., 2018; Kandler & Zapko-Willmes, 2017). Despite the fact that there are a number of possibilities to address this issue by means of multivariate behavior genetic analysis (e.g., bivariate analysis of the phenotype of interest and an environmental variable or moderator analyses), most univariate behavior genetic studies that exist in the field have relied on the CTD (for exceptions, see Hatemi et al., 2010, and Kandler et al., 2012), and might, therefore, have produced biased estimates of heritability and contributions of shared environmental influences.

Taking the outlined limitations into account, current knowledge on the sources of political orientation provides an incomplete picture of whether and to what degree political orientation measured as the identification with a political party is heritable, and to what extent the shared environment contributes to individual differences between families.

One possibility to address several problems of the CTD is the use of a Nuclear Twin Family Design (NTFD) analysis (Keller, Medland, & Duncan, 2010; Keller et al., 2009), which we describe in greater detail in later sections. This sophisticated modeling is based on genetically informative data of an extended circle of family members, and allows for a more detailed and confident

[1] Additive genetic influences reflect combined effects of gene variants at two or more gene loci equal to the sum of their specific effects on phenotypic differences. Nonadditive genetic influences reflect interaction effects between two gene variants (the dominant variant suppresses the effect of the recessive one) within gene loci (allelic dominance) and/or two or more gene variants between different gene loci (emergenesis). Shared environmental influences are nongenetic influences that are effectively shared by family members producing phenotypic similarities among them and phenotypic differences between families. Nonshared environmental influences are nongenetic influences that are effectively unique to a given individual and produce phenotypic differences (among family members).

analysis of nonadditive genetic variation, assortative mating, and passive gene-environment correlation (Hatemi et al., 2010). In addition, nonadditive genetic effects and the impact of several shared environmental effects can be estimated simultaneously (Coventry & Keller, 2005).

The Current Study

The current study had four major aims. First, we wanted to shed light on the inconsistent results regarding the heritability of political orientation reported in the literature. For this purpose, we used a German sample of MZ and DZ twins reared together, their biological parents, and (if available) one full sibling to overcome some of the limitations posed by the CTD. The NTFD we applied allowed for the calculation of more robust and unbiased estimates of additive and nonadditive genetic, and diverse shared and nonshared environmental influences on twins' political orientation. As we included the twins' biological parents into the analyses, the aforementioned factors could be controlled for the contribution of twin parents' assortative mating. In addition, because of the information on the parents' political orientations, we were able to estimate effects from a family's common environment that is effectively shared by all children in a family because of mothers', fathers', or both parents' transmission from one generation to the next. Moreover, we estimated passive gene-environment correlation (Scarr & McCartney, 1983). A positive passive gene-environment correlation is observed if parents not only pass their genes on to the next generation, but also provide an environment for their offspring that facilitates the development of a corresponding political orientation, in line with their genetic tendencies (e.g., by sharing their views or a certain type of media with their children).

The inclusion of a sibling allows one to analyze shared environmental effects in greater detail by estimating the effect of environments exclusively shared by the twin siblings (i.e., twin-specific shared environmental influences contributing to the similarity of twins, but not between twins and nontwin siblings), as well as within-generational environmental influences (i.e., sibling-specific shared environmental influences contributing to the similarity among all siblings). Sibling- and twin-specific environmental influences may also reflect parental influences that do not contribute to the similarity between parents and offspring. A twin-specific shared environment could possibly be age-related in the sense that these effects do not emerge because the children are twins, but because they are the same age (e.g., sharing the same school; experiencing living conditions at the same age). Moreover, including a nontwin sibling also increases the power to detect additive genetic effects in the presence of shared environmental influences (Coventry & Keller, 2005; Posthuma & Boomsma, 2000).

Second, using twin family data from two different twin birth cohorts, we studied age differences in genetic and environmental sources of variance in political orientation. Even though our cross-sectional design did not allow for the investigation of developmental processes, the exploration of age differences provided important information about the etiology of political orientation in two distinct age groups with differing developmental premises. Using two twin age cohorts additionally allowed for the investigation of an active form of gene-environment correlation (Scarr & McCartney, 1983). A contribution of positive active gene-environment correlation would be consistent with genetic variance being lower in adolescents compared with young adults. Altogether, our study design allowed us to explore differences in passive and active gene-environment correlations in emerging adulthood (Scarr & McCartney, 1983)—a time in which most people start to engage in social or political activities and develop political preferences (Eckstein, Noack, & Jugert, 2015). We expected that passive gene-environment correlation played a stronger role for adolescents' political views, whereas active gene-environment correlation was more important for young adults' political orientation. In the same vein, we hypothesized the variance components of the shared environment to be larger in the younger cohort.

Third, apart from the advantages of using NTFD model analyses and relying on two age cohorts, this study was one of the first to address political orientation in a political system with more than two truly influential parties. Thus, the present study provided a new perspective that helped us to better understand etiological sources and underlying mechanisms of individual differences in political preferences. We measured political orientation indirectly through the identification with a political party, which is an efficient proxy because right–left political orientation and party identification correlate highly on a phenotypic level, and because party identification can almost completely be explained by political orientation on a genetic level (Bell & Kandler, 2015). We focused on a one-dimensional ordering of the parties from right-wing to left-wing. Though some researchers hold the opinion that a two- or more-dimensional approach might be more suitable (for a review, see Jost, Federico, & Napier, 2009), the left–right dimension itself is far from outdated (Jost, 2006), and it is still the most important way to evaluate political parties in Germany (e.g., Neundorf, 2011). It might also be adequate to rank German parties along a social and economic dimension (see, e.g., Linhart & Shikano, 2009), however, our data did not provide evidence for this (see the Method section for details).

Fourth, we aimed to investigate the broader framework of political orientation, and therefore, we examined the relationship of the Big Five personality traits with political orientation. Political orientation, political beliefs, and identification with a particular political party can be regarded as characteristic adaptations resulting from the interplay of basic traits with a strong genetic influence, and individual and culture-specific environments (Kandler et al., 2012). Kandler and colleagues (2012) have shown that personality traits account for a substantial proportion of genetic variance in political orientations. We expected correlations in line with previous research (i.e., especially with openness and conscientiousness, e.g., Sibley & Duckitt, 2008). The pattern of correlations with personality traits, thus, served as a validation of our indirect measure of political orientation.

Method

The TwinLife study ("Genetic and social causes of life chances. A genetically informative, longitudinal study of the life course and individual development") received ethical approval from the German Psychological Association (Deutsche Gesellschaft für Psychologie; protocol numbers: RR 11.2009 and RR 09.2013).

Participants

The sample analyzed in this study was a subsample of the TwinLife study (Hahn et al., 2016). The full TwinLife sample consists of 4,097 German twin families and is representative of the population of twin families in Germany. The families were recruited by a collaborating survey institute via registration offices. Only families of same-sex twins were recruited. All participants were contacted and surveyed by interviewers employed by the survey institute from September 2014 to May, 2015, and from September 2015 to April 2016 (for a detailed overview on the recruiting and assessment procedures, see Brix et al., 2017). The twins and their families were grouped into four birth cohorts. The twins in the two younger cohorts were born in 2009–2010 and in 2003–2004, whereas the twins of the two older cohorts were born in 1997–1998 and in 1990–1993.

Our sample consisted of 2,024 families from the two oldest birth cohorts (age 17 [C17] and age 23 [C23], respectively), in which the twins were questioned about their political attitudes, including the twins themselves, their biological parents, and, if available, one biological full sibling (total $N = 8{,}678$). In the following, we set those persons to missing who did not identify with any particular party, or with a party that was not listed (37.6% of the original two-cohort sample; for further information on the wording of the item, see Measurement section). This is particularly relevant because it left us with only those individuals who felt in-line with a certain party. In the same vein, it was not possible to determine a person's placement on the right–left continuum if they stated either that they did not affiliate with any party or with a party that was not relevant in the daily politics of Germany. The final sample for the current study consisted of 4,224 participants (see Table 1). In total, 50.4% of the twin pairs were monozygotic, and 54.1% were female. For descriptive statistics of the other included family members, see Table 1. Siblings had to be older than 10 to participate in this part of the interview.

Table 1
Sample Descriptions

Family member	*N* Total	*N* % female	*N* Complete pairs	Age *M* (*SD*)	Age Range
MZ twins					
C17	415	52.4	124	17.04 (0.378)	16–18
C23	572	52.3	210	23.08 (0.844)	21–25
DZ twins					
C17	486	58.5	145	17.01 (0.337)	16–18
C23	477	53.3	158	23.08 (0.819)	21–25
Siblings					
C17	190	46.1	—	19.40 (3.785)	11–31
C23	185	51.9	—	24.50 (5.058)	14–38
Mothers					
C17	576	100.0	—	48.43 (4.078)	35–60
C23	544	100.0	—	53.10 (4.490)	41–65
Fathers					
C17	450	0.0	—	50.82 (5.108)	34–74
C23	329	0.0	—	56.18 (5.159)	43–73

Note. MZ = monozygotic; DZ = dizygotic; C17 = younger cohort; C23 = older cohort.

Zygosity Determination

Zygosity of the twin pairs was diagnosed by means of a standardized questionnaire predominantly based on self-reported ratings of their physical similarity, (e.g., eye color; Oniszczenko, Angleitner, Strelau, & Angert, 1993; see also Lenau & Hahn, 2017). For a subsample of twins (from the three younger cohorts; 328 pairs), zygosity was determined by molecular genetic methods (i.e., genetic fingerprints). DNA-based zygosity was used as a criterion to cross-validate the zygosity questionnaire and to obtain a zygosity measure corrected for the result of the saliva test (for further details, see Lenau et al., 2017). If DNA-based zygosity was available for a participant, this information was used instead of the questionnaire data. This procedure resulted in an average correct classification of 94.4% for self-rated zygosity, and 97% for parent-assessed zygosity, respectively.

Measurement of Political Orientation

Many variables collected in the TwinLife survey were assessed in a personal interview (Brix et al., 2017); however, to ensure greater privacy and to reduce influences by other family members, measures of political orientation were assessed individually on a laptop or tablet computer, or in rare cases, by means of a paper-and-pencil questionnaire. Participants were asked, "Do you usually think of yourself as close to any particular party? Which party do you feel closest to?" (cf. Falter, Schoen, & Caballero, 2000). They were given a list of the eight most popular political parties in Germany (plus the options *No Party* and *Other Party*) presented in random order. The question was brought together into a variable, in which the options *Other Party* and *No Party* were coded as missing values because political orientation could not to be determined for these participants (Brähler, Kiess, & Decker, 2016). To obtain the measure of political orientation, the question was rescaled by positioning the parties on a right–left ordered-categorical variable according to their attitudes and values.

To determine the correct ordering of the parties, we conducted a preliminary study in which we asked 60 participants (15 participants were experienced political scientists, 2 students of political science, 50% were female) to rate them from right to left (see Table 1 in the supplemental material) and to evaluate the similarity of the eight political parties pairwise. The right–left ratings resulted in an ordered-categorical variable from right to left, with *NPD* at the extreme right and *The Left* at the extreme left endpoint (1: NPD/Republicans, 2: AfD, 3: CDU/CSU, 4: FDP, 5: SPD, 6: Pirates, 7: Greens, 8: The Left).[2] This variable was used as the outcome for all analyses. As outlined above, because many lines of research suggest two or more dimensions of the political space which complement (or even substitute) the left–right dimension, we considered including additional dimensions into our analysis.

[2] The NPD (National Democratic Party of Germany) and the Republicans are extreme right-wing parties, with connections to neo-Nazi organizations. The AfD (Alternative for Germany) is a recently established right-wing party. CDU/CSU (Christian Democratic/Social Union of Germany) is the major German conservative party. The FDP (Free Democratic Party of Germany) is a central-right free-market liberal party. The SPD (Social Democratic Party of Germany) is the major German central-left party. The Pirate Party is a recently established central-left party with a focus on digital rights. The Greens is a central-left party with a focus on ecological aspects. The Left is a classical left-wing party.

However, the analysis of similarity ratings did not result in a second political dimension of perceiving parties, but rather discriminated between established (e.g., SPD and CDU) and less established parties (e.g., Pirates and AfD; see Tables 2 and 3 and Figures 1 and 2 in the supplemental material).

Measurement of Personality

Personality was assessed via the Big Five Inventory-SOEP (BFI-S; Gerlitz & Schupp, 2005; Hahn, Gottschling, & Spinath, 2012), which is a 16-item short version of the original BFI consisting of 44 items (John, Donahue, & Kentle, 1991). It consisted of three items per personality trait (e.g., for neuroticism: "I see myself as someone who worries a lot") plus one additional item for openness, which were rated on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach's α for the Big Five scales ranged from .44 (agreeableness) to .68 (extraversion).

Analyses

Polychoric family correlations were calculated using the R-package polycor (Fox, 2010). We used structural equation modeling (SEM) techniques to analyze the specific patterns of variance–covariance matrices of the ordinal outcome variable in the NTFD (Keller et al., 2009). The SEM analyses were conducted by means of the statistical software Mx (Neale, Boker, Xie, & Maes, 2003) using the full information maximum likelihood algorithm (FIML; Little & Rubin, 2014) to use all available data and to handle missing data.

The full NTFD for both MZ and DZ twin families is depicted in Figure 1. It allows for estimates of additive genetic effects (*a*) that are shared between relatives, depending on their genetic relatedness. Additive genetic effects act to make MZ twins more similar to each other than other relatives in the NTFD. In addition, nonadditive genetic effects can be estimated as well, taking significant interactions of alleles on the same gene loci (dominance deviation, *d*) into account. Nonadditive genetic influences because of dominance are completely shared by MZ twins and correlate to some degree ($r = .25$) in DZ twins and nontwin siblings, but are not shared by parents and offspring (see Figure 1). In the NTFD, both types of genetic effects can be estimated in the presence of a number of other shared and nonshared environmental influences. This prevents the overestimation of additive genetic effects and the underestimation of nonadditive genetic and shared environmental sources of variance, whereas taking assortative mating (μ) into account prevents overestimating shared environmental influences and underestimating additive genetic effects.

Familial environmental influences are shared by all children of a family and act to make the children more similar to each other, if the influences are effectively shared. These influences can be partitioned into shared family environmental effects (*f*), provided through parental environmental transmission from mother to child (*m*) and from father to child (*p*), and into estimates of shared environmental influences that go beyond the direct parental transmission to the offspring generation. Because of the inclusion of a nontwin sibling, these within-generational shared environmental influences can be further disentangled into an environmental effect shared by all siblings (*s*) and an environmental contribution only shared by the same-aged twin siblings (*t*), which might be because

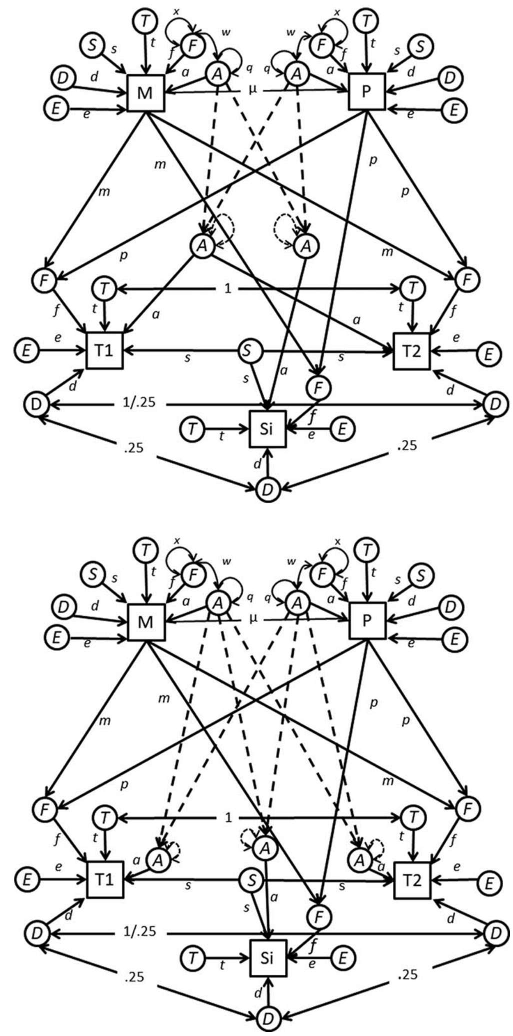

Figure 1. Nuclear Twin Family Model (NTFD). Graphical depiction of the NTFD model for monozygotic (MZ; upper part) and dizygotic (DZ; lower part) twin families. Variances of latent variables (factors) are fixed to one to estimate parameter coefficients with the exception of *A* and *F*. Dashed lines represent path coefficients of .5. T1 = phenotypic variance of twin 1; T2 = phenotypic variance of twin 2; Si = phenotypic variance of sibling; M = phenotypic variance of mother; P = phenotypic variance of father; *A* = additive genetic factors; *D* = nonadditive (dominance) genetic factors; *E* = nonshared environmental factors (including measurement error); *S* = environmental factors shared by all siblings; *T* = environmental factors shared only by the twins; *F* = family environmental factors transmitted from parents to offspring; *a* = additive genetic effects; *d* = nonadditive (dominance) genetic effects; *e* = nonshared environmental effects; *s* = environmental effects shared by all siblings; *t* = twin-specific shared environmental effects; *f* = family environmental effects, fixed to 1 to estimate *m* and *p*; *m* = environmental transmission from mother to offspring; *p* = environmental transmission from father to offspring. *x* = variance of the family environment *F*, constrained to values between 0 and 1. *q* = variance of the additive genetic factor *A*; *w* = covariance between *A* and *F*, that is, passive GE-correlation, constrained to values between 0 and 1; μ = phenotypic spouse correlation, that is, assortative mating. See text for further details.

of age-related effects. Lastly, nonshared environmental influences (*e*, including measurement error) are not shared by the family members, and hence act to make them less similar to each other. All these genetic and environmental factors can account for variance in political orientation.

As already mentioned, a special benefit of the applied model is that it also allows for an estimate of a passive gene-environment correlation (*w*) as a potential source of variance if both genetic and environmental transmission from parents to the offspring matter: $w = ½(qa + w)m + ½(qa + w)p + ½(qa + w)\mu m + ½(qa + w)\mu p$. The total (standardized) variance can be decomposed into the following components: $\sigma^2 = a^2q + d^2 + 2aw + x + s^2 + t^2 + e^2 = 1$. In this equation, the parameters q and x stand for the variances of additive genetic factors A and shared family environmental factors F, respectively. Variances of all other latent variables are fixed to 1, which allows for the calculation of genetic and environmental variance components by squaring the path coefficients (Kandler, Richter, & Zapko-Willmes, in press). Details on variance decomposition of specific variances and covariances are described in Table 2. The present implementation of the NTFD relies on nonlinear constraints, which warrant that model parameters are estimated in an internally and logically consistent way (see Keller et al., 2009, for more details, and Table 3 for specific constraints).

As we measured political orientation indirectly, we relied on the assumption that underlying the ordered-categorical variable is a continuous variable with a normal distribution (Byrne, 2010), which seems reasonable in our case, and fitted the model on the raw ordinal data. The Mx program computes the likelihood for a vector of observed ordinal responses by the expected proportion in a multivariate normal distribution (Neale et al., 2003). We provided the respective thresholds for mothers, fathers, twins, and siblings (calculated across both zygosity groups and both cohorts) from the polychoric correlations (please find the thresholds in Table 4 in the supplemental material). We ran a four-Group SEM model (two zygosity groups by two age cohorts) to compare the estimates of genetic and environmental contributions to individual differences in political orientation between adolescents and young adults. The estimates of the variance of the family environmental factor (x) and the covariance between the additive genetic and the family environmental factors (w) were bounded to be between 0 and 1. As disentangling nonadditive genetic effects and the sibling-specific environmental effects requires sufficient statistical power that the available sample did not provide, the confidence intervals (CIs) of the estimates in the full model were very large. Therefore, we tested two reduced models against each other, in which either d or s were set to zero. To test whether there were differences between the estimates of the two age cohorts, we set all parameters equal across the cohorts for the better fitting reduced model (i.e., either $d = 0$ or $s = 0$), and checked for a significant decline in model fit, as indicated by the likelihood-ratio χ^2-difference test, based on the −2 logarithmized Likelihood (−2logL) and the Akaike Information Criterion (AIC; Akaike, 1969). We then evaluated the parameter estimates and standardized variance components for the two cohorts.

As we also wanted to explore the role of Big Five personality traits for political orientation, we additionally calculated polyserial correlations between political orientation and each of the five personality traits. This was done separately for each family member and separately for the two age cohorts, and also averaged over the whole sample.

Results

Descriptive Statistics

The frequencies for party affiliation are depicted in Table 4. As expected, the two major and most influential parties, SPD and CDU/CSU, had the highest frequencies of identification. With respect to the other parties, the Green Party appeared to be somewhat overrepresented compared with the results of the German Federal Elections of 2013 (The Federal Returning Officer, 2013). However, note that our sample was intended to proportionally reflect and represent the population of families with children in a certain age range (younger people more often tend to vote for the Greens) and not the general population of voters in Germany.

Table 2
Variance Decomposition of Nuclear Twin Family Design (NTFD) Model Including Monozygotic (MZ) and Dizygotic (DZ) Twins Reared Together, Parents of Twins, and Nontwin Siblings

Variance/covariance	Variance decomposition
Total variance	$\sigma^2 = a^2q + d^2 + 2aw + x + s^2 + t^2 + e^2 = 1$
MZ twin covariance	$a^2q + d^2 + 2aw + x + s^2 + t^2$
DZ twin covariance	$a^2(q - ½) + ¼d^2 + 2aw + x + s^2 + t^2$
Siblings covariance	$a^2(q - ½) + ¼d^2 + 2aw + x + s^2$
Parents covariance	μ
Mother–child covariance	$½a\,(qa + w) + ½a\,(qa + w)\mu + m + p\mu$
Father–child covariance	$½a\,(qa + w) + ½a\,(qa + w)\mu + p + m\mu$

Note. σ^2 = total variance; a^2q = additive genetic variance; q = variance of the additive genetic factor A corrected for assortative mating; d^2 = nonadditive genetic variance; s^2 = variance of environmental influences shared by all siblings; t^2 = variance of twin-specific shared environmental influences; e^2 = variance of environmental factors not shared by family members (including measurement error variance); μ = phenotypic spouse correlation (assortative mating); m = effects of maternal environmental transmission; p = effects of paternal environmental transmission; w = covariance between additive genetic factors and the family environment; x = variance of the shared family environmental factor F. Variances of all latent variables, except for the additive genetic factor A and the shared family environmental factor F, are fixed to 1.

Table 3
Nonlinear Constraints of the NTFD Model

Constraint	Explanation
$x = m^2\sigma^2 + p^2\sigma^2 + 2m\sigma^2\mu p\sigma^2 = m^2 + p^2 + 2mp\mu$	Variance of the family environment *F*; can be simplified since $\sigma^2 = 1$.
$w = ½(qa + w)m + ½(qa + w)p + ½(qa + w)\mu m + ½(qa + w)\mu p$	GE covariance between additive genetic factor *A* and the family environmental factor *F*; can be simplified if maternal and paternal effects are equal.
$q = 1 + \mu(qa + w)^2$	Variance of the latent additive genetic factors *A*. $q > 1$ if there is significant assortative mating (μ).

Note. NTFD = Nuclear Twin Family Design; x = variance of the shared family environmental factor *F*; σ^2 = model-implied trait variance (standardized phenotypic variance), set to 1; *m* = effects of maternal environmental transmission; *p* = effects of paternal environmental transmission; μ = assortative mating; *w* = passive GE correlation; *a* = additive genetic effects; *q* = variance of the additive genetic factor *A* corrected for assortative mating.

Phenotypic Correlations Between Family Members

Table 5 shows the phenotypic polychoric correlations between family members. In general, correlations were substantial, ranging from $r = .46$ to $r = .81$. Inspecting these family correlations, especially the MZ and DZ twin correlations, can provide initial indications of the importance of certain genetic and environmental factors, respectively, because the degree of the genetic relatedness is given.

In our sample, MZ twin correlations tended to be larger than correlations between all other family members who share 50% of the genetic material that can vary among unrelated humans (i.e., DZ twins, siblings, parent–offspring dyads). Because MZ twins share 100% of their genetic makeup, the higher similarity of MZ twins compared with other dyads suggests the presence of genetic contributions to the variance. However, MZ twin correlations were lower than 1, which generally indicates nonshared environmental effects (that act to make the twins less alike). DZ twin and other sibling correlations were at least more than half the size of the MZ correlations, which indicates the influence of shared environmental effects, or the contribution of a passive gene-environment correlation, particularly for the younger twin cohort (C17). At the same time, correlations between twins and their nontwin siblings tended to be higher than the DZ correlations, which might indicate contrast effects between same-aged twin siblings. Parent–child correlations tended to be higher in C17, which indicates shared environmental effects and a passive gene-environment correlation. We also found high mother–father correlations, indicating substantial nonrandom mating and emphasizing the necessity of considering assortative mating in the model.

Nuclear Twin Family Modeling

Model fitting results are presented in Table 6. The model in which nonadditive genetic effects were set to zero ($d = 0$) did not result in a significant decline in model fit compared with the full model, and showed a better model fit than the model with sibling-specific environmental effects set to zero ($s = 0$). The latter model also resulted in a significantly lower model fit compared with the full model. Setting all parameters in the parsimonious model $d = 0$ equal across age cohorts resulted in a significant decrease in model fit, so we evaluated the cohorts separately.

The unstandardized path coefficients and the standardized variance components of the model $d = 0$ are depicted in Table 7, along

Table 4
Frequencies of the Single Parties for All Family Members Split by Twin Age Cohort

		Family member				
Party	Cohort	Twin a	Twin b	Sibling	Mother	Father
NPD	C17	5 (1.1)	6 (1.4)	4 (2.1)	1 (0.2)	2 (0.4)
	C23	9 (1.7)	5 (1.0)	6 (3.2)	0 (0.0)	3 (0.9)
AfD	C17	16 (3.4)	11 (2.5)	8 (4.2)	12 (2.1)	20 (4.4)
	C23	22 (4.2)	32 (6.1)	4 (2.2)	23 (4.2)	19 (5.8)
CDU/CSU	C17	143 (30.8)	137 (31.4)	67 (35.3)	202 (35.1)	138 (30.7)
	C23	166 (31.6)	162 (31.0)	55 (29.7)	199 (36.6)	113 (34.3)
FDP	C17	13 (2.8)	11 (2.5)	1 (0.5)	10 (1.7)	19 (4.2)
	C23	11 (2.1)	14 (2.7)	5 (2.7)	8 (1.5)	12 (3.6)
SPD	C17	137 (29.5)	135 (31.0)	48 (25.3)	173 (30.0)	153 (34.0)
	C23	144 (27.4)	136 (26.0)	43 (23.2)	174 (32.0)	112 (34.0)
Pirates	C17	13 (2.8)	16 (3.7)	6 (3.2)	2 (0.3)	3 (0.7)
	C23	15 (2.9)	14 (2.7)	10 (5.4)	1 (0.2)	1 (0.3)
Greens	C17	103 (22.2)	92 (21.1)	43 (22.6)	143 (24.8)	87 (19.3)
	C23	107 (20.3)	118 (22.6)	40 (21.6)	106 (19.5)	50 (15.2)
Left	C17	35 (7.5)	28 (6.4)	13 (6.8)	33 (5.7)	28 (6.2)
	C23	52 (9.9)	42 (8.0)	22 (11.9)	33 (6.1)	19 (5.8)

Note. C17 = younger cohort; C23 = older cohort; Twin a = firstborn twin; Twin b = second-born twin; NPD = national democratic party; AfD = alternative for Germany; CDU/CSU = Christian democratic/social union; FDP = liberal democratic party; SPD = social democratic party. Percentages are presented in parentheses. Parties are ordered from right (NPD = 1) to left (The Left = 8).

Table 5
Phenotypic Polychoric Family Correlations of Political Orientation

Dyads	Cohort	*r*	95% CI	N_{Pairs}
MZ twins a and b	C17	.725	[.644; .805]	124
	C23	.813	[.768; .858]	210
DZ twins a and b	C17	.503	[.374; .632]	145
	C23	.524	[.412; .636]	158
Twin a and sibling	C17	.778	[.699; .856]	104
	C23	.591	[.475; .707]	117
Twin b and sibling	C17	.681	[.485; .787]	100
	C23	.689	[.589; .789]	114
Mother–twin a	C17	.643	[.574; .712]	303
	C23	.465	[.379; .551]	346
Mother–twin b	C17	.650	[.579; .721]	279
	C23	.546	[.468; .624]	338
Mother–sibling	C17	.681	[.587; .824]	130
	C23	.498	[.355; .641]	123
Father–twin a	C17	.636	[.558; .714]	228
	C23	.516	[.414; .618]	211
Father–twin b	C17	.456	[.344; .568]	220
	C23	.529	[.429; .629]	207
Father–sibling	C17	.607	[.474; .740]	91
	C23	.585	[.426; .744]	75
Mother–father	C17	.722	[.661; .783]	273
	C23	.709	[.638; .779]	202

Note. MZ = monozygotic; DZ = dizygotic; Twin a = firstborn twin; Twin b = second-born twin; C17 = younger cohort; C23 = older cohort; 95% CI = 95% confidence interval.

with a tentative evaluation of whether our hypotheses were met. As expected, the additive genetic variance component (a^2q) was larger in C23, and in contrast to C17, the estimate was significantly different from zero. The passive gene-environment correlation (*w*) and its contribution to the variance (2*aw*), as well as the sibling-specific shared environmental component (s^2), tended to be higher in the younger cohort. However, CIs largely overlapped, and *w* was not statistically significant in either cohort, whereas *s* was significant in both cohorts. The variance component because of direct parental transmission (*x*) was, as expected, substantially larger in C17 (21.5 vs. 0%). A closer look at the specific parameters yielded that the latter was because of a substantial maternal effect in C17, whereas paternal transmission was not statistically significant in both cohorts. Finally, the twin-specific shared environmental component was not statistically significant in both cohorts, which was contrary to our expectations. The nonshared environmental component, including random error variance, also tended to be larger in the younger cohort.

In C17, genetic effects accounted for 12.4% of the variance in political orientation, whereas shared environmental components accounted for 38.0% and the passive gene-environment correlation for 16.6%. In C23, 61.3% of the variance was accounted for by genetic effects, 17.8% by shared environmental effects, and 0% by the passive gene-environment correlation. Thus, our main hypotheses were supported in the sense that the contribution of the passive gene-environment correlation was present in C17, and that the genetic variance was substantially larger in C23. This pattern of results was consistent with the hypothesis of a shift from passive to active or reactive gene-environment correlation with advancing age (Scarr & McCartney, 1983).

Correlations With Big Five Personality Traits

Polyserial correlations of political orientation with the Big Five personality traits split by family member subsamples and twin age cohort, and averaged over the whole sample, can be found in Table 8. Correlations with openness and conscientiousness were highest (averaged $r = .14$ for openness and averaged $r = -.12$ for conscientiousness), whereas correlations with the other three personality traits were negligible. This was in line with previous research (e.g., Sibley & Duckitt, 2008) and provided evidence for the validity of our measure of political orientation. However, correlations were generally smaller than expected, which can partly be explained by the measurement instrument of the Big Five personality traits (see discussion).

Discussion

We aimed to gain a more detailed and less biased understanding of what is genetically and what is environmentally transmitted in political orientation, measured by party identification along a right–left ordering, and of how different types of gene-environment correlations contribute to these influences. We addressed the sources of variance in political orientation by (a) using a Nuclear Twin Family Design involving twin pairs, their biological parents, and full siblings, (b) investigating two age cohorts of adolescents and young adults, and (c) relying upon a large population-based German sample and thereby a

Table 6
NTFD Model Fit Indices for the Two Age Cohorts

Model	Fit statistics					
	−2logL	*df*	AIC	Δ−2logL	Δ*df*	Δ*p*
Full model, cohort differences	12093.083	4206	3681.083			
Nonadditive genetic or sibling-specific shared environment?						
$d = 0$[a]	**12096.328**	**4208**	**3680.328**	3.245	2	.197
$s = 0$[a]	12101.982	4208	3685.982	8.899	2	.012
Equal parameters for each cohort?						
Equal parameters[b]	12125.178	4216	3693.178	28.850	8	<.001

Note. NTFD = Nuclear Twin Family Design; Full model = all parameters are free across the cohorts; Constrained model = all parameters are set equal across cohorts. Better fitting model is presented in boldface. −2logL = −2 log likelihood; Δ-2logL = χ^2-differences test comparison with full model, cohort differences; Δ*df* = χ^2-differences test degrees of freedom; Δ*p* = significance χ^2-differences test; AIC = Akaike Information Criterion.
[a] Models compared with the full model with cohort differences. [b] Model compared with model $d = 0$.

Table 7
Path Coefficients and Standardized Variance Components of the NTFD Model With d = 0

Model parameters	C17	C23	Hypotheses
Unstandardized path coefficients			
a	0.302 [0.000; 0.533]	0.623 [0.561; 0.655]	**C17 < C23**
m	0.454 [0.229; 0.661]	−0.042 [−0.176; 0.384]	**C17 > C23**
p	0.013 [−0.212; 0.232]	0.042 [−0.091; 0.170]	C17 > C23
s	0.400 [0.223; 0.519]	0.405 [0.239; 0.509]	C17 > C23
t	0.000 [−0.217; 0.217]	0.193 [−0.299; 0.392]	C17 > C23
e	0.568 [0.500; 0.634]	0.488 [0.446; 0.535]	—
w	0.267 [0.000; 0.318]	0.000 [0.000; 0.090]	**C17 > C23**
μ	0.732 [0.664; 0.798]	0.637 [0.573; 0.695]	—
Standardized variance components			
a^2q	.124 [.000; .526]	.613 [.483; .668]	**C17 < C23**
2*aw*	.166 [.000; .222]	.000 [.000; .089]	**C17 > C23**
x	.215 [.029; .468]	.001 [.000; .016]	**C17 > C23**
s^2	.165 [.051; .276]	.144 [.041; .226]	**C17 > C23**
t^2	.000 [.000; .048]	.033 [.000; .135]	C17 > C23
e^2	.331 [.278; .416]	.209 [.172; .254]	—

Note. C17 = younger cohort; C23 = older cohort; *a* = additive genetic effects; *d* = nonadditive (dominance) effects; *m* = effects of maternal environmental transmission; *p* = effects of paternal environmental transmission; *s* = environmental effects shared by all siblings; *t* = twin-specific shared environmental effects; *e* = nonshared environmental effects; *w* = covariance between additive genetic and family environmental effects; μ = assortative mating; a^2q = additive genetic variance; *q* = variance of the additive genetic factor *A*; 2*aw* = passive GE covariance; *x* = variance of the shared family environmental factor *F*; s^2 = variance of environmental influences shared by siblings; t^2 = variance of twin-specific shared environmental influences; e^2 = variance of environmental factors not shared by family members (incl. measurement error variance). *x* and *w* were bounded to values between 0 and 1. 90% confidence intervals are presented in square brackets. Differences between C17 and C23 in line with the hypotheses are presented in boldface.

multiple-party system. Additionally, we examined the relationship between political orientation and measures of Big Five personality traits.

Genetic Sources and the Role of Gene-Environment Correlation

The results supported previous research in showing that political orientation derived from the tendency to affiliate with a certain party ordered from right-wing to left-wing was indeed partly heritable, especially in young adulthood, whereas genetic variance in adolescent political orientation was found to be marginal (see also e.g., Abrahamson et al., 2002; Eaves et al., 1997). The genetic impact on individual differences in political orientation we found in the young adult twins was comparable with what other studies reported for middle-aged U.S. and Canadian samples (e.g., Bell & Kandler, 2015; Settle et al., 2009).

The design of this study also enabled us to go beyond providing more solid heritability estimates. As predicted, there were differences between the age cohorts, which might indicate—in line with established developmental theories (Scarr & McCartney, 1983)—differential importance of (re)active and passive gene-environment transaction at two important phases of young people's evolving political lives. The small and statistically insignificant additive genetic component in the 17-year-old cohort and the substantial and statistically significant genetic component in the 23-year-old cohort indicated a shift from passive to (re)active gene-environment correlation in emerging adulthood: Enhanced autonomy from the parents' environment (e.g., children move out of their initial home) and increased freedom to choose and create an environment of one's own that matches the individual's genetic makeup (active gene-environment correlation), and to evoke social reactions (reactive gene-environment correlation), may result in an increase of genetic effects.

The active and reactive forms of gene-environment correlation are confounded with the genetic component if not explicitly captured (Briley et al., 2018; Kandler & Zapko-Willmes, 2017) and, thus, provide a compelling rationale for age differences concerning the magnitude of the genetic variance. Yet, there are other possible explanations, such as the increased relevance of political choices in young adulthood compared with adolescence, especially because young people in Germany are eligible to vote from the age of 18. Genetic maturation and the onset of novel genetic influences, which also might reflect interactions between shared environmental influences and the genetic sensitivity toward them, could as well be reasons for a larger additive genetic variance in young adults compared with adolescents (Kandler, Waaktaar, Mõttus, Riemann, & Torgersen, 2019). Another potential explanation for our results might be cohort effects because the etiology of political phenotypes is dependent on societal circumstances at a certain time. For example, heritable differences (such as right-wing authoritarianism) might account more strongly for differences in political orientation in the older cohort because the topics of the political discourse in society might vary, even within relatively short periods of time. In the same vein, the relative weight assigned to certain political topics (e.g., taxation, climate change) might differ between the age groups.

The impact of a passive gene-environment correlation in the adolescent twin cohort might reflect parents as genetically equipped with characteristics that allow them to provide an environment (e.g., parenting style, choice of school, and social environments in general) that further enhances the genetic tendencies of their offspring to develop a certain party preference. This form of gene-environment correlation is confounded with estimates of shared environmental effects, if not explicitly modeled (Bleidorn, Hufer, Kandler, Hopwood, & Riemann, 2018; Briley et al., 2018). The applied NTFD allowed the explicit modeling and consideration of passive gene-environment correlation beyond actual shared environmental influences.

Table 8
Polyserial Correlations of Political Orientation With the Big Five Personality Traits

		Big Five personality trait				
Person	Cohort	O	C	E	A	N
Twin a	17	**.149**	**−.102**	**−.117**	.053	.070
		[.057; .241]	**[−.196; −.008]**	**[−.211; −.023]**	[−.041; .147]	[−.024; .164]
	23	**.181**	**−.149**	−.041	.143	.064
		[.097; .265]	**[−.235; −.063]**	[−.129; .047]	[.057; .229]	[−.022; .152]
Twin b	17	**.130**	**−.100**	**−.115**	−.004	.079
		[.034; .226]	**[−.198; −.002]**	**[−.211; −.019]**	[−.102; .094]	[−.019; .177]
	23	**.187**	−.084	−.042	.050	.130
		[.103; .271]	[−.172; .004]	[−.130; −.374]	[−.038; .138]	[.044; .216]
Sibling	17	.076	−.152	−.038	−.024	.010
		[−.073; .225]	[−.297; −.007]	[−.187; .111]	[−.173; .125]	[−.139; .159]
	23	**.350**	−.078	.005	.057	−.029
		[.225; .475]	[−.227; .071]	[−.146; .156]	[−.094; .208]	[−.179; .122]
Mother	17	**.118**	−.058	**.093**	−.046	.005
		[.034; .202]	[−.144; .028]	**[.008; .179]**	[−.132; .040]	[−.081; .091]
	23	**.126**	−.070	.037	−.078	.033
		[.042; .210]	[−.156; .016]	[−.049; .123]	[−.164; .008]	[−.053; .119]
Father	17	.025	**−.251**	−.040	.067	−.083
		[−.063; .113]	**[−.339; −.163]**	[−.136; .056]	[−.031; .165]	[−.179; .013]
	23	.088	**−.126**	−.004	.030	.000
		[−.024; .199]	**[−.238; −.014]**	[−.118; .109]	[−.084; .144]	[−.114; .114]
Averaged *r*	Both	.137	−.115	−.024	.024	.035

Note. Twin a = firstborn twin; Twin b = second-born twin; O = openness for experiences; C = conscientiousness; E = extraversion; A = agreeableness; N = neuroticism. The 95% confidence intervals are presented in square brackets. Significant correlations ($r \neq 0$) are shown in boldface.

Between- and Within-Generational Shared Environmental Sources

Shared environmental factors accounted for more than twice as much of the individual differences in political orientation in the younger cohort than in the older. The impact of the family environment because of parental transmission appeared to be limited to the adolescent cohort. Mostly, 17-year-olds still live in their parents' home, and they are not yet eligible to vote, which could result in lower political interest. Therefore, their political views are likely to be more strongly influenced by their parents' than is the case for the young adults.

Parental environmental transmission was primarily maternal, basically reflecting higher mother–offspring correlations compared with father–offspring correlations. The presence of strong assortative mating could entail the possibility that only one parental path reaches significance, although both could be of importance. The parental transmission does not need to be *direct* in the sense of, for example, parenting style or the verbal expression of opinions and beliefs, but may also be mediated by more subtle processes, such as the preference for certain media or salience of certain topics (e.g., economic or social) in conversations at home. Finally, it might reflect a stronger effect of a third variable (e.g., social milieu) on mothers and their children than on fathers and their children.

Beyond parental transmission shared by all offspring, we found significant within-generational effects of the environment shared by all siblings in both cohorts. This is consistent with arguments for a sociological perspective, assuming strong influences of environmental contexts on political opinions. Contextual circumstances shared by all siblings, such as living in the same neighborhood, sibling interactions, shared activities, shared friends and (nonparental) role models, or attending the same school, may play a role in shaping adolescents' political views, but they may also influence young adults' preferences for a political party.

The Role of Big Five Personality Traits

We have outlined that personality traits, particularly openness and conscientiousness, have shown themselves to be associated with political orientations and party identification (e.g., Gerber et al., 2012; Kandler et al., 2012). Therefore, we also examined the correlations between the indirectly measured right–left political orientation, and the Big Five personality traits, to validate the indirect measure of political orientation. In line with previous research, openness and conscientiousness turned out to show the highest correlations with political orientation. However, with a few exceptions, all correlations were small. A reason for these low associations might be the very short Big Five personality measure with modest reliability (Cronbach's α from .44 to .68) and bandwidth.[3] In addition, other personality models with conceptually related, but also different, trait dimensions (such as the HEXACO framework) include promising trait concepts (e.g., Honesty–Humility) that have been found to be systematically associated with political orientations (Lee, Ashton, Griep, & Edmonds, 2018). Nevertheless, the relationships between openness and conscientiousness and political orientation yielded evidence for the validity of measuring political orientation indirectly through the identification with a political party because they were consistent with a body of research concerning political attitudes and personality.

[3] For the sake of practicability in a long-term panel study, personality was assessed rather narrowly in this study.

Strengths, Limitations, and Future Directions

The results were derived from a less bias-prone nuclear twin family design, and they extended previous findings based on the CTD requiring several assumptions (no assortative mating, no nonadditive and shared environmental influences at the same time, and independent genetic and environmental sources) that do not need to be presupposed in the NTFD. This prevents up- or downward biases of genetic and environmental effects, especially in the case of strong parental correlations, as found in our study.

Political party system. In the presented study, the analyses were based on a German sample and, thus, a multiple-party system, whereas most previous studies were based on two-party systems. In general, when comparing the size of the variance components in the literature, the results seem to depend on the measure used in a certain study. In a more or less two-party system, such as in the United States, political orientation and party identification might be conceivably more influenced by environmental components. In a political system such as that in Germany, young people's identification with one of many parties could be more closely linked to latent political opinions. Our study of German twin families, thus, helped to provide a more refined understanding of the underlying mechanisms contributing to variation in political orientation.

Cultural influences. We studied individual differences—and their sources—in political orientation in Germany, a mid-European culture. Hence, environmental effects shared within a culture (e.g., historical experiences) cannot be reflected by parental transmission and sibling-specific or twin-specific shared environmental influences in our study. Even so, this does not imply that cultural effects are irrelevant. If cultural influences were more important relative to genetic variation, the cross-cultural variance should be larger and the respective estimates of shared environmental contributions should be higher in intercultural studies (e.g., see Kandler, Bell, Shikishima, Yamagata, & Riemann, 2015).

Cohort versus age differences. Our study design was cross-sectional; thus, the age effects discussed here should not be interpreted as developmental processes, and we cannot separate age effects from cohort or other time-dependent effects. Nevertheless, the differential patterns we found help us to gain a better understanding of the interplay between genetic and environmental influences on the variation of political orientation of adolescents and young adults, and are in line with the hypothesized different impacts of (re)active and passive gene-environment correlations (Scarr & McCartney, 1983): To a lesser degree, adolescents are affected by genetic influences, whereas they are still influenced by the family environment provided by their parents and partly created by their parents' genetic makeup. The NTFD allows one to separate the source of family environment from an environment shared among siblings, which is almost of the same size in both cohorts. As part of the maturation process, people grow out of their parents' home and actively choose partners, friends, and acquaintances whose characteristics match their genetic endowment, and who, in turn, may influence their political orientation. Influences from peers can also be reflected by the nonnegligible nonshared environmental component, apart from environmental factors, which are objectively shared but perceived differently by the offspring, such as parenting style or life events. To address these considerations appropriately, there is a need for longitudinal studies spanning those interesting periods from adolescence to emerging adulthood.

Measurement issues. Even though our study provided new and refined evidence for the sources of political orientation based on a more indirect measure via party affiliation, some methodological problems need to be considered when interpreting the results. As a result of the assessment strategy, only those participants who thought of themselves as close to a certain political party could were not coded as missing in the analyses, which were the ones we were interested in because we did not want to investigate the strength of a person's political conviction, but the direction in the sense of which specific party the person was affiliated with on a right–left continuum. Although this strategy may produce lower error of measurement, it leads to a large number of missing values, and hence reduced statistical power.

Different processes might result in missing data: First, in German culture, political topics are perceived as highly sensitive, which could lead participants to omit related questions, even though they were assessed via tablet or laptop. A second aspect might be a phenomenon often referred to by social scientists, called *voter dealignment*. It describes the fact that people tend to be less bound to political parties nowadays than they were in past decades (Dalton, 2014). We took both processes into account in our data collection, and with respect to the latter process, we decided to study established rather than ad hoc preferences for political parties. Contributing to the complexity, there is evidence that political orientation is not entirely independent of short-term political incidents (Bakker et al., 2015; Schmitt-Beck, Partheymüller, & Faas, 2011), which makes it more complicated to determine the underlying processes of political orientation. However, it might be possible that the fact that the individuals investigated in this study clearly felt close to a certain party could also, in part, explain the relatively high heritability we found for the young adults, because strong attitudes tend to be more heritable than weaker ones (Tesser, 1993). Unfortunately, we cannot test this hypothesis because we do not have any data on the party preferences of those who did not state feeling particularly close to any certain party.

Polychoric correlations between twins and their nontwin siblings tended to be higher than the DZ correlations. This might indicate contrast effects in the same-aged twin siblings in the sense that twins may aim at highlighting the differences between them. However, this effect was by far not as strong as it has been shown for other traits, such as temperament (Spinath & Angleitner, 1998).

Implications and future directions. The results of the current study added to a better understanding of age-group differences in the sources of variation in political orientation. From here, more steps can be taken to integrate the existing literature findings. We stated that political affiliation was heritable, and that the genetic sources were increasingly expressed in emerging adulthood, possibly reflecting active gene-environment covariation. Yet, because it is unlikely that there is a small number of genes directly causing identification with a politically left-wing or right-wing party, the next steps should focus even more on the psychological processes affecting political orientation. The stable relationship between political orientations and personality leads to the assumption that personality might be a potential mediating factor partly explaining the heritability estimates for political orientation (Gerber et al., 2012). However, our results supported this only to a certain degree. Other potential mediators that have been proposed are cognitive ability (Oskarsson et al., 2015) and cognitive style (Ksiazkiewicz, Ludeke, & Krueger, 2016). In addition, other political traits, such as political interest and political efficacy, might as well be involved in this complex network (Jennings et al., 2009). Nevertheless, all those variables and their relationships need to be carefully evaluated with regard to possible genetic or environmental confounds (Turkheimer & Harden, 2014). As mentioned before, our study design was cross-sectional, which means that it could only suggest developmental aspects. To entirely understand the causal mechanisms and developmental processes that lead to political orientation, longitudinal studies are urgently required.

Conclusion

Altogether, our study was one of the first to investigate the genetic and environmental sources of political orientation in a German sample while providing robust estimates by using an NTFD (see also Kandler et al., 2012). Our results showed that political orientation, measured as identification with a political party in a multiple-party system, was moderately or even substantially heritable, and that there was likely a shift from a passive to a more active form of gene-environment correlation, underlying and explaining the empirical difference between a small genetic component in adolescents and a substantial one in young adulthood. Moreover, shared parental influences provided a stronger basis of early political views of adolescents compared with young adults, whereas within-generational effects shared by offspring of a family appeared to be important for both adolescents and young adults. The measure of political orientation was validated by examining the relationships with the Big Five Personality traits. Thus, our study contributed to a refined and deeper understanding of political orientation, and provided the basis for further research that needs to be longitudinal, cross-cultural, and desirably interdisciplinary in nature.

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