Political Psychology

Political Psychology, Vol. 44, No. 6, 2023
doi: 10.1111/pops.12901

Extraversion Probably Does Not Cause Political Participation. Evidence from Two Genetically Informed Designs

Rafael Ahlskog
Uppsala University

A substantial literature in political psychology has emphasized the importance of personality traits for understanding differences in political participation. One such trait is extraversion. However, the causal status of this relationship is complicated by a number of issues, not least genetic confounding stemming from the heritability of both personality traits and political participation. This study confirms the well-established naive relationship between extraversion and participation, but goes on with (a) a discordant MZ twin design and (b) a new approach using measured genetic variation, or a polygenic index, in the given trait (extraversion) to assess the causal nature of this relationship. First, utilizing variation in extraversion and participation within identical twin pairs shows that twins with higher extraversion do not participate more. Second, random variation within fraternal twin pairs in a polygenic index of extraversion does predict trait extraversion, but does not predict political participation. In summary, previously identified associations between extraversion and political participation are not likely to be causal, but instead reflect common underlying familial factors.

KEY WORDS: cotwin design, extraversion, personality, political participation, polygenic index

Participation in politics and public life can be driven by many different motivations, both extrinsic and intrinsic. The strength and character of these motivations may in turn be influenced by a plethora of factors—e.g. level of political interest, stakes involved, resources, and time available. However, there may also be individual psychological endowments at play that are perhaps less immediate. In political psychology, a significant portion of research has been devoted to understanding the effects of fundamental psychological traits on political participation. A psychological domain that has been argued to lie at the core of why people differ in their participatory proclivities is the cluster of traits referred to as personality (Caprara & Vecchione, 2013; Gerber et al., 2011; Mondak & Halperin, 2008).

While a consensus definition of personality remains elusive, it is usually described as a set of patterns of individual behavior that vary between people and that are relatively stable over time, or as "dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings, and actions" (McCrae & Costa, 2003, p. 25). This separates personality traits from universal human characteristics (Brown, 1991) but also from more transient behavioral

patterns, such as emotions (Fleeson, 2004). The dimensions of personality can and have been delineated in countless different ways, but recent decades have seen a relatively strong convergence around a disaggregation of traits called the "Big Five" dimensions—openness, conscientiousness, extraversion, agreeableness, and neuroticism (McCrae & Costa, 2008). Several of these personality dimensions have been connected to political attitudes and behavior in past studies (see, e.g., Cooper et al., 2013; Dinesen et al., 2014; Lindell & Strandberg, 2018).

One of the findings is that extraversion, the personality trait characterized by being outgoing and talkative rather than reserved and inward focused (John et al., 2008), is often associated with various forms of political participation. Mondak and Halperin (2008) were among the first to explore this link and presented evidence that extraverts tend to participate more in political activities. This has since been replicated in several studies of electoral participation (e.g., Mattila et al., 2011), other types of civic engagement (e.g., Ha et al., 2013; Mondak et al., 2011; Vecchione & Caprara, 2009), or both (e.g., Gerber et al., 2011). The relationship has also been shown to vary substantially between country contexts, such that it may be strongly positive in some countries and weak or even weakly negative in others (Huber et al., 2021; Weinschenk, 2017). Vitriol et al. (2019) further show that the meta-analytical relationship is positive and generalizes to representative samples.

Studying the effects of personality, however, is hampered by a number of salient methodological problems. While it is possible to manipulate behavior in the short term by, for example, asking participants to try to behave in a more extraverted manner for some amount of time (e.g., Fleeson et al., 2002; Margolis & Lyobomirsky, 2020), it is not clear that it is possible to manipulate actual personality traits in the long run experimentally. Meanwhile, since personality is relatively stable over time, approaches utilizing variation within individuals over time are also likely to fall short due to lack of variation.[1]

Studies of the effects of extraversion on political participation have therefore relied on observational cross-sectional data.[2] However, increasing amounts of evidence over the last decades have shown that there are rarely good grounds for drawing causal conclusions from the traditional approach of using observational data and multiple regression to partial out possible confounders (Ahlskog & Oskarsson, 2023; Angrist & Pischke, 2010). In addition to contextual and environmental confounders that might be difficult to measure, it is now also known that both personality and aspects of political behavior are moderately genetically heritable (Bouchard & Loehlin, 2001; Fowler et al., 2008), meaning that any observational approach that does not factor in genetic confounding (i.e., the possibility that the dependent and independent variables are both influenced by the same genetic architecture) may be unlikely to give an accurate causal estimate.

In this article, I test the effect of extraversion on several types of political participation in a large sample of Swedish twin pairs.[3] On the one hand, I use register-based validated turnout data from both first- and second-order elections. On the other, I use survey data on self-reported measures of both collective and individual forms of political participation.

[1]To the extent that there is variation over time, it is unlikely that the factors that precede changes in personality are unrelated to the outcome of interest (such as political participation), making it difficult to infer causality regardless.

[2]Studies using panel data, for example, Blais and Labbé St-Vincent (2001) and Denny and Doyle (2008), have not actually used the panel dimension to partial out confounders but at best (in the case of Denny and Doyle) to get measures of personality and participation that are further apart in time. From the perspective of familial confounding, this is statistically identical to a cross-sectional analysis.

[3]While other personality traits are also highly interesting, this article is only concerned with extraversion due to data limitations regarding other traits.

The effect of extraversion on these outcomes is tested using two genetically informed designs. First, I use a discordant twin design, where identical (monozygotic or MZ) twins are compared to each other, in effect factoring out confounding effects of both genetics and shared environmental factors. I replicate previous studies in the sense that naive associations are in line with existing results showing a positive correlation between extraversion and participation across the board. However, when accounting for familial confounding in the discordant twin design, all these seeming effects disappear. That is, if you have an identical twin who is more extraverted than you, they will still not participate more in politics.

Second, I complement this with a design that utilizes actual molecular genetic data, leveraging variation in a polygenic index of extraversion within fraternal (dizygotic or DZ) twin pairs. I show that this genetic measure is indeed causally related to actual trait extraversion, but does not predict any of the political participation measures. Again, if you have a fraternal twin with a larger genetic propensity for extraversion, they are indeed more extraverted than you, but they will still not participate more.

In summary, these results indicate that previously identified associations between extraversion and different types of political participation, at least in this context, may not be causal but instead reflect common underlying causes. Since the relationship does exist in a naive sense in this data, but appears to disappear when proper controls for familial confounding are used, and since the existing literature on personality and political participation has not adequately controlled for these types of confounding, there is a tangible risk that many of the findings in the field are spurious.

Theory

To connect the dots between personality psychology and political participation research, a good starting point is to depart from what is arguably the most famous model of political participation in the discipline, namely the "paradox of participation." This age-old formulation tells us, briefly condensed, that a rational agent should have very little incentive to participate in politics—least of all elections—since the probability p of being the decisive participant is exceedingly small (Downs, 1957), and that any associated cost C will therefore dominate the possible benefit B of one's own side winning.[4] People do, however, participate nonetheless (hence the paradox), leaving ample room for political analysts to propose explanations of why.

I argue that there are, broadly speaking, two classes of explanations that are relevant for evaluating the possible impact of personality on this calculus (these are also laid out formally in the online supporting information). The first one is to simply conclude that people are not actually rational in this narrower sense—in particular, they may be bad at estimating probabilities. One reason they choose to participate is therefore, perhaps, that they overestimate the impact they will have (Blais, 2000; Riker & Ordeshook, 1968), in effect increasing *extrinsic* motivation to participate. To capture this, we can introduce the perceived probability $p^* > p$, such that the degree to which the perceived probability of being the decisive participant exceeds the true probability becomes a measure of overconfidence. From this vantage point, we can hypothesize our first connection between extraversion and participation, namely what we may call *the optimism pathway*: Extraverts tend to be happier and more optimistic than introverts (Marshall

[4]This model has typically been applied to the case of voting in elections, where p can be at least approximately quantified, but the logic of this cost-benefit framework extends to any kind of participation.

et al., 1992; Williams, 1992). This could also predispose them to have a more positive outlook on politics and therefore, speaking in the language of the aforementioned paradox of participation, to be more likely to overestimate their impact on political outcomes. If so, they would participate to a higher degree than introverts. It has also previously been shown that optimistic people do in fact participate more (Stapleton et al., 2021).

The second explanation is that political participation possesses a utility unrelated to the outcomes of the process, such that individuals choose to participate because it gives them a sense of community or expressive satisfaction (Riker & Ordeshook, 1968), of moral satisfaction (Harsanyi, 1977), or approval from their group (Uhlaner, 1989).[5] This leads to the second proposed pathway from extraversion to participation, what we may call *the sociability pathway*: Extraverts by definition enjoy the company of others and may therefore possess larger *intrinsic* motivation to participate in political activities that involve organizational work, gatherings, demonstrations, etc. than introverts do. Extraversion may therefore positively play into both the extrinsic and the intrinsic motivation to participate in political activities.

The distinction between these pathways also tells us something about which specific types of activities that we are likely to see extraverts engage in. A distinction that has been made in the literature is between collective and individual forms of participation (e.g., Huber et al., 2021; Mondak & Halperin, 2008), where collective forms of participation are those which, in one way or another, involve interacting with other people. If extraversion exerts an effect on political participation via the sociability pathway, we should expect them to be more likely to participate in collective political activities than individual ones. This distinction is also explicitly tested by Huber et al. (2021), who find that extraversion is indeed related to collective forms of participation, but not individual forms, at least in three out of five countries tested. The optimism pathway, on the other hand, could be related to either, and Stapleton et al. (2021) find that trait optimism is related to both voting and campaign participation.

The Problem of Familial Confounding

We have seen that there are compelling theoretical reasons to expect a relationship between extraversion and political participation and a plethora of studies confirming this relationship empirically. However, there are important considerations that have often been acknowledged in the previous empirical literature, but whose implications have been neglected. One such consideration is that both traits are now well known to have a sizable heritable component. The literature on the heritability of personality traits is extensive, and extraversion is typically shown to be around 50% heritable, with the remaining variation being explained by so-called nonshared, or unique, environmental factors (e.g., Bouchard & Loehlin, 2001; Jang et al., 1996). Meanwhile, the heritability of voting behavior and other types of political participation has been documented using both traditional twin studies (Fowler et al., 2008; Klemmensen et al., 2012), studies on adoptees (Cesarini et al., 2014; Oskarsson et al., 2022) and more recently with molecular genetic methods (Aaroe et al., 2021; Dawes et al., 2021).

[5]An alternative formulation of this argument is to say that both the costs and expected benefits of participating are often so miniscule that they are not even worth taking into consideration (Barry, 1978), and that other values therefore take precedence. This may be true of voting, but with many other forms of participation it is not reasonable to overlook the cost aspect.

Furthermore—and perhaps most importantly—Dawes et al. (2014) find, using some of the same data sources that are utilized in this article, that there is substantial genetic overlap (and some overlap in environmental factors) specifically between extraversion and self-reported measures of political participation, meaning that the two traits likely share a nonnegligible portion of their etiology. Similar results are found for several psychological constructs by Weinschenk et al. (2019, 2022). This observation is not trivial, since it raises the very real possibility that the observed relationship between extraversion and political participation is, at least in part, driven by genetic confounding. In short, without using a genetically informed design, it is impossible to rule out that the relationship can be attributed to both extraversion and participation being caused by the same underlying genetic architecture, rather than being causally related to each other.

In addition to this, there are likely a large number of nongenetic familial factors that are difficult to measure and therefore to control for in a conventional observational regression framework. The importance of this is further underscored by the fact that family-based designs almost invariably find substantially smaller effects when investigating influences on political participation and behavior. For example, effect sizes are generally more than halved or even disappear completely when looking at education and participation (Ahlskog, 2021; Dinesen et al., 2016), education and political knowledge (Robinson, 2020; Weinschenk & Dawes, 2019) and attitudes and participation (Weinschenk et al., 2021). Furthermore, Ahlskog and Oskarsson (2023) argue that a reasonable rule of thumb is that at least half of the effect size in even conservative observational studies is composed of confounding. There thus appears to be good reason to investigate whether the proposed effects of extraversion on political participation are robust to using more careful empirical methods that can appropriately partial out familial confounding factors.

Methods and Data

This study utilizes two distinct and complementary ways of testing the relationship between extraversion and political participation, both of which rely on genetically informed designs. Since at least the latter of these two may be new to a fair number of readers, this section will be somewhat lengthy.

The first approach is a so-called discordant twin design. This design requires data on identical (MZ) twins and departs from the fact that these individuals are genetically identical to each other and will also share a substantial part of their early-life environmental determinants of political participation (i.e., parenting, neighborhood effects, networks, etc.). Thus, comparing MZ twins to each other—does the twin with higher extraversion also participate more?—provides a way of estimating the relationship net of possible genetic and shared environmental confounders (Vitaro et al., 2009). In a conventional regression framework (the approach taken here), this can be achieved by limiting the data to complete identical twin pairs, simply adding fixed effects per twin pair and clustering standard errors at the pair level. Leveraging within-pair variation therefore means relying on variation in the exposure induced by the nonshared factors: unique life events, nonoverlapping social circles, unique biological factors like womb placement, randomness, etc.[6] A crucial prerequisite is therefore that there is enough variation left within the pairs. This is verified in the auxiliary analyses below.

[6]It is noteworthy that this also captures possible changes across the life-span (so long as these changes are not identical between the two twins).

The discordant twin design has been extensively used in medical and psychological research for decades. In recent years, it has also been gaining traction in political science (see, e.g., Ahlskog & Brännlund, 2021; Oskarsson et al., 2016; Robinson, 2020; Weinschenk & Dawes, 2019), spurred both by increasing availability of twin datasets with politically relevant variables and the growing realization that conventional observational research, even with extensive statistical controls, probably fails to remove most confounding (Angrist & Pischke, 2010; Clark & Golder, 2015).

In the results section, both naive models and discordant twin models will be presented and contrasted.

The complementary second design instead relies on actual molecular genetic data from fraternal twin pairs. Unlike identical twins, fraternal twins are genetically comparable to regular siblings (just born at the same time) and will as such share only on average about 50% of their segregating genes, thus leaving a considerable amount of genetic variation between them. To understand how such genetic variation can be utilized in this setting, a brief introduction to recent advances in quantitative genetics is necessary.

Complex human traits, like personality, are known to be highly polygenic—that is, in contrast to typical monogenic examples like eye-color or certain heritable diseases, they are influenced by a very large number of genetic variants that each have very small effect sizes (this is often also called the Fourth Law of Behavior Genetics—see Chabris et al., 2015). This pattern has been confirmed by large-scale genome-wide association studies on a number of social and psychological phenotypes (e.g., Barban et al., 2016; Karlsson Linnér et al., 2019; Lee et al., 2018; Meddens et al., 2021). A consequence of polygenicity is that a study attempting to capture the effect of any single genetic variant on a particular trait will have to be very large and will still only capture a tiny fraction of the genetic effect. This was the approach of the so-called candidate-gene research era—an approach that is now effectively abandoned due to its overwhelming issues with statistical power (see e.g., Duncan et al., 2019).

Instead, a more involved solution is to use all the genetic variants that previous studies have identified in relation to a trait of interest and construct a so-called polygenic index, or PGI. In this case, we are interested in constructing a genetic measure of extraversion. One would then depart from the results of one or more large genome-wide association studies (GWAS), in which genetic variants significantly associated with extraversion have been identified out of sample. Moving to our own genotyped sample, a PGI becomes the sum of these variants multiplied by their respective effect sizes, as estimated in the GWAS. This, in essence, gives each individual in a genotyped sample a single number representing some portion of their genetic propensity for extraversion.

However, genetic differences within a population can correlate with an outcome for reasons that are entirely nongenetic—for example, certain variants might be more common in a given part of the country or in particular social strata, and the outcome might be more or less common for reasons that are unrelated to the genetic endowment (Hamer & Sirota, 2000). This is called *population stratification*. Thus, a naive approach to studying effects of a PGI runs the risk of capturing other factors that are correlated with the genetic variants that make up the index. However, we can again rely on the phenomenon of twinning: Genetic differences between siblings are by nature random. As such, downstream differences that correlate with a genetic difference between siblings are plausibly causal. This can be used to our advantage when investigating the possible effects of extraversion: Put simply, we can leverage within-pair differences in a PGI for extraversion versus political participation. If extraversion causes political participation, a

PGI for extraversion should too (with caveats mentioned below), and we can estimate this causal effect using DZ twin pairs. The main models using variation in a polygenic index of extraversion within fraternal twin pairs are therefore fairly straight forward: on the one hand, a within-family model with the PGI as the independent variable and extraversion as the dependent variable, and on the other hand a within-family model where the dependent variable is switched to political participation.[7]

Note that although this at first glance might seem like a type of reduced-form instrumental variables approach, this is not quite the case because of possible violations of the exclusion restriction. Due to a phenomenon called *pleitropy* (when a set of genetic variants has downstream effects on multiple traits), it is possible that the PGI is also associated with traits other than extraversion. It is therefore warranted to interpret the PGI effect as causal, but not necessarily exclusively an effect of actual trait extraversion. If the net effect of such *other* downstream variables on political participation is positive, the effect of extraversion could be overestimated. In the unlikely event that their net effect is negative, on the other hand, it could be underestimated. Another consequence of this is that the PGI design does not in fact strictly rule out genetic confounding, for the very same reason: If the same genetic factors influence both extraversion and participation, then the PGI for extraversion would also be related to both. To investigate whether this poses any problems for the identification, I also present models with controls for a large range of polygenic indices for traits *other* than extraversion.

In addition, one also needs to be cautious about power issues in this type of analysis since the coefficient is now affected by two implicit "stages" of dilution—the first being that the PGI only captures a small amount of the variation in trait extraversion, and the second being that trait extraversion in turn only captures a small amount of variation in participation. Negative results could therefore result not only from a lack of an actual effect but also from the relationship being too weak to be captured with this method in a sample of this size. PGI analysis could therefore be interpreted as a weak test, but a look at the effects of other PGIs included as controls will give a hint as to whether this is a real issue (see Auxiliary analyses).[8]

Finally, it is worth contrasting the relative strengths of the discordant MZ design and the PGI design. Whereas the MZ design relies on variation in trait extraversion within twin pairs induced by nonshared environmental factors, the PGI method instead relies on a direct measure of genetic variation in extraversion. Thus, in the first case, the identifying variation stems from the environment and in the other from genetics. This fundamental difference becomes of paramount importance if we have the (unlikely) suspicion that a causal effect on political participation is only driven by the variation in extraversion induced by one or the other. If this is the case, however, effect estimates using the complementary method should be even clearer. Additionally,

[7]Typically, in a conventional regression framework, one also includes controls for population stratification—such as the top 10 genomic principal components (see e.g., Price et al., 2006). However, in within-family models, population stratification is held constant by design (both twins have the same parents), which precludes the need for using these types of controls.

[8]There are additional considerations with PGIs. First, the genetic discovery phase (the GWAS) will capture naive trait-level correlations with participation, regardless of whether the trait-level correlations are causal or not. That is, if a particular genetic variant is correlated with extraversion, and extraversion is correlated with participation, the variant will also be correlated with participation. In a between-family analysis, the resulting extraversion PGI will also pick up noncausal correlations between extraversion and participation. In a within-family analysis, however, the extraversion PGI can only be related to participation for two reasons: either because the same genes that cause extraversion also cause participation via some other pathway, or because extraversion really does cause participation.

there is the (equally unlikely) case that the naive correlation is attributable to complete genetic overlap, but there is a true causal effect of extraversion through vertical pleiotropy (where the same genes cause both x and y exclusively because x causes y). If so, this effect will be invisible in the MZ design but clear in the PGI design.

Data

To test the relationship between extraversion and political participation with these methods, I use data from the Swedish Twin Registry (STR) (Zagai et al., 2019), connected to a number of population register variables. There are measures of trait extraversion from two different surveys conducted by the STR. First, I use a seven-item measure from the Eysenck Personality Questionnaire (EPQ) in the STAGE survey, which was completed in 2005–2006. Second, I use a 16-item measure called Adult Measure of Behavioral Inhibition (AMBI) from the SALTY survey. A reverse coding of the AMBI measure is closely conceptually related to extraversion and has been used to capture extraversion in prior studies of political behavior (Dawes et al., 2014; Oskarsson et al., 2012). It has also been shown to be strongly correlated with extraversion when both are measured (Gladstone & Parker, 2005). The survey was conducted in, 2009–10. Details on the specific questions and how they were coded in both of these questionnaires can be found in the online supporting information. The summary trait extraversion measure is rescaled to 0–1.

As outcomes, I use (1) election turnout and (2) an index of other political activities. For election turnout, I use register-based validated turnout data for the European elections in 2009 and 2019 and the national elections in 2010 and 2018. I will test both the average across all four elections, as well as the separate averages of the European elections and the national elections. The SALTY survey from STR also contains a battery of questions on participation in different types of political activities. The respondent is asked to indicate whether, at some point during the last five years, they have contacted a politician, contacted a public official, participated in a protest, boycotted any goods, donated to any causes, or signed a petition. These six items will be tested both added together (as an index of the proportion of affirmative responses) as well as separated into two subindices of collective versus individual forms of participation. As mentioned in the background section, this distinction has previously been proposed by Mondak and Halperin (2008) and Huber et al. (2021) and distinguishes between forms of participation that require interacting with other individuals versus those who do not. As individual forms of participation, I classify boycotting goods, donating money, and signing a petition. As collective forms of participation, I classify contacting a politician or public official and participating in a protest. While it can be discussed whether contacting a politician is a "collective" form of participation, it does require interaction with someone else, which is the central theoretical dimension relevant for capturing the possible effects of extraversion.[9]

For the PGI analysis, I use a polygenic index of extraversion from the Polygenic Repository Project (Becker et al., 2021), currently the state-of-the-art genetic predictor of extraversion. Since DZ pairs can also be of different sex, the models also include sex as a control to increase statistical precision. To check whether results may be biased by pleiotropic effects, I will also

[9]The partitioning of these items can surely be subject to debate; it should be noted, however, that the results are insensitive to reclassifications of the items (in fact none of the items individually are associated with extraversion, as shown in Table S9 in the online supporting information).

Table 1. Descriptives, MZ Twin Pairs

Variables	*N*	Mean	SD	Min	Max
Birth year	3548	1961	12.98	1943	1985
Sex (female)	3548	0.639	0.480	0	1
Extraversion	3548	0.555	0.215	0	1
Vote	3544	0.832	0.228	0	1
National election vote	3542	0.962	0.161	0	1
EU vote	3542	0.701	0.379	0	1
Participation	1772	0.136	0.187	0	1
Collective participation	1772	0.0852	0.209	0	1
Individual participation	1772	0.188	0.248	0	1

Note: Sample restricted to pairwise complete MZ twin pairs with nonmissing extraversion.

Table 2. Descriptives, DZ Twin Pairs

Variables	*N*	Mean	SD	Min	Max
Birth year	16,884	1969	24.51	1913	2001
Sex (female)	16,884	0.533	0.499	0	1
Extraversion	4606	0.540	0.194	0	1
Vote	16,872	0.776	0.285	0	1
National election vote	16,208	0.932	0.229	0	1
EU vote	16,712	0.627	0.439	0	1
Participation	3374	0.156	0.193	0	1
Collective participation	3374	0.0955	0.212	0	1
Individual participation	3374	0.217	0.263	0	1
PGI extraversion	16,232	−0.0153	0.998	−3.793	4.249

Note: Sample restricted to pairwise complete DZ twin pairs with nonmissing values on either extraversion or any of the outcomes (voting/participation).

report models with controls for a large range of other polygenic indices that may be correlated with the primary index for extraversion: educational attainment, ADHD, chronotype, cognitive performance, depression, drinking, narcissism, neuroticism, risk tolerance, openness to experience, self-rated health, and subjective well-being.[10] Each polygenic index has been standardized to have a mean of 0 and a standard deviation of 1 in the full sample. Tables 1 and 2 contains descriptive statistics for the MZ and DZ samples separately. All analyses are run using Stata 15 (Statacorp, 2017).

Results

I will begin by exploring the results from the discordant twin models. Figure 1 presents these models, compared to naive models (i.e., the same models without the twin-pair fixed effects). Starting with the electoral outcomes, the naive models show that the positive relationship between extraversion and electoral participation is substantively strong and significant in each case. The effect size is stronger for EU elections, corresponding to an increase of more than 11

[10]In each case, the single-trait as opposed to the multitrait indices were used. The expected predictive capacity of the indices, as estimated by Becker et al. (2021, Supplementary Data 1) is as follows: extraversion: 3.88%; educational attainment: 7.27%; adhd: 4.01%; chronotype: 7.76%; cognitive performance: 10.73%; depression: 3.08%; drinking: 2.17%; narcissism: 1.73%; neuroticism: 5.69%; risk tolerance: 2.45%; openness: 1.33%; self-rated health: 5.48%; and subjective well-being: 3.01%.

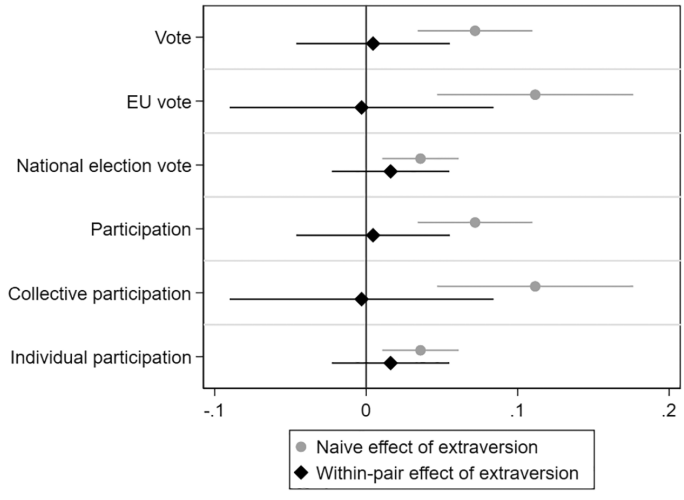

Figure 1. Coefficient plot, discordant MZ twin models; 95% CIs.

percentage points when going from lowest to highest extraversion—a natural consequence of the lower average participation rate and consistent with the so-called law of dispersion (e.g., Tingsten, 1937). A first important result is therefore that relationships found in the previous literature are replicated in this sample.

When adding twin-pair fixed effects (within-pair bars) and thereby partialing out all genetic and shared environmental confounders from this relationship, things look starkly different. Not only are none of the estimates statistically significant, they have also all moved very close to zero. The largest shift is observed for EU elections, where the coefficient even changes sign.

Moving from electoral outcomes to the other participatory measures, we similarly observe significant positive relationships with extraversion in the naive models in each case. The largest coefficient is found for collective participation, which is consistent with the sociability pathway and the findings of Huber et al. (2021). Again, however, when adding twin pair fixed effects, all of these relationships disappear—the coefficients all move substantially toward zero, and none is statistically significant. The largest reduction in the effect size is seen for collective participation.

Going on to the PGI models in Figure 2, we will begin by making sure that the PGI for extraversion does indeed robustly predicts extraversion in our sample, within DZ twin pairs. In the top row, we can see that the within-pair effect of a polygenic index for extraversion on measured extraversion. As discussed in the methods section above, the distribution of alleles between siblings is random, meaning that we are in fact looking at a causal effect of this particular genetic measure on trait extraversion. The effect of the PGI on trait extraversion is statistically robust (significant at the 99% level), and one standard deviation increase in the PGI translates to a 1.8 percentage point increase in trait extraversion, or about 1/10th of a standard deviation. Moving from the bottom to the top of the PGI distribution moves the expected level of extraversion up by just below one standard deviation. We can thus be confident that the PGI does capture some of the causal effect of genes on extraversion.

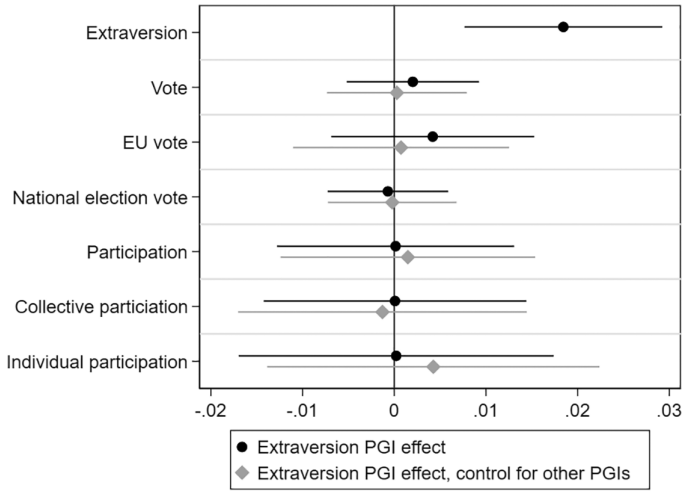

Figure 2. Coefficient plot, PGI models within DZ twin pairs; 95% CIs.

Next, we can see how the extraversion PGI affects the voter-participation variables. As argued in the methods section: If the PGI predicts extraversion, and extraversion causes participation, then within DZ-twin pair differences in the PGI should also to some extent predict participation. In each case, however, the effect size is now very close to zero and neither is statistically significant. Furthermore, to make sure that the extraversion PGI does not simply have a positive effect via extraversion, but a counteracting negative effect via pleiotropic effects, models in grey in Figure 2 also control for a large range of other genetic indices. There are no marked changes in the estimates when these are included.

Moving to the PGI results for the other participation measures, the picture is roughly the same. Again, the estimates of the PGI effect on the participation measures is effectively zero and also not statistically significant. This picture is repeated when including other PGIs as controls. In short, genetic factors that cause extraversion do not appear to be related to any measures of political participation.

Thus, in line with the results from the discordant MZ twin models, there is no evidence from these PGI models that extraversion has a causal impact on any aspect of political participation.

Auxiliary Analyses

Several interpretations of the negative results are possible. Beginning with the discordant MZ twin models, the most pressing issue may be that within-pair differences are going to be smaller than the overall variation in the sample—perhaps even to the point where not enough variation is left to be able to capture an existing causal relationship. Table 3 lays out both the overall and the within-pair standard deviations in the key variables. We can see that there is, as expected, less variation within the twin pairs, but that there is a substantial amount of within-pair variation remaining. Among the MZ twins, about half of the variation is intact, which is consistent with the previous literature consistently finding about 50% heritability and 0% attribution to shared environment (Bouchard & Loehlin, 2001). This worry is thus not borne out by the data. An additional argument in this regard is that problems of insufficient variation would lead to larger standard errors but not systematic depressions of

Table 3. Overall Versus Within-Pair Variation

	MZ	MZ	DZ	DZ
	Overall SD	Within SD	Overall SD	Within SD
Extraversion	.215	.112	.194	.127
Vote	.279	.130	.285	.166
Participation	.186	.105	.193	.126

Note: Standard deviations shown for MZ and DZ samples separately. Within-pair *SD* is calculated by first absorbing twin-pair fixed effects (i.e., subtracting within-pair means).

the effect sizes. However, as we have seen, all effect sizes were moved substantially toward the null.

Another consideration pertains to the negative results from the PGI models. One possibility is that these results are simply due to the method at hand, and that genetic measures are still, in general, simply too noisy to predict political participation. To safeguard against this, the online supporting information contains the full regression tables for the PGI models (Tables S3 and S4 in the online supporting information), with the control PGIs also shown. Several other PGIs do in fact come out significant. For example, the PGIs for educational attainment and subjective well-being successfully predict the voting outcomes. Both subjective well-being (Flavin & Keane, 2012) and especially education (e.g., Ahlskog, 2021; Dawes et al., 2021) are well-established correlates of participation in the existing literature. For the other participation measures, the PGI for chronotype is significant, but interestingly the effect is negative indicating that morning people participate *less* in civic activities, unlike what is reported in previous literature on election turnout (Ksiazkiewicz & Erol, 2022). Since the previously proposed mechanism for chronotype is conscientiousness, this should perhaps not be all that surprising—it seems intuitive that conscientiousness is positively associated with following a voting norm, but negatively associated with nonconventional forms of participation (e.g., protests). Finally, the PGI for ADHD, which has not to my knowledge been investigated in previous literature, also shows an effect.

Evaluating the estimated expected predictive capacity of these indices (as calculated in Becker et al., 2021, Supplementary Data 1) shows that extraversion (at 3.88%) is very close to both ADHD (at 4.09%) and subjective well-being (at 3.01%), but somewhat lower than chronotype (7.76%) and educational attainment (7.27%). That is, unlike the PGI for extraversion, other PGIs of almost identical predictive capacity (i.e., similar levels of noise) evidently have effects on political participation. The lack of results for extraversion is thus not likely to be a consequence of the PGI method itself, or the measure simply being too noisy, but more likely a consequence of the trait in question.

Moreover, Table S10 in the online supporting information shows the correlations between extraversion and the other PGIs, as well as the correlations between the PGIs. The trait measure of extraversion is also correlated with, for example, the PGI for subjective well-being, which might speculatively indicate that naive associations between extraversion and voting are partially driven by a genetic overlap between extraversion and subjective well-being.

A brief final mention of the PGI results for openness in the online supporting information is warranted. Openness to experience is, like extraversion, one of the personality traits that have been suggested to be connected to political participation (e.g., Mondak et al., 2011). The PGI results do not bear that out. It is important to note, however, that the lack

of trait-level data for openness to experience means that a full evaluation of openness is not possible—the null PGI results may be an indicator that openness lacks a causal relationship with participation, but it may also be a consequence of the PGI itself not successfully predicting the trait in this sample.

Discussion

The first thing to note with the results presented in this study is that there is indeed a strong naive relationship between extraversion and all the included measures of political participation. At the descriptive level, the hypothesis is therefore undeniably true: Extraverts participate more in both elections and in other types of civic matters. As far as elections go, the apparent extraversion premium is even larger for second-order elections than it is for first-order elections, and it also appears larger for collective political activities than for individual ditto. In this regard, the results could be added to the list of studies with similar findings.

However, this relationship is more often than not portrayed in causal rather than descriptive terms in the literature—if not explicitly, then implicitly, for example by theorizing different causal pathways between personality traits and participation. On this point, the results from the analyses in this study are more sobering. When familial confounding is removed, the relationship consistently disappears.

As argued in the background section of this article, the possibility that relationships between personality traits and political participation reflect common underlying causes needs to be taken seriously, and the main strength of this study lies in addressing this concern. The two methods used to accomplish this are not, however, without their own sets of problems. Some of these deserve to be critically discussed in the light of the negative results. To begin with, we have already seen that a crucial factor is whether enough variation remains when moving to within-family analyses. Twins are always going to be more similar to each other than two randomly chosen individuals from a population, meaning that the amount of variation is smaller. We have seen that this does not appear to be a likely explanation for the lack of results, given that (1) a substantial amount of variation is still left within the MZ twin pairs, (2) there is enough variation within the DZ twin pairs for the main PGI to exert a clear and significant effect on trait extraversion, and (3) other PGIs than for extraversion are significantly associated with political participation within DZ twin pairs.

A related issue is that the independence assumption is unlikely to hold in within-family analyses. In short, twins will influence each other. If this influence leads to niche formation (i.e., where the twins seek to accentuate their individual differences), effect sizes may be overestimated in within-pair analyses. If, on the other hand, the twins mimic each other, thus becoming even more similar, effect sizes will be underestimated. In this setting, the latter would pose a bigger problem, since null results are consistently found. There is no straight-forward way of safe-guarding against this. In this regard, however, the PGI design is strongly complementary to the discordant MZ twin design, since the PGI was found to predict extraversion even within DZ twin pairs (and furthermore, other PGIs than for extraversion were found to predict political participation).

A remaining possibility is that while extraversion as a whole may not be a causal factor behind political participation, perhaps some of the subfacets of extraversion (activity, assertiveness, excitement seeking, gregariousness, positive emotion, and warmth/kindness) may be.[11] Departing from the model outlined in the theory section, we may expect specifically

[11]Thank you to an anonymous reviewer for this suggestion.

assertiveness or positive emotion to be related to extrinsic motivation to participate via the optimism pathway, if these facets are more likely to be related to overconfidence in the likelihood of being the thumb on the scale. Meanwhile, gregariousness, and perhaps excitement seeking, may be more likely than other subfacets to be related to intrinsic motivation to participate in collective types of political participation via the sociability pathway. In the future, it may therefore be fruitful to further dig into these subfacets rather than trait extraversion itself.

Something should be said about the context of the study. Fatke (2016) and Weinschenk (2017) argue that the effects of personality traits should be expected to differ between countries and contexts, and that they may be zero or even negative in certain places. It could therefore be considered a weakness that the analysis is limited to Swedish respondents. There are, however, arguments to be made that this context is a reasonable most-likely case in several ways. First of all, the analysis found that the naive correlations between extraversion and political participation were fairly strong for all of the types of participation studied. We can therefore be confident that the country falls into the same category as other countries where naive correlations have also been found. Second of all, especially with regard to electoral participation, other participatory barriers are exceptionally low in the Swedish context. Voter registration is automatic, elections are always held on weekends, and mail-in voting is easily accessible. When extrinsic barriers are low, the explanatory space for variation in intrinsic factors like personality should be larger. Additionally, to the extent that extraversion may be empirically negatively correlated with, for example, conscientiousness, this should make effects of extraversion, specifically, more likely. Lastly, Sweden does not have compulsory voting laws. It is not unreasonable to say, therefore, that if effects of extraversion on political participation do not manifest in this context, they may be unlikely to manifest elsewhere too.

From a normative perspective, the results presented in this study can be interpreted in a rather positive light. Generally speaking, equality in participation is regarded as a democratic virtue. To the extent that it is unequal, it can result from factors that are amenable to political intervention or from factors that are not. Though the possible mechanisms through which personality traits like extraversion may affect levels of political participation could conceivably be altered, the trait itself is likely to be fairly stable; additionally, it would probably be considered unethical by many, for a variety of reasons, to fundamentally alter people's personality on a population level for the purposes of socially engineering more equal participation. The fact that we don't appear to observe any causal effects of extraversion is, therefore, comforting, since it is a type of inequality that may be more difficult than other causes of inequality to ameliorate.

The stark differences between estimates obtained from naive models and models that address familial confounding should not, at this point, be surprising, but are actually rather typical. As outlined in the background section, previous studies utilizing similar methods to study other traits and outcomes relevant to political scientists also tend to find substantial effect size reductions—typically associations are at least cut in half, and more often than not disappear completely (e.g., Ahlskog & Brännlund, 2021; Dinesen et al., 2016; Oskarsson et al., 2016; Weinschenk et al., 2021; Weinschenk & Dawes, 2019). While this study has addressed the possibility that the relationship between extraversion and participation may be affected by different types of familial confounding, the take-home message in the light of this growing body of evidence is likely larger than inferences about a single personality trait. The larger conclusion, instead, is to even further underscore that we should be skeptical of explicit or implicit causal interpretations of naive observational estimates.

ACKNOWLEDGMENTS

The author wishes to thank Vetenskapsrådet (201-9-00244) and Riksbankens jubileumsfond (P1-80782:1) for the funding that made this research possible, and also the anonymous reviewers whose comments and suggestions have improved this manuscript considerably. Correspondence concerning this article should be addressed to Rafael Ahlskog, Department of Government, Uppsala University, Statsvetenskapliga institutionen, Box 514, 751 20 Uppsala, Sweden. E-mail: rafael.ahlskog@statsvet.uu.se

REFERENCES

Aaroe, L., Appadurai, V., Hansen, K. M., Schork, A. J., Werge, T., Mors, O., Børglum, A. D., Hougaard, D. M., Nordentoft, M., Mortensen, P. B., Thompson, W. K., Buil, A., Agerbo, E., & Petersen, M. B. (2021). Genetic predictors of educational attainment and intelligence test performance predict voter turnout. *Nature Human Behavior, 5,* 281–291.

Ahlskog, R. (2021). Education and voter turnout revisited: Evidence from a Swedish twin sample with validated turnout data. *Electoral Studies, 69,* 102186.

Ahlskog, R., & Brännlund, A. (2021). Uncovering the source of patrimonial voting: Evidence from Swedish twin pairs. *Political Behavior, 44,* 1681–1702. https://doi.org/10.1007/s11109-020-09669-4

Ahlskog, R., & Oskarsson, S. (2023). Quantifying bias from measurable and unmeasurable confounders across three domains of individual determinants of political preferences. *Political Analysis, 31,* 181–194.

Angrist, J. D., & Pischke, J. S. (2010). The credibility revolution in empirical economics. *Journal of Economic Perspectives, 24*(2), 3–30.

Barban, N., Jansen, R., de Vlaming, R., Vaez, A., Mondemakers, J. J., Tropf, F. C., Shen, X., Wilson, J. F., Chasman, D. I., Nolte, I. M., Tragante, V., van der Laan, S. W., Perry, J. R., Kong, A., BIOS Consortium, Ahluwalia, T. S., Albrecht, E., Yerges-Armstrong, L., Atzmon, G., … Mills, M. C. (2016). Genome-wide analysis identifies 12 loci influencing human reproductive behavior. *Nature Genetics, 48,* 1462–1472.

Barry, B. (1978). *Sociologists, economists, and democracy*. Chicago University Press.

Becker, J., Burik, C. A. P., Goldman, G., Wang, N., Jayashankar, H., Bennett, M., Belsky, D. W., Karlsson Linnér, R., Ahlskog, R., Kleinman, A., Hinds, D. A., 23andMe Research Group, Caspi, A., Corcoran, D. L., Moffitt, T. E., Poulton, R., Sugden, K., Williams, B. S., Harris, K. M., … Okbay, A. (2021). Resource profile and user guide of the Polygenic Index Repository. *Nature Human Behavior, 5,* 1744–1758.

Blais, A. (2000). *To vote or not to vote: The merits and limits of rational choice theory*. University of Pittsburgh Press.

Blais, A., & Labbé St-Vincent, S. (2001). Personality traits, political attitudes and the propensity to vote. *European Journal of Political Research, 50,* 81–91.

Bouchard, T. J., & Loehlin, J. C. (2001). Genes, evolution, and personality. *Behavior Genetics, 31*(3), 243–273.

Brown, D. (1991). *Human universals*. McGraw-Hill.

Caprara, G. V., & Vecchione, M. (2013). Personality approaches to political behavior. In L. Huddy, D. O. Sears, & J. Levy (Eds.), *The Oxford handbook of political psychology*. Oxford University Press.

Cesarini, D., Johannesson, M., & Oskarsson, S. (2014). Pre-birth factors, post-birth factors, and voting: Evidence from Swedish adoption data. *American Political Science Review, 108*(1), 71–87.

Chabris, C. F., Lee, J. J., Cesarini, D., Benjamin, D. J., & Laibson, D. I. (2015). The fourth law of behavior genetics. *Current Directions in Psychological Science, 24*(4), 304–312.

Clark, W. R., & Golder, M. (2015). Big Data, causal inference, and formal theory: Contradictory trends in political science? *PS: Political Science and Politics, 48*(1), 65–70.

Cooper, C. A., Golden, L., & Socha, A. (2013). The Big Five personality factors and mass politics. *Journal of Applied Social Psychology, 43*(1), 68–82.

Dawes, C., Cesarini, D., Fowler, J. H., Johannesson, M., Magnusson, P. K. E., & Oskarsson, S. (2014). The relationship between genes, psychological traits, and political participation. *American Journal of Political Science, 58*(4), 888–903.

Dawes, C. T., Okbay, A., Oskarsson, S., & Rustischini, A. (2021). A polygenic score for educational attainment partially predicts voter turnout. *Proceedings of the National Academy of Sciences of the United States of America, 118*(50), e2022715118.

Denny, K., & Doyle, O. (2008). Political interest, cognitive ability and personality: Determinants of voter turnout in Britain. *British Journal of Political Science, 38,* 291–310.

Dinesen, P. T., Dawes, C. T., Johannesson, M., Klemmensen, R., Magnusson, P., Norgaard, A. S., Peterson, I., & Oskarsson, S. (2016). Estimating the impact of education on political participation: Evidence from monozygotic twins in the United States, Denmark and Sweden. *Political Behavior, 38*(3), 579–601.

Dinesen, P. T., Norgaard, A. S., & Klemmensen, R. (2014). The civic personality: Personality and democratic citizenship. *Political Studies, 62*(S1), 134–152.

Downs, A. (1957). *An economic theory of democracy*. Harper & Row.

Duncan, L. E., Ostacher, M., & Ballon, J. (2019). How genome-wide association studies (GWAS) made traditional candidate gene studies obsolete. *Neuropsychopharmacology, 44,* 1518–1523.

Fatke, M. (2016). Personality traits and political ideology: A first global assessment. *Political Psychology, 38*(5), 881–899.

Flavin, P., & Keane, M. J. (2012). Life satisfaction and political participation: Evidence from the United States. *Journal of Happiness Studies, 13,* 63–78.

Fleeson, W. (2004). Moving personality beyond the person-situation debate: The challenge and the opportunity of within-person variability. *Current Directions in Psychological Science, 13*(2), 83–87.

Fleeson, W., Malanos, A. B., & Achille, N. M. (2002). An intraindividual process approach to the relationship between extraversion and positive affect: Is acting extraverted as 'good' as being extraverted? *Journal of Personality and Social Psychology, 83,* 1409–1422.

Fowler, J. H., Baker, L. A., & Dawes, C. T. (2008). Genetic variation in political participation. *American Political Science Review, 102*(2), 233–248.

Gerber, A. S., Huber, G. A., Doherty, D., & Dowling, C. M. (2011). The big five personality traits in the political arena. *Annual Review of Political Science, 14,* 265–287.

Gladstone, G., & Parker, G. (2005). Measuring a behaviorally inhibited temperament style: Development and initial validation of new self-report measures. *Psychiatry Research, 135*(2), 133–143.

Ha, S. E., Kim, S., & Jo, S. H. (2013). Personality traits and political participation: Evidence from South Korea. *Political Behavior, 34*(4), 511–532.

Hamer, D., & Sirota, L. (2000). Beware the chopsticks gene. *Molecular Psychiatry, 5,* 11–13.

Harsanyi, J. C. (1977). Morality and the theory of rational behavior. *Social Research, 44*(4), 623–656.

Huber, B., Goyanes, M., & Gil de Zúñiga, H. (2021). Linking extraversion to collective and individual forms of political participation: The mediating role of political discussion. *Social Science Quarterly, 102*(4), 1289–1310.

Jang, K. L., Livesley, W. J., & Vemon, P. A. (1996). Heritability of the Big Five personality dimensions and their facets: A twin study. *Journal of Personality, 64*(3), 675–709.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative Big Five trait taxonomy. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research*. The Guilford Press.

Karlsson Linnér, R., Biroli, P., Kong, E., Meddens, S. F. W., Wedow, R., Fontana, M. A., Lebreton, M., Tino, S. P., Abdellaoui, A., Hammerschlag, A. R., Nivard, M. G., Okbay, A., Rietveld, C. A., Timshel, P. N., Trzaskowski, M., Vlaming, R., Zünd, C. L., Bao, Y., Buzdugan, L., … Beauchamp, J. P. (2019). Genome-wide association analyses of risk tolerance and risky behaviors in over 1 million individuals identify hundreds of loci and shared genetic influences. *Nature Genetics, 51,* 245–257.

Klemmensen, R., Hatemi, P. K., Hobolt, S. B., Peterson, I., Skytthe, A., & Norgaard, A. S. (2012). The genetics of political participation, civic duty, and political efficacy across cultures: Denmark and the United States. *Journal of Theoretical Politics, 24*(3), 409–427.

Ksiazkiewicz, A., & Erol, F. (2022). Too tired to vote: A multi-national comparison of election turnout with sleep preferences and behaviors. *Electoral Studies, 78,* 102491.

Lee, J. J., Wedow, R., Okbay, A., Kong, E., Maghzian, O., Zacher, M., Nguyen-Viet, T. A., Bowers, P., Sidorenko, J., Karlsson Linnér, R., Fontana, M. A., Kundu, T., Lee, C., Li, H., Li, R., Royer, R., Timshel, P. N., Walters, R. K., Willoughby, E. A., … Cesarini, D. (2018). Gene discovery and polygenic prediction from a genome-wide association study of educational attainment in 1.1 million individuals. *Nature Genetics, 50,* 1112–1121.

Lindell, M., & Strandberg, S. (2018). A participatory personality? Examining the influence of personality traits on political participation. *Scandinavian Political Studies, 41*(3), 239–262.

Margolis, S., & Lyobomirsky, S. (2020). Experimental manipulation of extraverted and introverted behavior and its effects on well-being. *Journal of Experimental Psychology, 149*(4), 719–731.

Marshall, G. N., Wortman, C. B., Kusulas, J. W., Hervig, L. K., & Vickers, R. R., Jr. (1992). Distinguishing optimism from pessimism: Relations to fundamental dimensions of mood and personality. *Journal of Personality and Social Psychology, 62*(6), 1067–1074.

Mattila, M., Wass, H., Söderlund, P., Fredriksson, S., Fadjukoff, P., & Kokko, L. (2011). Personality and turnout: Results from the Finnish longitudinal studies. *Scandinavian Political Studies, 34*(4), 287–306.

McCrae, R. R., & Costa, P. T., Jr. (2003). *Personality in adulthood: A five-factor theory perspective*. Guilford Press.

McCrae, R. R., & Costa, P. T., Jr. (2008). The five-factor theory of personality. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research*. The Guilford Press.

Meddens, F., de Vlaming, R., Bowers, P., Burik, C. A. P., Karlsson Linnér, R., Lee, C., Okbay, A., Turley, P., Rietveld, C. A., Fontana, M. A., Ghanbari, M., Imamura, F., McMahon, G., van der Most, P. J., Voortman, T., Wade, K. H., Anderson, E. L., Braun, K. V. E., Emmett, P. M., … Koellinger, P. D. (2021). Genomic analysis of diet composition finds novel loci and associations with health and lifestyle. *Molecular Psychiatry, 26,* 2056–2069.

Mondak, J. J., & Halperin, K. D. (2008). A framework for the study of personality and political behavior. *British Journal of Political Science, 38*(2), 335–362.

Mondak, J. J., Hibbing, M. V., Canache, D., Seligson, M. A., & Anderson, M. R. (2011). Personality and civic engagement: An integrative framework for the study of trait effects on political behavior. *American Political Science Review, 104*(1), 85–110.

Oskarsson, S., Ahlskog, R., Dawes, C. T., & Lindgren, K. O. (2022). Persistent inequalities: The origins of intergenerational associations in voter turnout. *Journal of Politics, 84*(3), 1337-1352.

Oskarsson, S., Dawes, C. T., Johannesson, M., & Magnusson, P. K. E. (2012). The genetic origins of the relationship between psychological traits and social trust. *Twin Research and Human Genetics, 15*(1), 21–33.

Oskarsson, S., Thisted Dinesen, P., Dawes, C. T., Johannesson, M., & Magnusson, P. K. E. (2016). Education and social trust: Testing a causal hypothesis using the discordant twin design. *Political Psychology, 38*(3), 515–531.

Price, A. L., Patterson, N. J., Plenge, R. M., Weinblatt, M. E., Shadick, N. A., & Reich, D. (2006). Principal components analysis corrects for stratification in genome-wide association studies. *Nature Genetics, 38,* 500–501.

Riker, W. H., & Ordeshook, P. C. (1968). A theory of the calculus of voting. *The American Political Science Review, 61*(1), 25–42.

Robinson, D. (2020). Education, family background, and political knowledge: A test of the compensation hypothesis with identical twins. *Political Studies, 68*(2), 350–369.

Stapleton, C., Oliver, J., & Wolak, J. (2021). The political consequences of an optimistic personality. *Political Behavior*. https://doi.org/10.1007/s11109-021-09717-7

Statacorp. (2017). *Stata (version 15).* [Computer software].

Tingsten, H. (1937). *Political behavior: Studies in election statistics*. P.S. King & Son Ltd.

Uhlaner, C. J. (1989). Relational goods' and participation: Incorporating sociability into a theory of rational action. *Public Choice, 62,* 253–285.

Vecchione, M., & Caprara, G. V. (2009). Personality determinants of political participation: The contribution of traits and self-efficacy beliefs. *Personality and Individual Differences, 46*(4), 487–492.

Vitaro, F., Brendgen, M., & Arseneault, L. (2009). The discordant MZ-twin method: One step closer to the holy grail of causality. *International Journal of Behavioral Development, 33*(4), 376–382.

Vitriol, J. A., Larsen, E. G., & Ludeke, S. G. (2019). The generalizability of personality effects in politics. *European Journal of Personality, 33*(6), 631–641.

Weinschenk, A. (2017). Big Five personality traits, political participation, and civic engagement: Evidence from 24 countries. *Social Science Quarterly, 98*(5), 1406–1421.

Weinschenk, A., & Dawes, C. T. (2019). The effect of education on political knowledge: Evidence from monozygotic twins. *American Politics Research, 47*(3), 530–548.

Weinschenk, A., Dawes, C. T., Kandler, C., Bell, E., & Riemann, R. (2019). New evidence on the link between genes, psychological traits, and political engagement. *Politics and the Life Sciences, 38*(1), 1–13.

Weinschenk, A., Dawes, C. T., Klemmensen, R., & Rasmussen, S. H. R. (2022). Genes, personality and political behavior: A replication and extension using Danish twins. *Politics and the Life Sciences, 40*(1), 4–16.

Weinschenk, A., Dawes, C. T., Oskarsson, S., Klemmensen, R., & Norgaard, A. S. (2021). The relationship between political attitudes and political participation. *Electoral Studies, 69,* 102269.

Williams, D. G. (1992). Dispositional optimism, neuroticism and extraversion. *Personality and Individual Differences, 13*(4), 475–477.

Zagai, U., Lichtenstein, P., Pedersen, N. L., & Magnusson, P. K. E. (2019). The Swedish twin registry: Content and management as a research infrastructure. *Twin Research and Human Genetics, 22*(6), 672–680.

Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Table S1. MZ Models, Voting
Table S2. MZ Models, Participation
Table S3. PGI Results, Voting
Table S4. PGI Results, Participation
Table S5. PGI Results, Voting—Matched Samples
Table S6. PGI Results, participation—Matched Samples
Table S7. PGI Models for Voting, Control for Trait Extraversion
Table S8. PGI Models for Participation, Control for Trait Extraversion
Table S9. MZ Models, Participation Items
Table S10. Pairwise Correlations, PGIs