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Genes, psychological traits and civic engagement

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Civic engagement is a classic example of a collective action problem: while civic participation improves life in the community as a whole, it is individually costly and thus there is an incentive to free ride on the actions of others. Yet, we observe significant inter-individual variation in the degree to which people are in fact civically engaged. Early accounts reconciling the theoretical prediction with empirical reality focused either on variation in individuals' material resources or their attitudes, but recent work has turned to genetic differences between individuals. We show an underlying genetic contribution to an index of civic engagement (0.41), as well as for the individual acts of engagement of volunteering for community or public service activities (0.33), regularly contributing to charitable causes (0.28) and voting in elections (0.27). There are closer genetic relationships between donating and the other two activities; volunteering and voting are not genetically correlated. Further, we show that most of the correlation between civic engagement and both positive emotionality and verbal IQ can be attributed to genes that affect both traits. These results enrich our understanding of the way in which genetic variation may influence the wide range of collective action problems that individuals face in modern community life.

1. Introduction

The concept of civic engagement encompasses a wide variety of cooperative behaviours that are theoretically related to one another but also present unique hurdles to collective action. While civic participation improves life in the community as a whole, it is individually costly and thus there is an incentive to free ride on the actions of others (for a review of evolutionary models supporting this idea, see [1]). Far and away the most studied facet of civic engagement is the act of voting, a classic example of a collective action problem. Political scientists have long studied the act of voting through an instrumental framework, emphasizing how variation in costs and benefits to individual voters affects participation rates. Downs [2] first posited a pure rational choice equation for the vote decision, where a person votes if the benefits from one's preferred candidate winning, weighted by the probability that the individual is making the decisive vote, is greater than the cost of voting. However, an obvious paradox exists in this model—and in models of civic engagement more broadly—in that if it were true, no one would ever vote: the probability of being the decisive voter is so low that the benefit becomes infinitesimally small and any cost is enough to override the calculated benefits. Yet, despite this theoretical expectation, we observe that millions of individuals are in fact civically engaged. This contrast between our theoretical expectations and the empirical reality has generated decades of scholarship seeking to disentangle the sources of inter-individual variation in participation.

Voting has been found to be strongly related to other forms of political participation, and typically, scholars have combined these participatory behaviours into additive indices, given the high correlations between them. Some

of the classic work in the field has studied typologies of participation, seeking to understand how various acts of participation are related to each other. For example, Verba & Nie [3] examine the degree to which participation entails conflict and the amount of initiative required, as well as the scope of the outcome of different modes of participation. Verba *et al.* [4] examine the resource factors that affect participation, finding that while a resources model works well for explaining an index of participation, the summary measure masks significant differences among different political acts. However, despite this insight, scholars typically group together various participatory acts to form overall participation scores.

In the efforts to understand what factors beyond a cost–benefit analysis impact participatory decisions, scholars have looked to other explanations, including civic duty, satisfaction from voting, desire to affirm one’s partisanship or efficacy, socialization and social norms. Most recently, the literature has turned towards studying the cognitive and personality factors that contribute towards participation, and the genetic factors underlying those traits. In the past 10 years, there have been several studies examining the contribution of genetics to political participation broadly construed [5–7].

The literature—both the classic research on participation and the newer genopolitics literature—has thus far emphasized political acts of civic behaviour. Establishing underlying genetic contributions to such behaviour broadly measured is an important first step, but previous work has rarely considered the genetic foundations of other types of collective behaviour beyond politics, behaviours that are considered to be significantly costlier, and thus more difficult to explain. While related to voting in the extent to which people often have incentives to free ride on the actions of others, other collective actions in the civic sphere, such as donating time and money to community causes, are conceptually distinct. Scholars thus debate the extent to which these other important civic behaviours can be explained by the same factors that predict whether an individual votes. Not all civic behaviours are created equally, from a collective action standpoint. For example, voting is discrete and infrequent, with fewer opportunities for engagement. It is inherently conflictual and zero sum. Volunteering, by comparison, is a behaviour that is costly in time but for which there are ubiquitous opportunities for engagement. Furthermore, most other political science studies of civic participation have only included *political* volunteering and donating in their index measures of participation, instead of considering those behaviours more broadly. Accordingly, while previous studies have included these (or similar) actions as part of a single index [4,8], there is good reason to believe that they represent different types of participation, and should be analysed separately.

This article seeks to explore the relationship between three important civic behaviours—voting, volunteering and charitable giving—using a uniquely assembled and comprehensive genetically informative dataset with information on personality and cognitive ability. We build on the extant literature in two ways. First, we assess the shared genetic relationships between different types of civically minded behaviours, arguing that there are theoretical reasons to expect some forms of civic behaviour to be more closely related to each other. Second, based on the patterns of shared genetic contributions and expectations about the

discrete psychological motivations for these behaviours, we explore a set of potential mediating psychological traits.

To preview our results, we find that there is an underlying genetic contribution to the extent to which someone is civically engaged, as well as for the individual acts of engagement, such as volunteering for community or public service activities, regularly contributing to charitable causes, and voting in national or state elections. While there are shared sources of genetic variation overall between the different forms of civic engagement, there are closer genetic relationships between donating and the other two activities, compared to the relationship between volunteering and voting. While positive emotionality is genetically related to all the measures of engagement, cognitive ability, measured by verbal IQ, is related only to voting and an overall measure of engagement. Our findings have two important implications for our understanding of collective action. First, we demonstrate that acts of civic, not just political, engagement are heritable. Second, we demonstrate that the personality traits underlying civic engagement *vary* based on the type of activity. Understanding a variety of forms of civic engagement thus asks us to appreciate the differences between these activities as much as their commonalities.

2. Theoretical and empirical evidence

As a field, behaviour genetics represents an impressive collection of findings on the influence of genetic variation on a large range of behaviours, including: altruism [9], entrepreneurship [10], financial risk taking [9,11], impulsivity [12], intelligence [13,14], leadership [15–17], non-rational decision-making [18], smoking addiction [19], socioeconomic status [20] and trust [21]. Indeed, so widespread are findings of heritable behaviour that one scholar has coined the ‘first law’ of behaviour genetics: ‘All human behavioural traits are heritable’ [22].

While the field of political science was a relative late comer in its application of behavioural genetic techniques, scholars have made substantial progress in the last decade. Several recent reviews of the genetics of politics provide an overview of the scope and findings within the field [23–26]. The earliest work studying the genetic foundations of political participation focused on index measures of participatory acts, emphasizing the act of voting. Fowler *et al.* [5] found that about half of the variation in turnout over six California primary and general elections could be attributed to genetic factors. Subsequent studies based on European and American samples have examined an even wider variety of non-voting acts of political participation, such as contributing time and money to a political party or candidate, contacting officials regarding issues of concern, running for public office and attending rallies or marches [6,7]. These studies find that between 36 and 60% of the variation in overall participation could be attributed to genetic factors [5–7].

Key questions remain, however, about non-political acts of civic engagement, such as donating time and money to community endeavours. The burgeoning civic engagement literature suggests that many of the same factors that can explain political participation—such as personality factors, parental and peer socialization, the acquisition of financial and cognitive resources, and mobilization by elites and social connections, for example—might also explain

non-political civic behaviour. But these activities also differ in essential ways, such that it is important to make clear distinctions between various forms of political and non-political engagement [27].

Such a reconceptualization seems especially important when assessing political and non-political civic engagement in a collective action framework, as five important properties of voting set it apart from other forms of civic engagement. First, the temporal nature of voting differs from volunteering for a charitable cause. Voting is a discrete and infrequent act. The opportunity to vote is constrained by set election dates¹ and the number of times an individual can vote is obviously limited. Accordingly, the ability to develop either a norm or a habit of voting is limited [29]. Likewise, the ability to learn the details of how and when to vote is also limited. By contrast, donating time or money can happen at any time and can be done multiple times a year, as citizens are often presented with regular opportunities for these forms of civic engagement.

Second, these acts vary in their material costs. While the material requirements of voting and volunteering are low, donating money obviously requires some baseline level of financial resource. From the perspective of opportunity costs, sustained volunteer engagement is much more costly than either voting or donating money [30]. Third, these acts vary in their cognitive costs. Voting requires specialized knowledge about where, when and for whom to vote. The infrequency of elections compounds this problem. By contrast, while volunteering and giving money can sometimes involve planning and deliberation over which particular acts best fit an individual's own charitable objectives [31], it is also the case that individuals are regularly solicited to donate both time and money.

Fourth, these acts differ both in the social pressure and the social benefits associated with them, including shame from non-participation and the social esteem rewarded for participation. Voting and donating money are often largely solitary and private acts, and are thus more inured both from social pressure and reward. By contrast, volunteering often occurs alongside others and is thus more likely to produce social rewards and deeper social connections [30].

Finally, elections are an inherently conflictual and zero-sum affair. Casting a vote often means both entering a heated debate and expressing views that set you apart from a large part of your community. Substantial parts of the population are conflict averse, and may thus select out of this form of engagement [32]. In sum, if voting is substantially different from other forms of civic engagement—like donating time and money—then it may rely on different personality traits and the different genetic factors which underly them. In the next two sections, we first describe the individual differences we measure and then articulate how variations in these traits may differentially affect several types of civic engagement.

3. Sample and measures

The dataset used for this analysis is based on a study actively being conducted by the Minnesota Center for Twin and Family Research (MCTFR). The Minnesota Twin Family Study (MTFS) is a population-based, longitudinal study of 1197 monozygotic (MZ) and 684 dizygotic (DZ) like-sex

twin pairs born between 1972 and 1984 and their parents [33]. Data were collected on these twins and their parents at an initial assessment as well as at follow-ups for the twins occurring at roughly three-year intervals. The MTFS comprises two age cohorts, one in which subjects were 11 years old at the time of their initial assessment and the other in which subjects were 17 years old. Participants in the study have been shown to be comparable to the overall Minnesota population.²

The MTFS has longitudinally collected detailed measures of cognitive ability and personality traits for participants. As part of the study, subjects completed the 198-question Multi-dimensional Personality Questionnaire (MPQ) [34]. There are three higher factors in the MPQ: *positive emotionality* reflects the tendency to be actively and pleurably engaged with one's social and work environments; *negative emotionality* is characterized by perceptions of the world as threatening, problematic and distressing; and *constraint* is primarily marked by self-restrictive caution, safety-consciousness and conventionality [35]. The three higher factors of the MPQ are strongly related to personality traits as measured by the popular five factor model of personality [36]. Positive emotionality is related to extraversion, negative emotionality is similar to emotional stability, and constraint is related to conscientiousness [35].

Subjects also completed an abbreviated version of the Wechsler Adult Intelligence Scale-Revised (WAIS-R). The WAIS is a widely used and validated test of intelligence [37]. The IQ measures we use are based on two subtests designed to measure verbal comprehension (information and vocabulary) and two designed to capture perceptual reasoning (block design and picture arrangement). The former two subtests are used to construct a measure of verbal IQ and the latter for performance IQ. All four subtests are combined to construct a score associated with overall (full scale) IQ.³

At age 29, subjects were asked to provide information about the extent to which they agreed with statements concerning their civic engagement. The statements were: 'I volunteer my time for community or public service activities'; 'I regularly contribute to charitable causes'; and 'I vote in national or state elections'. Participants could respond that they found each statement 'Not at All True', 'Not Very True', 'Pretty True', or 'Very True'; we coded responses from 1 to 4, with 'Not at All True' assigned the value of 1 and 'Very True' assigned the value of 4. Figure 1 displays the frequency of responses within our sample for each question. There is considerable variation in each mode of civic engagement, however, each displaying somewhat different patterns. Only 25.78% of individuals report volunteering their time (responding 'Pretty True' or 'Very True'), 40.11% contribute to charitable causes, and 81.40% vote regularly. These differences reflect the distinctions discussed in the previous section.

We conducted a principal components analysis of responses to these three survey questions. All three questions were loaded onto a single dimension and our overall measure of civic engagement is the first principal component.⁴ Figure 2 displays the distribution of our measure of overall civic engagement.

To study the relationship between personality and cognitive ability respectively and civic engagement, we analysed measures of the MPQ and WAIS-R elicited at approximately

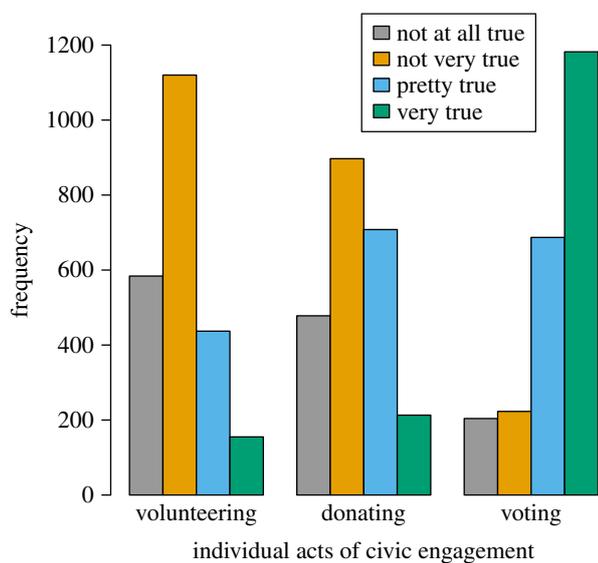


Figure 1. The extent to which respondents agreed with statements concerning their civic engagement. The statements were: 'I volunteer my time for community or public service activities'; 'I regularly contribute to charitable causes' and, 'I vote in national or state elections'. (Online version in colour.)

age 29 and 17, respectively, for all subjects. Table 1 includes summary statistics for each of these variables broken out by zygosity.

4. Hypotheses

A necessary step in the continuing theoretical evolution of the concept of civic engagement lies in identifying both its antecedents as well as predispositions known to influence participation, such as interest in politics, civic duty, political efficacy and political knowledge. Importantly, many of these antecedents have been demonstrated to have a genetic basis [6,7,39,40]. Based on how these previous findings might differentially affect various forms of engagement according to the typology developed above, we have several expectations regarding the genetic basis of the behaviours we study. First, we expect at least some of the variation in each form to be attributed to genetic factors. Second, we expect there to be both genetic and environmental correlation between each form. However, based on the greater conceptual similarity between donating and volunteering we outlined above, we expect a stronger genetic and environmental correlation between those two behaviours than with either of those behaviours and voting. We also expect to see genetic variation in our overall measure of civic engagement.

Examining how predispositions relate to the properties of various forms of civic engagement, we also expect the behaviours to be differentially related both to personality factors—in this instance, positive emotionality, negative emotionality and constraint—as well individual difference in cognitive ability. First, given the social benefits of volunteering and the comparatively private nature of voting and donating money, we expect positive emotionality to be more strongly correlated with volunteering than with the other two behaviours.⁵

Second, owing to the more contentious nature of voting, we expect there to be a greater correlation between voting and negative emotionality. Given the conceptual similarity

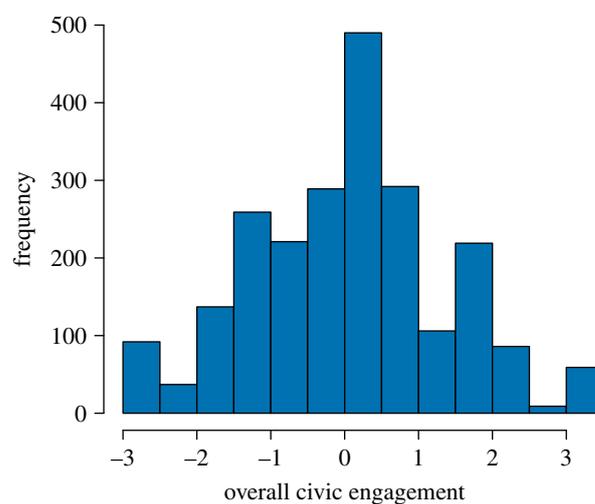


Figure 2. The overall measure of civic engagement based on the first dimension factor loadings from a principal components analysis of responses to these three survey questions. (Online version in colour.)

of constraint and conscientiousness [35], we do not forward a strong hypothesis on the relationship between constraint and any individual participatory act. As noted by Gerber *et al.* [41], conscientiousness can be associated with both norm compliance and a focus on instrumental benefits. Accordingly, greater constraint may predict both greater voting (where senses of duty and norm compliance are central [43]) and greater volunteering (where instrumental social benefits are higher).⁶ Likewise, there is growing empirical evidence that cognitive ability is related to political participation [4,45–47]. Thus, given the greater cognitive requirements of voting, we expect measures of genetic variation in cognitive ability to be most strongly related to voting.

Our theoretical development of the constituent components of various acts of civic engagement, combined with findings from behavioural genetics that personality traits and cognitive ability are heritable [48] and recent work establishing the heritability of political participation and predispositions [5,6,49], suggest that genetic factors may be related to political participation indirectly through psychological traits. The exact nature of this relationship has not been fully understood, though Verhulst and colleagues find that the phenotypic variables they study explain much more of the additive genetic variance than they do of the environmental variance in a composite index of political attitudes, further supporting the idea of a shared genetic relationship between predispositions and participation [49–51]. Our work will add to this understanding by broadening the participatory behaviours under study to more fully encompass the variety of ways in which a person could be civically engaged.

5. Biometric modelling

The analysis proceeds in two steps.⁷ In the first step, we employ a univariate twin model to estimate how much of the variation in our overall measure of civic engagement, as well as the individual acts, can be attributed to genetic and environmental factors.⁸ This approach cannot tell us which genes contribute to a particular behaviour or the mechanism by which genes and the environment interact to produce

Table 1. Summary statistics for MZ and DZ twins. *N* male and *N* female represent the number of complete male and female twin pairs with non-missing data for all three measures of civic engagement.

	MZ				DZ			
	mean	s.d.	<i>N</i> male	<i>N</i> female	mean	s.d.	<i>N</i> male	<i>N</i> female
civic engagement	0.04	1.29	352	387	−0.06	1.31	183	226
volunteering	2.09	0.85	352	387	2.04	0.84	183	226
donating	2.31	0.89	352	387	2.24	0.90	183	226
voting	3.24	0.93	352	387	3.23	0.99	183	226
verbal IQ	96.38	13.88	312	365	96.38	13.31	162	207
performance IQ	106.94	17.27	289	342	106.88	17.03	158	182
full IQ	100.97	14.56	289	342	100.90	13.77	158	182
positive emotionality	122.83	12.96	342	368	123.00	13.32	176	221
negative emotionality	78.97	13.30	342	368	79.49	13.81	176	221
constraint	143.96	15.13	342	368	143.01	16.21	176	221
age	29.45	0.67	352	387	29.35	0.67	183	226
male	0.48	0.50	352	387	0.45	0.50	183	226

participatory behaviours, but it is useful for testing the existence of a genetic basis and establishing the relative importance of the environment for a specific behavioural outcome. Thus, the results from this model will provide bounds on the extent to which the underlying variation in participatory behaviour, as well as each act separately, can be attributed to genetic and environmental factors.⁹

In the second step, using multivariate twin models, we estimate how much of the covariation between individual acts of civic engagement, as well as the covariation between civic engagement and psychological traits, can be attributed to the same genetic source. Genetic correlation quantifies the degree to which the genetic endowment of two traits covary.¹⁰ A correlation of 0 means that the two traits are influenced by completely different genes and a correlation of 1 means the same genes influence both traits.¹¹ For an excellent primer of univariate and multivariate biometric modelling written for social scientists, see Medland & Hatemi [53].

6. Results

The univariate estimates of heritability, common environment and unique environment are shown in table 2. The heritability estimates for all three of the acts of civic engagement are significantly different from zero at the 5% level (95% confidence intervals are provided in table 2) and range between 0.27 and 0.33. The point estimates for common environment are at or near zero for both volunteering and donating to a charity. The common environment estimate for voting is 0.16; however, it is not significantly different from zero at the 5% level. Finally, the univariate results suggest that unique environmental factors account for the largest amount of the variation in volunteering, donating to charity and voting.

We next estimate a multivariate Cholesky ACE model to establish the amount of genetic and environmental correlation between each of the three participatory behaviours.

Table 3 presents the genetic and environmental correlations between each behaviour. The genetic correlations are quite high between donating and volunteering (0.91) and donating and voting (0.53), suggesting significant, at the 5% level, shared genetic origins for these pairs of behaviours. Conversely, the genetic correlation between voting and volunteering is low (0.13) and not significantly different from zero at the 5% level, suggesting that the observed phenotypic correlations between these two behaviours do not stem from genetic factors.

As an additional step, we quantify the amount of the covariation between acts of civic engagement and psychological traits that can be attributed to a common genetic source. Table 4 presents the correlations between each trait and MPQ higher factor personality traits as well as the WAIS measures of cognitive ability. All but one of the correlations are significant at the 5% level (the correlation between performance IQ and donating is not), however they range in magnitude from 0.03 to 0.27 in absolute terms. The correlations between positive emotionality and all three acts of civic engagement are moderate in magnitude, ranging from 0.19 to 0.27, whereas the correlations for negative emotionality and constraint are 0.15 or smaller in absolute terms. As for the measures of verbal and performance IQ, the largest correlation, 0.23, is between voting and verbal IQ and the rest are 0.14 or smaller. The strongest correlations with the overall index of civic engagement, in terms of magnitude, are positive emotionality (0.33) and verbal IQ (0.18). Since without very large samples the ability to decompose the covariation between two traits using the Cholesky model is hampered when the traits are weakly correlated [54], we restrict our bivariate analysis to positive emotionality and the three acts of civic engagement as well as voting and verbal IQ.

The genetic and environmental correlations for the three acts of civic engagement as well as the overall index are presented in table 5. The genetic correlations between positive emotionality and both volunteering and donating to a charity

Table 2. Heritability estimates for psychological and political traits. Parameter estimates and 95% confidence intervals in parentheses are shown for a univariate ACE model. Age and gender are included in the models as control variables. *N* male and *N* female represent the number of complete male and female twin pairs with non-missing data for all three measures of civic engagement.

	heritability	common environment	unique environment	MZ		DZ	
				<i>N</i> male	<i>N</i> female	<i>N</i> male	<i>N</i> female
civic engagement	0.41 (0.23, 0.47)	0.00 (0.00, 0.16)	0.59 (0.54, 0.65)	352	387	183	226
volunteering	0.33 (0.11, 0.38)	0.00 (0.00, 0.19)	0.67 (0.62, 0.74)	352	387	183	226
donating	0.28 (0.13, 0.35)	0.00 (0.00, 0.13)	0.72 (0.65, 0.78)	352	387	183	226
voting	0.27 (0.08, 0.47)	0.16 (0.00, 0.32)	0.57 (0.52, 0.63)	352	387	183	226
verbal IQ	0.52 (0.39, 0.66)	0.30 (0.16, 0.42)	0.18 (0.16, 0.20)	312	365	162	207
performance IQ	0.57 (0.38, 0.67)	0.06 (0.00, 0.23)	0.38 (0.33, 0.42)	289	342	158	182
full IQ	0.58 (0.44, 0.74)	0.23 (0.07, 0.36)	0.20 (0.17, 0.22)	289	342	158	182
positive emotionality	0.49 (0.39, 0.54)	0.00 (0.00, 0.08)	0.51 (0.46, 0.57)	342	368	176	221
negative emotionality	0.43 (0.27, 0.48)	0.00 (0.00, 0.14)	0.57 (0.52, 0.63)	342	368	176	221
constraint	0.49 (0.39, 0.54)	0.00 (0.00, 0.07)	0.51 (0.46, 0.57)	342	368	176	221

are significant and large in magnitude. While not significant at conventional levels, the genetic correlation between positive emotionality and voting is very similar to that for the other two acts of civic engagement. The genetic correlation between verbal IQ and voting is also significant. All of these results are evidence of genetic overlap for the index of civic engagement and positive emotionality. Further, they suggest that most of the correlations between these traits reported in table 4 are due to common genetic factors.

7. Discussion

These results have important implications for our understanding of the relationship between various forms of civic behaviour. There are many previous findings between the psychological traits studied in this paper and civic participation [4,41,42,45–47,55–60], and our findings give credence to the idea that the correlations in these behaviours have genetic origins. However, fully disentangling the nature of the genetic relationship between the traits and the behaviours is a complicated endeavour. While most assume that personality and cognitive ability precede civic engagement, implying that genes exert an indirect influence on civic engagement via psychological traits, a plausible alternative story is that if the same set of genes influence psychological traits and civic engagement separately, then the observed relationship between the two may be at least in part confounded by genetic factors [49–51].

Our univariate results suggest that there is an underlying genetic contribution to the extent to which someone is civically engaged (0.41), as well as for the individual acts of engagement, such as volunteering for community or public service activities (0.33), regularly contributing to charitable causes (0.28) and voting in national or state elections (0.27). The range of these heritability estimates is consistent with previous work. However,

while there are shared sources of genetic variation overall between the different forms, it appears that there are closer genetic relationships between donating and the other two activities. Volunteering and voting are not genetically correlated. As we noted, this is to be expected, as these activities are distinct from one another across several properties, including frequency, cognitive requirements, social esteem and contention.

Our bivariate results for civic engagement further explore the nature of the relationship between cognitive and personality traits. Genetic factors account for 57–71% of the correlation between positive emotionality and the three acts of participation we examined as well as the overall measure of civic engagement, a figure similar to a recent studies [7]. While positive emotionality is genetically related to all the measures of engagement, cognitive ability, measured by verbal IQ, is related only to voting and the overall measure of engagement. Again, this is consistent with our understanding of which traits are most necessary to differentially motivate civic behaviour. Cognitive ability is more likely to be relevant for collective action behaviours that require specialized knowledge and intentional planning [61].

These results thus present evidence that a large portion of the relationship between psychological traits and political participation can be explained by *the same set of genes*. In this light, we view the work presented here as an important step in a research agenda aimed at better understanding the role that variation in genetic endowments for personality, skills, traits and preferences plays in generating heritable variation in civic engagement.¹² Mondak [55] suggests that a significant genetic correlation should be interpreted as evidence of mediation, but because the Cholesky model cannot establish mediation, instead our estimates should be interpreted as an upper bound on the proportion of the heritable variation in civic traits that *may* be mediated by the psychological traits we study.

Table 3. Genetic (r_g) and environmental correlation (r_c and r_e) and 95% confidence intervals from multivariate Cholesky ACE models of volunteering, donating, and voting. Age and gender are included in the models as control variables. Overall phenotypic correlations are also provided (r_p). Analysis is based on 739 MZ (352 male and 387 female) and 409 DZ (183 male and 226 female) complete twin pairs.

	volunteering						voting					
	r_g	r_c	r_e	r_p	r_g	r_c	r_e	r_p	r_g	r_c	r_e	r_p
donating	0.91 (0.76, 1.00)	-1.00 (-1.00, 1.00)	0.39 (0.34, 0.45)	0.53 (0.50, 0.56)	0.53 (0.13, 0.87)	-1.00 (-1.00, 1.00)	0.17 (0.10, 0.23)	0.26 (0.22, 0.29)				
voting	0.13 (-0.34, 0.60)	1.00 (0.77, 1.00)	0.13 (0.06, 0.20)	0.19 (0.15, 0.23)	—	—	—	—				

Table 4. Relationship between civic traits and psychological traits. Correlation coefficients and 95% confidence intervals in parentheses are shown. N male and N female represent the number of complete male and female twin pairs with non-missing data for all three measures of civic engagement.

	volunteering			donating			voting			MZ		DZ	
										N male	N female	N male	N female
verbal IQ	0.07 (0.03, 0.12)	0.14 (0.10, 0.19)	0.23 (0.19, 0.27)	0.18 (0.14, 0.22)	0.18 (0.14, 0.22)	0.18 (0.14, 0.22)	0.18 (0.14, 0.22)	0.18 (0.14, 0.22)	0.18 (0.14, 0.22)	312	365	162	207
performance IQ	0.05 (0.01, 0.09)	0.03 (-0.02, 0.07)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	0.06 (0.01, 0.10)	289	342	158	182
full IQ	0.07 (0.03, 0.11)	0.11 (0.06, 0.14)	0.17 (0.13, 0.21)	0.14 (0.10, 0.18)	0.14 (0.10, 0.18)	0.14 (0.10, 0.18)	0.14 (0.10, 0.18)	0.14 (0.10, 0.18)	0.14 (0.10, 0.18)	289	342	158	182
positive emotionality	0.27 (0.23, 0.31)	0.26 (0.22, 0.30)	0.19 (0.15, 0.23)	0.33 (0.29, 0.36)	0.33 (0.29, 0.36)	0.33 (0.29, 0.36)	0.33 (0.29, 0.36)	0.33 (0.29, 0.36)	0.33 (0.29, 0.36)	342	368	176	221
negative emotionality	-0.09 (-0.13, -0.05)	-0.08 (-0.12, -0.04)	-0.15 (-0.19, -0.11)	-0.13 (-0.17, -0.09)	-0.13 (-0.17, -0.09)	-0.13 (-0.17, -0.09)	-0.13 (-0.17, -0.09)	-0.13 (-0.17, -0.09)	-0.13 (-0.17, -0.09)	342	368	176	221
constraint	0.08 (0.04, 0.13)	0.15 (0.11, 0.19)	0.05 (0.01, 0.09)	0.14 (0.09, 0.18)	0.14 (0.09, 0.18)	0.14 (0.09, 0.18)	0.14 (0.09, 0.18)	0.14 (0.09, 0.18)	0.14 (0.09, 0.18)	342	368	176	221

Table 5. Top panel: genetic and environmental correlation and 95% confidence intervals from a bivariate Cholesky ACE model of verbal IQ and positive emotionality with volunteering, donating to charity, voting and the civic engagement index. Bottom panel: percentage of total correlation due to genetic and environmental correlation and 95% confidence intervals from a bivariate Cholesky ACE model of verbal IQ and positive emotionality with volunteering, donating to charity, voting, and the civic engagement index. Age and gender are included in the models as control variables. Analysis of verbal IQ is based on 677 MZ (312 male and 365 female) and 369 DZ (162 male and 207 female) complete twin pairs. Analysis of positive emotionality is based on 710 MZ (342 male and 368 female) and 397 DZ (176 male and 221 female) complete twin pairs.

	verbal IQ			positive emotionality		
	r_g	r_c	r_e	r_g	r_c	r_e
civic engagement	0.39 (0.14, 0.67)	-1.00 (-1.00, 1.00)	0.05 (-0.02, 0.13)	0.53 (0.38, 0.69)	0.78 (-1.00, 1.00)	0.18 (0.12, 0.25)
volunteering				0.49 (0.28, 0.71)	0.97 (-1.00, 1.00)	0.15 (0.08, 0.22)
donating				0.52 (0.37, 0.75)	0.40 (-0.93, 1.00)	0.13 (0.06, 0.19)
voting	0.39 (0.09, 0.82)	0.32 (-1.00, 1.00)	0.03 (-0.04, 0.11)	0.29 (-0.02, 0.65)	1.00 (-1.00, 1.00)	0.11 (0.04, 0.18)
	$\%r_g$	$\%r_c$	$\%r_e$	$\%r_g$	$\%r_c$	$\%r_e$
civic engagement	0.97 (0.34, 1.61)	-0.06 (-0.66, 0.53)	0.09 (-0.04, 0.22)	0.70 (0.41, 0.83)	0.00 (-0.09, 0.25)	0.30 (0.19, 0.42)
volunteering				0.69 (0.28, 0.86)	0.00 (-0.12, 0.35)	0.31 (0.18, 0.46)
donating				0.71 (0.43, 0.90)	0.00 (-0.13, 0.23)	0.29 (0.14, 0.44)
voting	0.64 (0.14, 1.17)	0.32 (-0.19, 0.78)	0.05 (-0.06, 0.15)	0.57 (-0.02, 1.10)	0.10 (-0.34, 0.61)	0.33 (0.13, 0.54)

There are a few limitations to our study. Though we have applied standard methodology, it is well known that the assumptions needed to identify a twin model are quite strong, especially the equal environments assumption (EEA). A violation of the EEA leads to an upward bias in heritability and a downward bias in common environment estimates.¹³ It is important to point out that our heritability estimates, like any other descriptive statistic, are specific to the time and population on which they are based.¹⁴ Therefore, we urge caution when extrapolating to other situations since the relative contribution of genetic factors is likely to be influenced by the prevailing setting.

8. Conclusion

Political science, and the broader social science in which it is situated, has long viewed voting as a principal act of engaged citizens. As a result, it has often assumed that other acts of civic engagement follow from the same values or traits as does voting. Our results suggest that this is largely not the case. Instead, while the sources of voting are deeply seated within individuals, they are not principally the same sources that drive individuals to donate time or money.

This is doubly important given the current nature of political engagement. While voter turnout is in decline around the world [66], and especially among young people [67], there is evidence of a newly engaged generation substituting in other forms of civic engagement. For example, pundits have noted that the generation of Americans who came of age in the post-9/11 world may express more interest in non-political forms of civic engagement, such as volunteering their time [68]. Such changes may only be accelerated by changes both in the nature of politics and the means to engage in voting, donating money and volunteering. For example, changes in election finance law, paired with technological change facilitating political and charitable contributions, have led to record

high levels of donation in political campaigns in the United States¹⁵ as well as rapid fire charitable responses to international crises [69]. Changing technologies create new forms of political behaviour and civic activism that did not exist before the rise of the Internet and social media. While there are reasons to think that changing technologies may lower the costs of collective action, concerns over the rise of 'slacktivism' [70] suggest that we pay attention to the factors that affect when people are willing to take costly action. Most importantly, our results suggest that different personality traits underlie different forms of participation (see also [71]). By logical extension, different people are drawn into civic engagement depending on the properties of the action.

Humans can and do overcome collective action problems, as evidenced by the millions of people who are civically engaged both within and outside the electoral realm. Our findings suggest that the factors that explain such engagement are not only social, but also find root in individuals' genes and their personalities. Our findings also underline the importance of understanding civic engagement behaviours as sometimes unique from one other, while at the same time suggesting that a fruitful way forward in understanding the conditions that make collective action most likely to be successful is to focus on the relationship between the traits that make some people more likely to engage in particular civic acts. If we can understand the commonalities and differences motivating some behaviours over others, we can adjust our institutions to better facilitate civic engagement as broadly as possible.

Ethics. Our study makes use of data from the Minnesota Center for Twin and Family Research. For details on ethics protocols, see [33].

Competing interests. We declare we have no competing interests.

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Endnotes

- ¹Even with increases in advance and postal voting [28], it is still the case that voting occurs infrequently.
- ²For a more detailed description of both the MTF5 study, see Iacono *et al.* [33].
- ³These specific subtests were chosen because they are highly correlated (more than 0.90) with the overall measure of IQ based on all of the WAIS subtests [38].
- ⁴The Cronbach alpha for the three items is 0.58. The eigenvalue associated with the first dimension was 1.68, accounting for 55.8% of the overall variance and the eigenvalues for the remaining dimensions were less than 1. The variance of the score corresponds to the eigenvalue of the first principal component.
- ⁵We note that previous work is conflicted on the relationship between extraversion and voting. Gerber *et al.* [41] report a significant positive relationship between extraversion and turnout, and Dawes *et al.* [7] found a significant genetic correlation between voting and extraversion; however Mondak *et al.* [42] report an insignificant relationship between extraversion and voting.
- ⁶It should be noted that Mondak *et al.* [42] do not find a significant relationship between turnout and conscientiousness. They do find, however, a significant relationship between emotional stability and turnout, but of the opposite sign. See Gerber *et al.* [44] for a discussion of why the two studies may have reached different conclusions.
- ⁷All reported analyses are conducted on complete twin pairs with non-missing data for all three measures of civic engagement. We first estimated bootstrapped correlations for MZ and DZ twins to test the hypothesis that the MZ correlation is higher than the DZ correlation. The results are reported in the electronic supplementary material, appendix table 2. All twin models are estimated using

the Mx software package [52] and include controls for gender and age.

⁸We ran sex limitation models which assume sex-specific variance components. In each case, we could not statistically reject a pooled model in favour of a sex limitation model. Model-fit statistics for the pooled and sex limitation models are reported in the electronic supplementary material, appendix table 2. Estimates from both models are presented in the appendix table 3. Based on the univariate results we only estimate pooled bivariate models.

⁹It is important to clarify the difference between the common environment and the unshared environment in the twin model. Strictly speaking the common environment (and unshared environment) is defined by its effects. It is due to all environmental factors that make children who grow up together phenotypically similar. They can share an experience, for example parent divorce, but if they react to it differently it is a non-shared environmental effect.

¹⁰We denote the genetic correlation as r_g , the common environment correlation as r_c and the unique environment correlation as r_e .

¹¹The genetic correlation, without incorporating the extent to which the two traits are heritable, only tells part of the story. For example, the same genes may be influencing two traits, but these genes may not account for very much of the variation in each of the traits.

¹²This genetic variation is probably an important component of the subsequent physiological and hormonal mechanisms that facilitate cooperation [62].

¹³New analytical tools have also recently been developed that rely on direct measures of genetic relatedness, and thus do not rely on the EEA, to estimate heritability [63–65].

¹⁴For a more detailed discussion of the concept of heritability, see Hatemi *et al.* [26].

¹⁵Center for Responsive Politics, <https://www.opensecrets.org/>.

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