The Genetics of Political Participation, Civic Duty, and Political Efficacy across Cultures: Denmark and the United States.

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Abstract

Recent studies have shown that variation in political attitudes and participation can be attributed to both genes and the environment. This finding begs the question of *why* genes matter to participation, and by which pathways. Two hypotheses suggest that feelings of civic duty and sense of political efficacy intermediate the relationship between genes and political participation and, thus, that these traits have a common heritable component. If so, how robust are the relationships across cultural contexts? Utilizing two new twin studies on political traits, one in Denmark and one in the United States, we show that the heritability of political participation and political efficacy is remarkably similar across cultures. Moreover, the majority of the correlation between efficacy and political participation is accounted for by a common underlying genetic component.

Introduction

One of the fundamental questions challenging political scientists is why some people decide to participate in democratic politics. Recently, genetic factors have been proposed to have a critical role in participation. Fowler, Baker and Dawes' (2008) study of voting behavior found that heritability accounts for a large proportion of the variation in turnout and in political participation more generally. These findings have important implications for the study of political behavior, which has traditionally ignored biological factors and focused almost exclusively on the environment. But they also raise two important issues, which we address in this paper. First, to what extent is the heritability of political participation culturally conditioned? So far genetic influences on political participation have only been explored in the United States. Second, is the genetic influence on participation specific to itself or is there an underlying latent genetic disposition that mutually influences participation and its best known correlates, such as sense of civic duty or political efficacy?

In this paper we address the cross-cultural robustness of the heritability of political participation by examining the genetic influence on political participation in Denmark and the US. As a small, homogenous and egalitarian society, Denmark offers a social and political context that differs in important ways from the United States. The paper also contributes to the discussion about which mechanisms link genes and political behavior. The present paper takes another step in this debate by examining the extent to which the genetic component of political participation is associated with an individual's sense of civic duty or political efficacy. Scholars have noted that civic duty and political efficacy are important determinants of voter turnout (see Riker and Ordeshook, 1968; Aldrich, 1993) as well as political participation more broadly (Verba, Schlozman, and Brady, 1993, 1995); and given the growing body of evidence showing genetic influences on pro-social behaviors, which include larger personality traits which encompass efficacy and civic duty (Bouchard and McGue 2003) , it seems plausible that variation in feelings of civic duty or political efficacy may mediate the relationship between genes and political participation, or at least share a common genetic factor.

The paper proceeds as follows. First, we briefly review the literature on pro-social behavior and its relationship to civic duty, political efficacy, and political participation. In doing so we discuss how these traits are related and why they may be genetically influenced. We then consider why we might

expect civic duty, efficacy and political participation to be influenced by a common genetic factor. Next we discuss why comparing the Danish and the American cases are instructive when evaluating the heritability of political participation. The subsequent sections present the twin study methodology and the details of the two twin surveys which provide the data for the analysis. We then present univariate ACE models with political participation, efficacy and, for Denmark, civic duty. Finding strong evidence that political participation and political efficacy have large heritable components across cultural contexts, we then show that most of the correlation between these two traits can be accounted for by a common, underlying genetic factor.

The Genetics of Political Participation, Efficacy and Civic Duty

There is great variance in who participates and who does not. However, the distribution of participation across individuals is not random. Rather, different participatory types are identified (Weber and Murnighan, 2008). Why these types persist remains largely unknown. In the following paragraphs we focus on whether individual differences in participation can be attributed to heritable factors.

A persistent puzzle in the literature on political behavior is why people turn out to vote at all, given that the probability that one vote will have an impact on the election outcome is infinitely small (Downs, 1957; Aldrich, 1993). That is, the cost of participating in an election, or indeed in politics more generally is likely to far outweigh any potential benefits in terms of actual influence on policy outcomes. To solve this "paradox of voting" scholars have suggested that citizens gain additional benefit from the satisfaction of fulfilling a civic duty (see Riker and Ordeshook, 1968; Ferejohn and Fiorina, 1974; Fiorina, 1976). In their classic account of *The Civic Culture*, Almond and Verba (1963) argue for a strong link between civic and democratic values and political participation (cf. also Knack, 1992; Rosenstone and Hansen, 1993). Alternatively, people who believe that voting and participating in politics make a difference are also more likely to partake in politics (Aldrich, 1993: 271-72; Verba, Schlozman, and Brady, 1993: 473). People who have a strong sense of political efficacy believe that government is responsive to their demands and needs or that participating in politics makes a

difference in the political process and, therefore, are more likely to participate in politics (Anderson, 2010).

In their seminal paper "A Theory of the Calculus of Voting," Riker and Ordeshook argued that the decision to vote could be modeled by a simple equation (1968: 25-28). We extend their argument and suggest that the decision to participate in politics more generally can be expressed by the very same equation:

$$R = P(B) - C + D,$$

where R is the reward an individual voter receives from participating. B is the differential instrumental benefit an individual receives if the political outcome to which he contributes is realized rather than the alternative(s). P is the probability that the citizen's contribution will bring about the benefit. C is the cost to the individual of participating in politics (for simplicity we assume C is constant). The D in the equation is the non-instrumental, intrinsic benefits from participating in politics.

P expresses the likelihood that the individual's contribution is decisive for bringing about B. In voting it is the probability that an individual's vote will be decisive for the election of his preferred candidate over his less preferred candidate. Thinking in terms of political participation more broadly, it is the probability that, for example, taking part in a political meeting, signing a petition, or contacting a politician will change the outcome in your favored direction. The P term includes political efficacy. Believing that political authorities will be responsive to your demands *ceteris paribus* increases the likelihood that you will be politically active for instrumental purposes. Several studies show that political efficacy correlates positively with political participation (Craig, Niemi, and Silver, 1990; Niemi, Craig, and Mattei, 1991; Verba, Schlozman, and Brady, 1995; Anderson, 2010).

Non-instrumental or expressive value (D) can be informed by the desire to flag partisan loyalty or social gratification, but it can also be related to an ethic of voting and a strong sense of civic duty (Riker and Ordeshook, 1968: 28; Fiorina, 1976). Political participation includes a number of more demanding and time-consuming activities than voting, such as taking part in rallies and political campaigns, making donations, etc. Arguably, these activities are also more rewarding in expressive

terms. Citizens who have a pronounced sense of civic duty may therefore be individuals with a strong taste/preference for political action (Aldrich, 1993: 258).

Evidence suggests that civic values are passed from one generation to another. This is commonly interpreted primarily as a result of early in life socialization and social learning, (see e.g. Krause et al., 1970; Plutzer, 2002). Still, the degree to which people believe in "doing one's duty as a citizen participant" (Krause et al., 1970: 383) may also be genetically influenced since we know that pro-social attitudes and behaviors are heritable (e.g. Sturgis et al., 2010; Eaves et al., 2008), and appear to be genetically related to personality traits (Scherner, 2011). Sense of political efficacy is related to social resources and communicative skills (Verba, Schlozman, and Brady, 1993: 473), but sense of efficacy is also connected to psychological traits and cognitive ability, which have proven to be highly heritable (Bouchard and McGue, 2003; cf. Mondak et al., 2010).

A long established literature has identified genetic influences on social and political attitudes (Bouchard et al., 2003; Martin et al., 1986). These findings have only recently entered the political science literature (Alford, Funk and Hibbing, 2005, 2008; cf. Hatemi et al., 2010), but in doing so have been expanded greatly. Genetic disposition has been shown to influence individual differences in tolerance (Eaves and Hatemi, 2008), social trust (Sturgis et al., 2010), political violence (Hatemi and McDermott, 2012) and many other politically relevant social and religious attitudes (for a review see Hatemi et al., 2011). Specifically important to political participation, there is a growing body of evidence that "pro-social behaviors" such as volunteering and religious activities, are influenced by genetic disposition (as well as the social environment) (D'Onofrio et al., 1999; Eaves et al., 2008; Son and Wilson, 2010; Scherner et al., 2011).

Political participation has also been found to be transmitted from parent to child by both social and genetic mechanisms. Fowler, Baker and Dawes (2008) find that individual differences in turnout and political participation are accounted for largely by genetic factors, up to .6. However, until now, Fowler et al remained the only study which explicitly focused on participation and called for more study in this area. Indeed, Fowler et al (2011: 210) argue that participating in politics is part of a greater individually-based propensity to participate in collective actions and they point to various mechanisms such as patience and to social preferences as possible mechanisms linking individual

differences to participation rates. Importantly, univariate heritability estimates such as those noted above, potentially contain the additive genetic influence of all covariates as well. And sense of civic duty and political efficacy, which are among the most important correlates of participation, have not yet been studied individually or in conjunction with participation. Given the body of evidence showing that most pro-social traits are genetically influenced, it seems reasonable that sense of civic duty and political efficacy are also partially heritable, and furthermore that the same heritability which accounts for variation in citizens' proclivity to be politically active may also be found in civic duty and political efficacy. Indeed, Fowler et al suggest that political efficacy is "an obvious place to start" looking for a genetically based account for individual variation in political participation (2008: 244). They also argue that "a fruitful avenue for future research is to study whether or not variation in feelings of civic duty *intermediate* the relationship between genes and political participation".

Here we undertake such an exploration of civic duty and political efficacy in their relationship with political participation. Before describing the details of the Danish and Minnesota twin studies, we first discuss why comparing the heritability of political participation in Denmark and the US offers additional advantages.

Cultural Context and the Heritability of Political Participation

We compare the heritability of political participation in Denmark and a recent US sample taken during the same time as the Danish study. Among the western, developed, democratic countries in the world, the US and Denmark are most different in a number of important respects (see Table 1). The US is a rich, large and culturally and ethnically heterogeneous country; Denmark is small and homogeneous. Denmark has one of the largest public sectors and welfare states in the world, and the highest level of income equality. Compared to other OECD countries, the American welfare state and public sector are very small, and income equality is one of the lowest in the developed world, on par with Uganda. As Table 1 also shows, the level of political participation, political efficacy and, to a lesser extent, civic duty is fairly similar across the two countries.

[TABLE 1 ABOUT HERE]

How these cross-country social and cultural differences relate to the heritability of political participation is not easy to predict. However, if variation in participation in general has a heritable component, we should see this across cultures. By adopting a most different systems design (Przewroski and Teune, 1970), which maximizes the likelihood that whatever similar relationships we find across contexts can be generalized to other, less different systems, we can test if, indeed, the individual differences in political participation are generalizable to western democracies. Not only are the two countries very different, but the two twin samples are also comprised of different age cohorts as we detail below. Thus if we find heritable estimates of similar sizes in the two samples we can provide *prima facie* evidence that while mean differences in expression of participation across countries may be culturally conditioned, individual differences in participating in politics within each country is attributable to both environmental and genetic factors.

Twin Methodology

We use the classic univariate twin design to estimate the genetic and environmental influence on political efficacy, civic duty and political participation in Danish and American populations (data described in detail below). We then employ a Cholesky decomposition to examine the nature of the relationship between participation and its correlates. That is, we partition the correlation between political efficacy, civic duty and political participation into genetic and environmental co-variation.

The classic univariate twin design (Neale and Cardon, 1992) is a powerful tool to partition the relative contribution of heritable and environmental factors on an observed behavioral trait. It is based upon a naturally occurring experiment; on average dizygotic (DZ) twins share 50 percent of their discriminating genes whereas monozygotic (MZ) twins share all their genes. Comparing co-variances between MZ and DZ twin pairs, raised in the same home environment, makes it possible to assess the extent to which variance in a phenotype – the behavioral trait under investigation - can be attributed to genetic and environmental factors. According to the model, variance in a phenotype can be partially attributed to an additive genetic factor, labeled A; environmental factors shared by the twins, labeled C; and an E component which denotes the unique environmental factors to which a twin has been

exposed. This univariate ACE model is our starting point in the analysis.[1] Its three components can be estimated using three observed statistics (see Medland and Hatemi, 2009 for a full description):

$$\sigma^2_P = \sigma^2_A + \sigma^2_C + \sigma^2_E$$

$$COV_{MZ} = \sigma^2_A + \sigma^2_C$$

$$COV_{DZ} = 1/2\ \sigma^2_A + \sigma^2_C$$

where σ^2_P is the observed phenotypic variance, COV_{MZ} and COV_{DZ} the observed co-variances for MZ and DZ twins, and σ^2_A, σ^2_C, σ^2_E the variance components for the genetic factor (A) and the factors for the common (C) and the unique environment (E). As a first approximation when MZ co-twin correlations are substantially greater than DZ co-twin correlations, genetic influences are suspected.

Conventionally, the C component in the ACE model has been understood to capture the common environment to which both twins have been exposed. For example, MZ and DZ co-twins are equally exposed to the family home environment, share the same school, and have the same access to resources. The E component is the unique or unshared environment to which each twin is uniquely exposed, for example one twin spending time with separate groups of friends, one twin having a different math teacher, etc. The E component also includes error, suggesting that interpretation of this term should be conservative. The C and E in ACE models include all environmental factors but are different in the extent to which twins are exposed to *and* influenced by the same environment (C) or not (E). For instance, two twins being exposed to, but not influenced by, some similar environmental factor would increase E and not C.

The univariate model can be modified or reduced to accommodate a number of multivariate extensions (see Medland and Hatemi,2009). The saturated bivariate Cholesky decomposition

[1] The full model includes a D term, called "genetic dominance" or non-additive genetic effects, yielding an ACDE model. However, the C and the D component cannot be estimated simultaneously in a model with only with twin pairs (see Hatemi et al. 2007: 440). In the analyses we have fitted both ACE and ADE models (along with simpler models). In all cases the traditional ACE model outperformed the ADE models.

calculates the extent to which additive genetic (A), common environmental (C), and unique environmental (E) factors in the first trait entered in the model accounts for the variance in the second or dependent trait. The residual variances for each latent ACE factor that remain are unique to the second trait in the model (Loehlin, 1996: 66). Depending on the logic underlying the sequence in which variables are considered the initial solution can be transformed to a number of other models that are more suitable and easy to interpret.

In our model, we have a strong theoretical reason to order the factors included in the Cholesky decomposition. In most models of behavior, civic duty and political efficacy are seen as predictors of political participation (e.g. Verba et al., 1995). Thus, we enter political participation as the last or second trait in the model, thus ensuring that all of the variance participation shares with civic duty and political efficacy are accounted for and the residual is attributed to participation alone. In our "correlated factors model," the shared A, C, and E across the traits are given as correlation coefficients. The results can be interpreted as the extent to which the genetic factor explaining variance in the phenotypes we explore – civic duty, efficacy and political participation – is shared or independent of each other.

The classic twin study design rests on a number of theoretical and statistical assumptions and limitations (Neale and Cardon, 1992). We discuss the two most prominent ones here. The assumption that has received the most attention is the so-called equal environment assumption (EEA), which says that the shared environment influences MZ twins and DZ twins to the same extent. Critics of the twin methodology argue that MZ twins are more likely to be treated more similarly than their DZ counterparts, since they look more alike and therefore evoke more similar social responses from their environments (and from each other) (Medland and Hatemi, 2009: 198-99). It is therefore possible that the higher concordance on a given phenotype by MZ twins is due to systematically different socialization across MZ and DZ twins and not heritable factors (Charney, 2008). According to this argument, we cannot safely assume that the A component in the ACE model is only a result of heritability. A great deal of research has focused on this assumption and has found that MZ twins are treated more similarly in childhood than DZ twins in certain aspects, such as dress, sharing a room, and hair styles (Kendler et al., 1987). However, the real question is whether similarities in the social

environment would influence the specific traits of interest. The use of twin and kinship models is quite new to socio-political traits; fortunately, three studies have already explored the validity of the EEA. One study, by Hatemi et al. (2010), utilized a large set of extended kinships (parents, spouses, in-laws, non twin siblings, and twin siblings) and found that there was no difference between twin-specific and non-twin sibling environment regarding ideology and attitudes. Another study, by Smith et al. (forthcoming), specifically tested the import of childhood similarity items (contact, room sharing, friends, dress style, etc.) and found they had no effect on attitudinal, ideological, partisanship similarity. However, the strongest evidence provided so far that MZ and DZ co-twins are equally influenced by their common environments for political traits was presented by Hatemi et al. (2009b). Their longitudinal study of MZ and DZ twin pairs aged 9-18 provided evidence that co-twin correlations for political preferences were almost exactly the same by zygosity type throughout childhood. However, once twins left home, DZ co-twin correlations dropped. That is, the home environment was responsible for keeping DZ co-twin pairs more similar during their upbringing but not after, which is exactly the opposite finding required to support an equal environments violation. In summary, the literature provides strong evidence that the EEA assumption is valid for political traits.

The second limitation often attributed to twin studies is that the results may be population or sample specific and require multiple studies for generalization. This limitation is well founded, as twin samples by their very nature are not random. Here we address this limitation by comparing the results of two new twin studies taken from two rather diverse contexts: one in the US with respondents aged 53-61 and a sister study in Denmark with respondents aged 19-39. Both studies were conducted during the same time frame and some of the themes were designed to make comparison possible.

Despite the criticism leveled against the classic twin design, twin studies have proven to be an invaluable tool for examining the influence of genetic factors on attitudes and behavior in the sciences and have led to important discoveries in biology, psychology and medicine (Hatemi and McDermott, 2011). Equally, this method is a promising tool for political scientists seeking to discover the potential heritability of variation in basic political attitudes and behaviors.

Data and Measures

The Danish study was conducted by the Danish Twin Registry at the University of Southern Denmark, which is one of the oldest twin registries in the world with data on more than 75,000 twin pairs born in Denmark over the last 130 years (Skytthe et al., 2002, 2006). With its focus on a full range of attitudinal and behavioral political variables, this study is the first political twin study conducted in a non-English speaking setting. The survey includes items that make direct comparisons to other twin studies possible. Furthermore, well-consolidated items have been included in the study so that comparisons to the International Social Survey Programme (ISSP), the World Values Survey (WVS), and the Danish Election Survey frameworks are possible. The study marks the first of several waves to be administered to a panel of young to middle aged Danish twins, aged 19 to 39 years.[2] Invitations to participate in this web-based survey were sent out on October 1, 2009 to 6,707 individuals and the last respondent had completed the survey on February 16, 2010. In the meantime two reminders were posted to non-respondents. The overall response rate was 54 percent (N=3,616).

The US sample was conducted as part of an NSF-funded study which relied on the Minnesota twin registry. This study was also devoted to studying a broad range of politically relevant traits, and included many of the same ISSP items as the Danish study. The sample for this study was 2,013 twins born from 1947 to 1956. The overall response rate was 67 percent (N=1,349).[3] As Table 2 shows, the Danish dataset for the present study consists of 815 twin pairs consisting of 440 MZ and 375 same sex DZ pairs, whereas the American set includes 355 MZ pairs and 240 same sex DZ pairs. In both samples women are somewhat overrepresented.

[TABLE 2 ABOUT HERE]

We have conducted analyses of mean and variances of the traits we are studying in order to investigate if there are differences between MZ and DZ twins, between male and female twin pairs and between various age groups. In the Danish sample, we find no significant differences between the two groups, implying that the assumption of homogeneity is met (Medland and Hatemi, 2009). In the

[2] The Danish survey, as well as an English translation of the questionnaire, is available upon request.

[3] For a full description of the Minnesota Study see Smith et al. (forthcoming).

US sample, there are certain mean differences between the sexes for certain traits, consistent with nationally representative surveys. In these cases additional steps in the structural model were required and are noted in the tables.

Our trait variables of interest in this study are individuals' level of political participation and their sense of civic duty and political efficacy. Our measure of *political participation* is an index that relies on standard survey items from the ISSP.[4] The items have been developed to measure the extent to which people engage in the political process and have been widely used (Verba, Schlozman, and Brady, 1995). The question wording for these items is:

> Here are some different forms of political participation and social action that people can take. Please indicate for each one whether you have done it (a) within the past year, (b) in the more distant past, (c) have not done it, but might do it, (d) have not done it and would never, under any circumstances, do it.

The index includes nine items: signed a petition; boycotted or deliberately bought certain products for political, ethical or environmental reasons; taken part in a demonstration; attended a political meeting or rally; contacted or attempted to contact a politician or a civil servant to express your views; donated money for a social or a political activity; contacted or appeared in the media to express your views; joined a political internet forum or a discussion group; participated in neighborhood activities.

In the American sample five items were used to generate the participation index: attended a political meeting or rally; contributed money to a political party or candidate or to any other political cause; held any governmental office no matter how minor; communicated thoughts or requests to a government official. The response categories were "yes" or "no". In Denmark a Cronbach's alpha test for internal consistency is 0.84 and slightly lower in the US at 0.70. However both are somewhat

[4] The wording is taken from the 2004 ISSP Questionnaire on Citizenship. We rely on validated translations by the ISSP.

higher than the levels Fowler et al (2008: 242) and Verba et al (1993, 1995) report. The scales were constructed by a summated rating.

The second trait variable of interest is individuals' sense of *civic duty*. Our index on civic duty, which we have only for the Danish twins, is derived from six items that are also used by the ISSP. They are designed to measure what a respondent sees as being "important to be a good citizen". The response categories are "very important", "rather important", "a little important" and "not important at all". The question for these items is:

> There are different perceptions of what it takes to be a good citizen. As far as you are concerned personally … how important is it to: Always vote in elections; never try to evade taxes; always obey laws and regulations; to keep watch on the actions of government; to be active in social or political associations; to try to understand the reasoning of people with other opinions?"

These items have also been used extensively in the literature to investigate the linkage between the quality of democracy and the civic duty of citizens (see for example Dalton, 2008; Marien, Hooghe, and Quintelier, 2010). The Cronbach's alpha is 0.75 which is sufficient to make group comparison meaningful (Bland and Altman, 1997: 572). Again, we created a summated rating scale from 1-4.

The third and final trait variable in this paper is measured by a *political efficacy* index, which is also based on questions from the ISPSS 2004. The Danish sample uses two items: "People like me have no influence on what the government does" and "The government does not care about what people like me think." We added two items replacing "government" with "city council" to allow for differences across levels of government. The US sample included the same two questions, but in the second question "government" was replaced by "public officials". For both the US and Denmark four categories ranging from "strongly agree" to "strongly disagree" are used.

Our index on efficacy is also well behaved. Conducting a Cronbach's Alpha test on the Danish data yields a value of 0.88, while the alpha value for the American sample is 0.80.

Results

The univariate results for political participation, civic duty, and political efficacy in Denmark are given in Table 3. A simple comparison of intra-twin correlations is a first approximation of the extent

of heritability in a trait. For political participation the correlation is significantly higher ($p<0.001$) for MZ twins (0.51) than for DZ twins (0.32). This is also the case for political efficacy ($p<0.01$) where MZ twins correlate at 0.39 and DZ's at 0.24, whereas for sense of civic duty the correlation is not significantly different ($p=0.37$) for MZ (0.27) and DZ (0.21) twins. The results for the US twin sample are roughly the same. The correlations for MZ and DZ twins are 0.46 and 0.24 (significant at the 0.01 level) for political participation and 0.41 and 0.13 for efficacy (significant at the 0.001 level). We have no data for civic duty in the US sample.

Hence, as a first approximation variation in political participation and political efficacy seem to have the same level of heritability across cultures, and there seems to be little or no heritability in sense of civic duty.

[TABLE 3 AND 4 ABOUT HERE]

The ACE is the baseline against which the simpler, nested models (AE and CE models) can be compared. These models are evaluated in terms of fit and whether a parameter can be deleted without a significant change in Chi-square; if so, they provide a more parsimonious fit.

In our analysis of political participation a model which includes only the additive genetic influence and the unique environmental influence (AE) gives the best fit in both Denmark and the United States (lowest $\Delta\chi^2$ at 1.78 and 0.001 respectively, which in neither case is a significant change, with $p=0.18$ and 0.97 respectively; cf. tables 3 and 4). This indicates that in both countries the best model of political participation is one that excludes shared environmental influences (C). Fowler and associates also report an AE model in their twin study of the Add Health Sample (2008: 242).

The analysis of the potential heritability of civic duty, for which we have data only for the Danish twins, gives quite another result. The full model estimates both A and C as not significant. Reducing the model, the best fit is a CE model ($\Delta\chi^2$ at 1.08 and $p=0.30$), although an AE model ($\Delta\chi^2$ at 1.68 with $p=0.20$) has almost as good a fit as the CE model. The results suggest that at least in Denmark there is little or no heritability in citizens' sense of civic duty. Apparently civic duty is

socialized and learned, partly through shared environment (c^2: 0.24) but predominantly through unique individual experiences (e^2: 0.76).

For political efficacy an AE model again provides the best fit in both the Danish and the American twin studies. In both samples the AE models have the lowest AIC values, and reducing the ACE model to an AE model does not change χ^2 significantly (Denmark: p=0.66; the US: p=1). Indeed, in the US the estimates for C in the full model were near zero, and in the Danish sample the confidence intervals crossed the zero bound. In both contexts political efficacy thus has a significant heritable and unique environmental component, and little shared environment.

The heritability in political participation is strong in both countries. In Denmark the additive genetic component a^2 is 0.53 (CI-95%: 0.46-0.59) and the unique environment component e^2 is 0.47 (CI-95%: 0.41-0.54). The figures for the US are roughly similar with an a^2 at 0.45 and an e^2 at 0.55. In both cases the findings are similar to those of Fowler et al. (2008: 242), who show that the genetic effect, a^2, accounts for up to 0.60 of the variation in their political participation index, which is similar, but not identical to the measures used here.

In political efficacy the genetic component is almost as strong as for political participation. In Denmark a^2 is 0.41 (CI-95%: 0.32-0.48), in the US 0.38 (CI-95%: 0.30-0.46), and the remaining part of the variance is accounted for by the unique environment e^2. To our knowledge this is the first evidence suggesting that political efficacy has an important and significant heritability across quite different cultural and political contexts; however, the results are probably not that surprising for behavioral genetics and psychology. Cognitive ability, intelligence, verbal ability, and personality traits have long been recognized as moderately to strongly heritable (cf. review in Bouchard and McGue 2003); expectedly this type of factors will be correlated with individuals' sense of political efficacy.

With a moderate to strong heritability in both political participation and efficacy the question is if the genetic influence on political efficacy and political participation is partially shared; that is, do the same latent genetic or environmental factors account for the covariance between these traits? A genetically disposed sense of political efficacy may be part of the reason why political participation is also heritable.

To address this question, we employ a bivariate Cholesky decomposition which enables us to examine whether the A, C and E components in political participation and political efficacy are correlated. We present the model fit statistics of the bivariate Cholesky analysis in Tables 5 and 6. The best fitting and most parsimonious model is identified by the same procedures as in the univariate analyses, only this time we test whether correlations for *a* and *c*, or both, can be removed without significantly reducing the chi-squares. Not surprisingly, given that the univariate analyses identified AE-models as the best fitting models, the best bivariate models in both Denmark and the US are also AE models (lowest AICs and insignificant changes in χ^2).

Figure 1 and 2 show the estimates of the variance components in the best fitting models (with CI-95% in brackets). The direct A and E components in efficacy and political participation are the same as in the univariate analyses, but in addition, there is a genetic correlation between the two traits. In Denmark is r_a is 0.30 (CI-95%: 0.16-0.41), in the US 0.52 (CI-95%: 0.39-0.60). The size of the genetic correlation is somewhat higher in the American sample, possibly because the respondents in the American sample are older and the age range is severely restricted. Still, in both countries a significant part of the genetic variance is shared between political efficacy and political participation, and most of the correlation between the two traits can be accounted for by genetic co-variation rather than unique environmental factors (in both countries r_e is significantly lower than r_a).

[TABLE 5 and 6 ABOUT HERE]

Conclusion

Variation in political participation in a broad sense is heritable at remarkably similar levels in the USA and Denmark. Thus, until evidence proves otherwise, we can now assume that variation in political participation is genetically influenced in western democracies. Our first recommendation for future research is to extend the research on the heritability of political participation to non-western countries to get a more solid grasp of the reach of this conclusion.

Understanding why and how variation in political participation is partially heritable is a complex issue. Previous research has shown that people who participate more in politics tend to have a

strong sense of civic duty and political efficacy. The present study has improved our understanding of why this is the case. Although building on evidence from Denmark only, our findings suggest that whatever effect civic duty has on political participation it is *not* due to genetic factors. Socialization, acculturation and other environmental factors are still the best candidates when explaining variations in civic duty and the effect in has on political participation.

In contrast, whatever effect political efficacy has on the variation in political participation it seems to be partially driven, perhaps even predominantly, by a common genetic factor. The correlation between political efficacy and political participation share a substantial, latent genetic component and this finding generalizes across our two populations. However, it is premature to conclude that the heritable component in political efficacy should be given causal priority to the genetic component in political participation. Rather, the Cholesky decomposition only shows that a latent genetic component accounts for the majority of covariation between political efficacy and political participation. Indeed, other traits like personality and cognitive ability may equally be implicated in the same genetic factor. Our findings suggest that any candidate mechanism must be able to account for the fact that the co-variation between political efficacy and participation share a genetic component. Further research is needed to investigate more closely these possible links and pathways.

Most importantly, the findings in this paper suggest that time-honored theories of political behavior would benefit from revision. Conceptually and theoretically the field has yet to integrate behavioral models that this genetic "turn" in political science warrants. Meeting this challenge requires theorizing and developing models of when, why and how genetic factors combine with contextual inducements, situational imperatives, and individual life events to produce patterned political behavior across and within political systems. Our findings here have only begun addressing this imperative.

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Tables and Figures

Table 1: Country Differences: United States and Denmark

	United States	Denmark
Population (in millions)*	295.9	5.4
	[1]	[23]
Size of country (km^2)*	9,629,091	43,094
Wealth (GDP/capita, US$)*	45,489	35,961
	[3]	[11]
Size of government (total tax revenue/GDP)*	28%	49%
	[28]	[1]
Equality (Gini coeff.)*	0.38	0.23
	[27]	[1]
Cultural heterogeneity (foreign-born population)*	13%	6.6%
	[17]	[7]
Volunteering (last month)*	42%	20%
	[1]	[18]
Political participation index (mean)**	2.77 (0.58)	2.79 (0.65)
Civic duty index (mean)**	3.22 (0.48)	3.39 (0.48)
Political efficacy (mean)**	3,76 (1.56)	3,69 (1,39)

* *Source:* OECD Factbook, 2009. Rank order among OECD countries in square brackets.
** *Source:* International Social Survey Program, 2004: Module on Citizenship. N=1184 (US), N=1486 (Denmark). Standard deviations in brackets.

Table 2: Descriptive statistics for twin pairs

Zygosity	Female	Male	Mean age
MZ_{DK}	283	157	30.1 (5.9)
DZ_{DK}	243	132	29.0 (6.0)
MZ_{US}	213	142	56.0 (2.5)
DZ_{US}	154	86	56.0 (2.5)

Table 3: Univariate Analyses of Political Participation, Civic Duty and Efficacy, Denmark

Intraclass correlations												
		Political Participation			*Sense of Civic Duty*			*Efficacy*				
No. of MZ pairs		440			440			440				
No of DZ pairs		375			375			375				
		r [95% C.I.]		p(cov_{MZ} =cov_{DZ})	r [95% C.I.]		p(cov_{MZ} =cov_{DZ})	r [95% C.I.]			p(cov_{MZ}= cov_{DZ})	
MZ		0.51 [0.44; 0.58]		<0.001	0.27 [0.18; 0.36]		0.37	0.39 [0.30; 0.48]			<0.01	
DZ		0.32 [0.23; 0.40]			0.21 [0.11; 0.30]			0.24 [0.13; 0.35]				
Model fit												
	Vs.	AIC	$\Delta\chi^2$	Δdf	P	AIC	$\Delta\chi^2$	Δdf	p	AIC	$\Delta\chi^2$	Δdf	p
ACE		-889.293				-1379.533				87.568			
AE	ACE	**-889.931**	**1.78**	**1**	**0.18**	-1379.856	1.68	1	0.20	**85.762**	**1.94**	**1**	**.66**
CE	ACE	-878.809	12.90	1	<0.001	-1380.450	1.08	1	0.30	92.003	6.435	1	.01
E	AE	-738.265	153.67	1	<0.001					154.823	71.95	1	<.001
E	CE					-1334.720	47.73	1	<0.001				
Heritability estimates												
		a^2	**c^2**	**e^2**	**a^2**	**c^2**	**e^2**	**a^2**	**c^2**	**e^2**		
ACE		0.39 (0.18 – 0.57)	0.12 (0.00 – 0.29)	0.49 (0.42 – 0.56)	0.13 (0.00 – 0.35)	0.14 (0.00 – 0.29)	0.73 (0.64 – 0.82)	0.35 (0.08-.48)	0.05 (0.0-.27)	0.60 (0.52-0.70)		
AE		0.53 (0.46 – 0.59)	****	0.47 (0.41 – 0.54)	0.30 (0.21 – 0.37)	****	0.70 (0.63 – 0.79)	0.41 (0.32-0.48)	****	0.59 (0.52- 0.68)		
CE					****	0.24 (0.17 – 0.30)	0.76 (0.70 – 0.83)	****	0.31 (0.24-0.38)	0.69 (0.62-0.76)		

Notes: There are no significant sex differences for these traits; all participants are pooled by zygosity.

Table 4: Univariate Analyses of Political Participation and Efficacy, US

Intraclass correlations													
		Political Participation				*Civic Duty*				*Efficacy*			
No. of MZ pairs		343				*(N/A)*				348			
No of DZ pairs		230								231			
		r [95% C.I.]			p(cov_{MZ} =cov_{DZ})	r [95% C.I.]			p(cov_{MZ} =cov_{DZ})	r [95% C.I.]			p(cov_{MZ}= cov_{DZ})
MZ		0.46 [0.37;0.54]			<0.01					0.41 [0.32; 0.49]			<0.001
DZ		0.24 [0.12; 0.36]								0.13 [0.01; 0.25]			
Model fit													
	Vs.	AIC	$\Delta\chi^2$	Δdf	P	AIC	$\Delta\chi^2$	Δdf	p	AIC	$\Delta\chi^2$	Δdf	p
ACE		2010.883								1912.107			
AE	**ACE**	**2008.884**	**0.001**	**1**	**0.97**					**1910.107**	**0**	**1**	**1**
CE	ACE	2019.063	10.18	1	<.01					1921.347	11.24	1	<.001
E	AE	2097.877	90.993	1	<.001					1974.472	55.125	1	<.001
E	CE												
Heritability estimates													
		a^2	**c^2**	**e^2**		**a^2**	**c^2**	**e^2**		**a^2**	**c^2**	**e^2**	
ACE		0.44 (0.17-0.54)	0.02 (0.00-0.25)	0.54 (0.47-0.63)						0.38 (0.19-0.46)	0.00 (0.00-0.16)	0.62 (0.54-0.70)	
AE		**0.45 (0.38-0.54)**	**0**	**0.55 (0.46-0.62)**						**0.38 (0.30-.46)**	**0**	**0.62 (0.54-0.70**	
CE		0	0.36 (0.29-.43)	0.64 (0.57- 0.71)						0	0.29 (0.22-0.36)	.71 (0.64-0.77)	

Notes: Unlike Denmark, there are significant sex differences in the US regarding political attitudes and traits. For Efficacy, means and variances did not differ across sexes and all MZ and DZ correlations were pooled across sexes. However, Political Participation measures significantly differed in means across sexes (p<.01). Therefore, we did not pool MZ and DZ twins across sexes for Political Participation prior to structural modeling; rather we estimated the 4 zygosity groups (MZ Males, DZ Males, MZ females, DZ females) separately, then formally tested equating the variance components across sexes. In both cases, this could be done; for participation (4.366 chi-square for 3 d.f., p=.22) and for civic duty (2.212 chi-square for 3 d.f., p=.53).

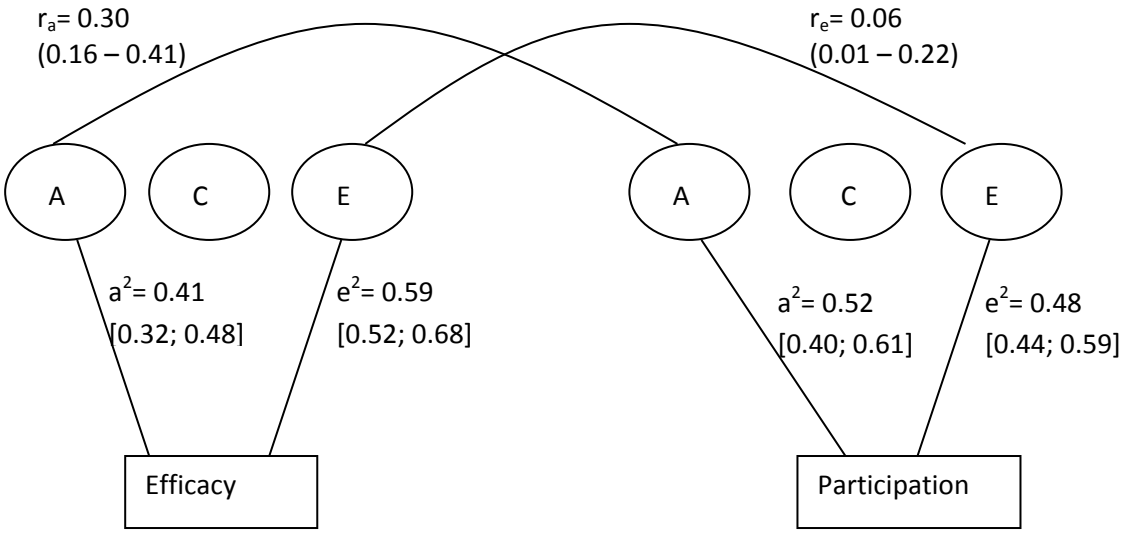
Table 5: Model Comparison, bivariate correlated factors model of political participation and efficacy, Denmark

Model fit					
	Vs.	AIC	$\Delta\chi^2$	Δdf	p
Full ACE		-668.056			
CE/CE	Full	-655.582	18.474	3	<.001
AE/AE	Full	-673.252	0.804	3	.85
E/E	AE/AE	-492.899	187.157	6	<.001

Table 6: Model Comparison, bivariate correlated factors model of political participation and efficacy, US

Model fit					
	Vs.	AIC	$\Delta\chi^2$	Δdf	p
Full ACE		3846.012			
CE/CE	Full	3857.155	17.143	3	<.001
AE/AE	Full	3840.912	0.900	3	0.83
E/E	AE/AE	3987.662	152.75	6	<.001

Figure 1: Bivariate analysis (AE model) of heritability in Efficacy and Participation, Denmark



Notes: ACE represents the additive genetic, common environment and unique environment latent factors. Ra is the genetic correlation between traits, A2 is the standardized univariate additive genetic variance for A, E2 is the standardized univariate additive genetic variance for E, Re is the genetic correlation between traits.

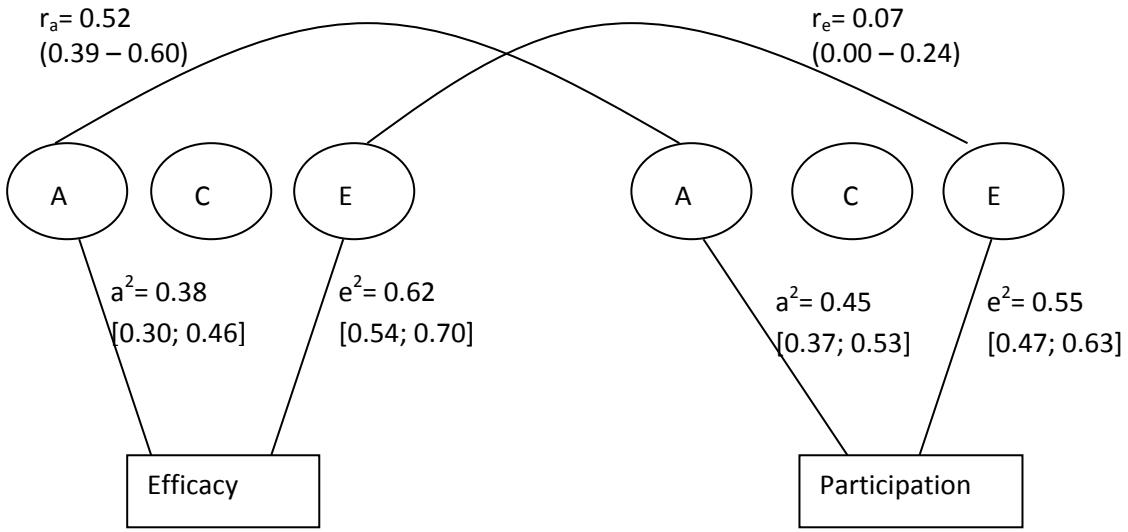


Figure 3: Bivariate analysis (AE model) of heritability in Efficacy and Participation, US
Notes: ACE represents the additive genetic, common environment and unique environment latent factors. Ra is the genetic correlation between traits, A2 is the standardized univariate additive genetic variance for A, E2 is the standardized univariate additive genetic variance for E, Re is the genetic correlation between traits.